DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

AUSTRALIAN
INTERNATIONAL DEVELOPMENT
ASSISTANCE BUREAU

BRIDGE MANAGEMENT SYSTEM

BRIDGE MANAGEMENT SYSTEM
BMS
A PROJECT JOINTLY FUNDED BY INDONESIA AND AUSTRALIA

BRIDGE INSPECTION MANUAL

FEBRUARY 1993

SMEC

SMEC - Kinhill Joint Venture

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SNOWY MOUNTAINS ENGINEERING CORPORATION LIMITED

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PART 2 - BRIDGE ELEMENTS AND DEFECTS

TABLE OF CONTENTS

PART 1 - BRIDGE INSPECTION PROCEDURES

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

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PART 1

BRIDGE INSPECTION PROCEDURES

DOCUMENT No. **BMS2-M.E**

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
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BRIDGE INSPECTION MANUAL

SECTION 1

GENERAL

FEBRUARY 1993

DOCUMENT No. **BMS2-M.E**

TABLE OF CONTENTS

1. GENERAL

1.1 INTRODUCTION

Bridges are important parts of the road system because of the consequences if they fail or if their function is impaired. Because of their strategic location over rivers or other obstacles to vehicles, the failure of a bridge may limit or restrict traffic, with consequent inconvenience to the public and economic loss to the community.

It is therefore essential that particular attention is given to *Inspection* of bridges as part of the management of the road system.

The purpose of Bridge Inspection is to ensure the safety of the public and protection of the capital investment in bridges. Inspection is the process by which data on the physical and structural condition of a bridge is collected.

Data from Bridge Inspections is used to plan maintenance, rehabilitation, strengthening and replacement of bridges.

Bridge Inspection is carried out under the *Bridge Management System (BMS)*. The BMS in this Manual means the Interurban Bridge Management System (IBMS), which relates to bridges on National and Provincial Roads.

1.2 BRIDGE MANAGEMENT SYSTEM (BMS)

The BMS has been developed by the Directorate General of Highways (DGH) to enable bridge activities to be planned, executed and monitored under an overall policy. The BMS includes all activities involved in management of bridges from inspections, planning, programming and design through to construction and maintenance.

The BMS enables these activities to be managed systematically, by providing the facility for regular inspection of bridges and by analysis of the inspection data by a computerised *Management Information System* (BMS MIS). With the assistance of the BMS MIS, the condition of bridges can be monitored and appropriate action determined to ensure their safety and serviceability, with optimum use of available funds for bridgeworks.

The overall procedures in the BMS are described in the BMS *General Procedures Manual*. A flow-chart for the BMS showing the relationship between inspection and other bridge management processes is shown in Figure 1.1.

1.2.1 BMS Management Information System (BMS MIS)

The BMS MIS contains a *database of bridges* and a suite of computer programs which allow the following :

- entry and retrieval of inspection and other data
- preparation of standard reports on bridges
- interrogation of the data base and retrieval of any combination of information
- screening and ranking of bridges and preparation of indicative treatment programs
- preparation of Annual and Five Year Programs of Bridgeworks
- case-by-case analysis of treatment strategies to determine the optimum treatment for each bridge

The BMS MIS is linked to the *Interurban Road Management System (IRMS)* by Local Area Network (LAN) in DGH, and by exchange of floppy-disk in Provinces. The BMS MIS uses traffic data, vehicle operating costs, reference data, projected traffic growth rates and other data from the IRMS, to carry out its planning and programming functions.

1.2.2 Reporting and Data Entry

The data from Bridge Inspections is reported on standard *Inspection Reports*. Copies of Inventory, Detailed and Routine Inspection Reports are shown in Appendix 1, with relevant IBMS Reports which are used as references during Inspections. IBMS Reports for use during Inspections must be produced by the BMS Supervisor as soon as possible after the Inspection program has been determined.

Inspection reports are submitted to the *BMS Supervisor* in each Province. The BMS Supervisor arranges for the data to be entered into the BMS *Bridge Database*. This should be carried out within two weeks of the inspection.

Prior to entering the data into the computer, the reports are temporarily held in the Bridge Inspection *Holding File* in the BMS Office.

After the data is entered into the computer, the reports are filed in the manual *Data File* for the particular bridge. The manual Data Files contain not only the inspection reports, but also design calculations, construction reports and photographs, and all other documentation which cannot be stored in the BMS Bridge Database.

Bridge Data Files and an overall Bridge Database are maintained by DGH for all Bridges on National and Provincial Roads in Indonesia. Each Province maintains Data Files and a computerised Database for its own bridges. A floppy-disk containing the latest Bridge Database is sent each month from Provinces to the Directorate of Planning (BIPRAN) in DGH so that the overall Database can be updated.

1.3 BRIDGE INSPECTION

Bridge inspection is one of the most important components of the BMS. It is an essential link between the operation of existing bridges and planning for future maintenance or upgrading.

The objective of bridge inspection is to assist to ensure that a bridge is able to function in safety and that appropriate action is taken to maintain and repair the bridge on a timely basis.

Thus bridge inspection has the following specific objectives :

- to check safety of the bridge under operating conditions
- to prevent the need for closure of the bridge
- to record the present condition of the bridge
- to provide feedback to design, construction and maintenance personnel
- to check the effects of vehicle loads and traffic volumes
- to monitor the long term performance of the bridge
- to provide information for load rating the bridge

Inspection should commence when a bridge is new and continue throughout its service life. It is important that the data collected is up-to-date, accurate and complete so that the output of the BMS MIS is reliable.

Inspections collect the following data for each bridge :

- administrative details such as bridge name, Province, Cabang, bridge number and year of construction.
- overall dimensions such as total length and number of spans
- dimensions, type of construction, and condition of the major components of each span and of individual bridge elements
- other data

Data is collected through various types of inspection which differ in scale or intensity, frequency and by virtue of the elements or details inspected.

The main types of inspection carried out under the BMS are as follows :

- *Inventory Inspections*
- *Detailed Inspections*
- *Routine Inspections*

In addition, *Special Inspections* are carried out under some circumstances.

1.3.3 Routine Inspections

Routine Inspections are carried out annually to check the effectiveness of routine maintenance and whether emergency action or repairs are necessary to maintain the bridge in a safe and serviceable condition. They serve as intermediate checks between Detailed Inspections.

Routine Inspections are carried out by trained inspectors from Cabang Dinas Bina Marga.

1.3.4 Special Inspections

Special Inspections are requested by an inspector during a Detailed Inspection if he lacks the resources, training or experience to confidently assess the condition of a bridge. Special Inspections can also be initiated by the BMS MIS during the Screening process.

Special Inspections are carried out by qualified and experienced Bridge Engineers or technical staff qualified in relevant disciplines.

1.4 BRIDGE INSPECTORS

To undertake bridge inspections, it is essential that properly trained and experienced inspectors are available.

A planned and on-going training programme for bridge inspectors is necessary, so that inspectors can acquire, maintain and upgrade the necessary skills for bridge inspection, and so that a high standard of reporting can be maintained.

Responsibility for appointment of inspectors and carrying out bridge inspections lies with Dinas Bina Marga and sub-Dinas Bina Marga in Provinces.

1.4.1 Co-ordination of Bridge Inspections

The Sub-Directorate of Bridge Design in the Directorate of Planning in DGH is responsible for the overall inspection programme, further development of inspection procedures, setting up training programmes for inspectors, and for testing and accreditation of bridge inspectors.

These hazards can be alleviated to a great extent by simple precautions such as :

- use of signs, barricades and traffic controllers, to slow the traffic and direct it safely around the activity on the bridge
- wearing high visibility safety vests
- use of safety harnesses, sturdy ladders, and special scaffolding when access to high or difficult locations is required
- use of boats, flotation vests and tether lines when working in swiftly-flowing streams
- checking for snakes, spiders and animals before accessing confined spaces especially under the bridge
- ensuring adequate assistance and the proper equipment is available at all times

1.5 BRIDGE INSPECTION MANUAL

The *Bridge Inspection Manual* describes procedures for carrying out the various inspections in the BMS. In addition, the Manual provides information about bridge elements and defects, for the guidance and training of inspectors.

The Manual is in two parts :

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The Manual contains a number of Appendices and Figures which are reproduced in a *Field Handbook for Bridge Inspection* for use in the field.

Appendix 4 of the Manual contains photographs of bridge types, bridge components and typical defects, and a series of photographs with condition ratings, to assist Inspectors with identification. Appendix 4 also includes photographs of situations where Emergency Action and Routine Maintenance is required.

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APPENDICES

TABLE OF CONTENTS

PART 1 - BRIDGE INSPECTION PROCEDURES

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MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

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TABLE OF CONTENTS

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The overall procedures in the BMS are described in the BMS *General Procedures Manual*. A flow-chart for the BMS showing the relationship between inspection and other bridge management processes is shown in Figure 1.1.

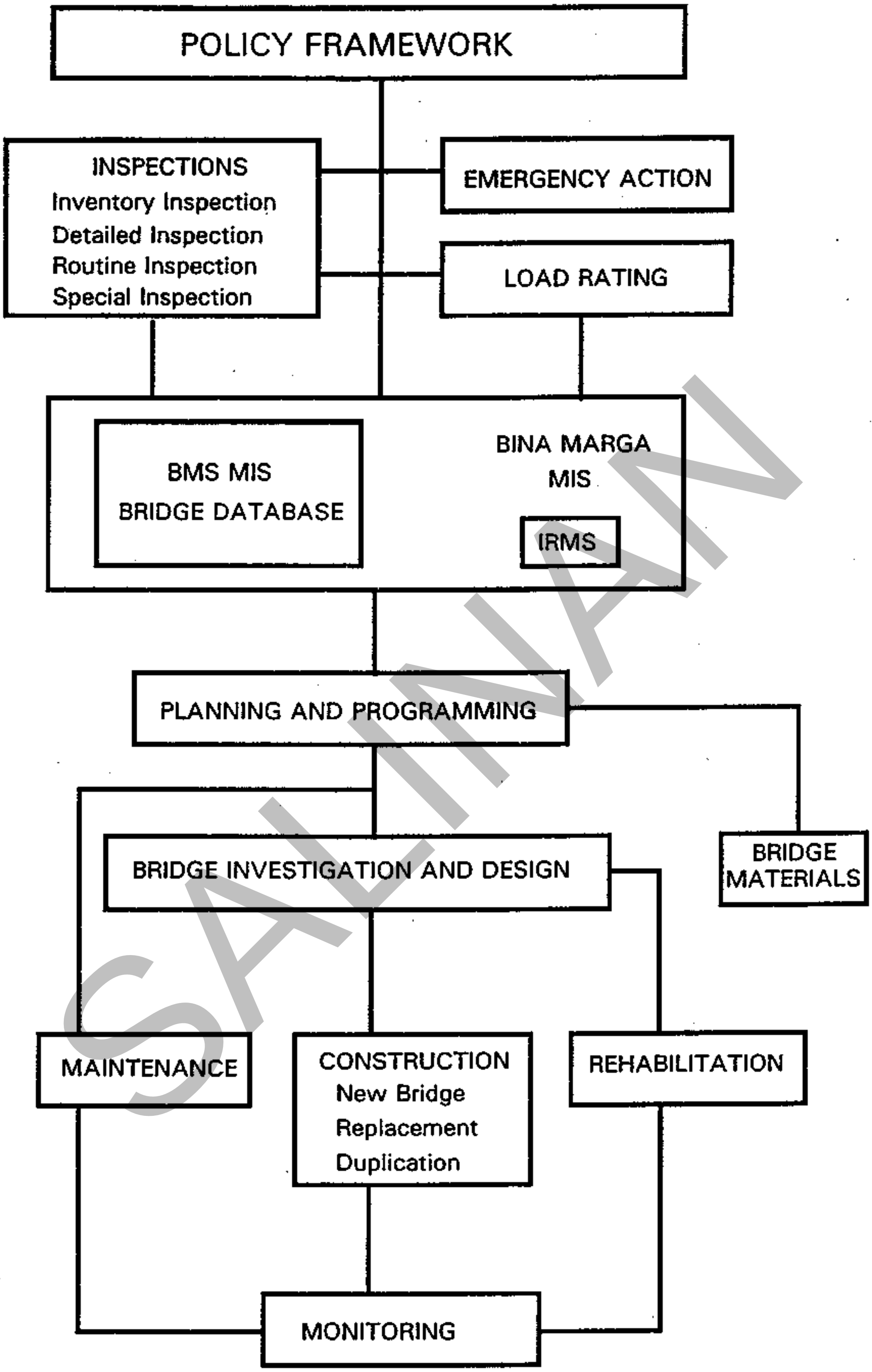

Figure 1.1 - Flow Chart of BMS Activities

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1.2.3 BMS Reports

After inspection of bridges and entry of data has been completed, updated Reports should be produced by the BMS Supervisor and given to the Chief of the Planning Section for distribution to relevant staff.

Some reports, eg. Bridge Data Reports, are of general interest to management as follows:

IBMS-BD2	-	General Bridge Data (for all bridges)
IBMS-BD3	-	Bridge Condition Summary (in tabular or graphical format)

Other reports, eg. Bridge Action Reports, are of specific interest, and list bridges where action is required, as follows :

IBMS - AR1	-	Emergency Action Report - lists bridges requiring emergency repairs or strengthening.
IBMS - AR2	-	Special Inspection Report - lists bridges referred by the Inspectors for a Special Inspection.
IBMS - AR3	-	Routine Maintenance Report - lists bridges where Routine Maintenance is required to correct minor defects.

1.2.4 Screening and Technical Ranking of Bridges

One of the programs in the BMS MIS is the *Screening and Technical Ranking* module, which uses the data from inspections to recommend treatments for each bridge. The recommended treatments are proposals only and they must be checked before commitments are made to the work because the screening is extremely sensitive to data. For major work, the proposed treatment should be confirmed by a Special Inspection or another site inspection by the Planning Engineer, and for other minor work, the data should be audited to ensure its basic accuracy.

The screening process identifies bridges which are in poor condition and those which have inadequate traffic capacity or load capacity, and technically ranks them in priority order, according to these criteria and the importance of the road in the road network. Those at the top of the ranking list are those which are in greatest need of treatment.

After screening, the data can be further processed to produce economically-ranked programmes of bridge work.

Thus the data from inspections is of great importance for planning and programming, and is used to assist planners to make appropriate decisions about the work required on each bridge.

1.3 BRIDGE INSPECTION

Bridge inspection is one of the most important components of the BMS. It is an essential link between the operation of existing bridges and planning for future maintenance or upgrading.

The objective of bridge inspection is to assist to ensure that a bridge is able to function in safety and that appropriate action is taken to maintain and repair the bridge on a timely basis.

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- *Inventory Inspections*
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- *Routine Inspections*

In addition, *Special Inspections* are carried out under some circumstances.

1.3.1 Inventory Inspections

Inventory Inspections are carried out at the start of the BMS in order to register each bridge in the BMS Database. Inventory Inspections are also carried out if bridges are found which have been overlooked when the BMS Database was first established. Following construction of a new bridge, the Inventory Inspection is carried out as part of a Detailed Inspection. Rail crossings, flood crossings, culverts and sites where ferries operate are also inspected and registered.

Inventory Inspections gather basic administrative, geometric, material and other ancillary data on each bridge, including the bridge location, span length and type of construction for each span. An overall condition rating is given to the major components of the bridge superstructure and substructure.

Inventory Inspections are carried out by trained inspectors from Dinas, Sub-Dinas or Cabang Dinas Bina Marga, or by experienced bridge engineers.

1.3.2 Detailed Inspections

Detailed Inspections are carried out to assess the condition of the bridge and its elements in order to prepare treatment strategies for individual bridges and to rank bridges in terms of priority for treatment.

Detailed Inspections are carried out at least once every five years or at shorter intervals depending on the condition of the bridge. Detailed Inspections are also carried out after rehabilitation or major work on a bridge, to record new data on the bridge, and after construction of a new bridge, to register it in the BMS and record other data in Detailed Inspection format.

For the purpose of Detailed Inspections, the structure of a bridge is divided into a hierarchy of elements. The hierarchy contains 5 Levels of Elements. The highest level is Level 1, which contains only the bridge itself and the lowest level is Level 5 which refers to individual elements such as stream bank, pile and diaphragm etc.

Detailed Inspections record all significant defects or damage to elements of the bridge, and assign a Condition Mark to individual elements, to groups of elements and to the major components of the bridge. A single Condition Mark for the bridge as a whole is derived from the Condition Marks for the elements of the bridge.

Detailed Inspections are carried out by certified BMS Bridge Inspectors from Dinas or sub-Dinas Bina Marga, assisted by Cabang Staff if necessary.

1.3.3 Routine Inspections

Routine Inspections are carried out annually to check the effectiveness of routine maintenance and whether emergency action or repairs are necessary to maintain the bridge in a safe and serviceable condition. They serve as intermediate checks between Detailed Inspections.

Routine Inspections are carried out by trained inspectors from Cabang Dinas Bina Marga.

1.3.4 Special Inspections

Special Inspections are requested by an inspector during a Detailed Inspection if he lacks the resources, training or experience to confidently assess the condition of a bridge. Special Inspections can also be initiated by the BMS MIS during the Screening process.

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To undertake bridge inspections, it is essential that properly trained and experienced inspectors are available.

A planned and on-going training programme for bridge inspectors is necessary, so that inspectors can acquire, maintain and upgrade the necessary skills for bridge inspection, and so that a high standard of reporting can be maintained.

Responsibility for appointment of inspectors and carrying out bridge inspections lies with Dinas Bina Marga and sub-Dinas Bina Marga in Provinces.

1.4.1 Co-ordination of Bridge Inspections

The Sub-Directorate of Bridge Design in the Directorate of Planning in DGH is responsible for the overall inspection programme, further development of inspection procedures, setting up training programmes for inspectors, and for testing and accreditation of bridge inspectors.

1.4.2 Provincial Bridge Inspectors

Bridge Inspectors in Provinces are responsible to the Chief of the Planning Section in Dinas or sub-Dinas Bina Marga, through the BMS Supervisor. At least two certified Bridge Inspectors should be appointed in each Province.

Bridge Inspectors can be graduate engineers but the minimum qualification necessary is a B.E. in Civil Engineering. Generally, at least 5 years experience in bridge related activities is considered essential.

The duties of Bridge Inspectors are as follows :

- to assist in preparing the inspection program
- to organise and carry out all types of bridge inspection
- to enter or supervise entry of data into the BMS computer and BMS Data files
- to liaise with Cabang Bina Marga in preparation of inspection programs and conduct of inspections
- to train Cabang Bina Marga and Kabupaten Public Works (DPUK) Staff in inspection procedures
- to maintain the BMS inspection vehicle and inspection equipment in good condition

1.4.3 Inspectors and Safety

When carrying out bridge inspections, inspectors have two basic responsibilities in respect of safety :

- the safety of the public, and
- their own safety

It is essential that adequate safety precautions are taken to minimise the danger and inconvenience to the public.

This involves the use of adequate warning signs and barricades, or the presence of traffic controllers to direct traffic and pedestrians if necessary. Vehicles and bystanders, especially children, should be kept away.

Inspection of bridges often exposes inspectors to hazardous conditions such as heavy traffic, difficult access, swift currents, and animals and reptiles.

These hazards can be alleviated to a great extent by simple precautions such as :

- use of signs, barricades and traffic controllers, to slow the traffic and direct it safely around the activity on the bridge
- wearing high visibility safety vests
- use of safety harnesses, sturdy ladders, and special scaffolding when access to high or difficult locations is required
- use of boats, flotation vests and tether lines when working in swiftly-flowing streams
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BRIDGE INSPECTION MANUAL

SECTION 2

SCOPE OF INSPECTIONS

FEBRUARY 1993

DOCUMENT No. BMS2-M.E

TABLE OF CONTENTS

2. SCOPE OF INSPECTIONS

2.1 GENERAL

Bridge Inspections are conducted using standard procedures, so that the inspection is efficient and thorough, and so that the condition of bridges is assessed uniformly.

The procedures ensure that :

- administrative data is complete and accurate
- all components and elements of the bridge including the approaches, waterway, superstructure and substructure are inspected and their condition assessed.
- all defects are observed and those which are significant or which require emergency action are recorded

All previously recorded defects should be reinspected to monitor the current state of the defects or to check that any previous treatment has been effective.

2.2 BASIC PROCEDURES

Bridges consist of a large number of *elements* which interact with each other and the environment. Their behaviour is complex, but for the purpose of inspections, the elements can be grouped into a number of *main components* as follows :

- *Waterway/Embankment* consisting of the stream itself, embankments and river training works (eg scour protection)
- *Superstructure* consisting of the support structures, deck and running surface, joints, bearings, railings and furniture
- *Substructure* consisting of the foundations, abutments and piers

These main components and major elements must be inspected during all types of inspections.

2.3 INVENTORY AND ROUTINE INSPECTIONS

During Inventory and Routine Inspections, elements are not inspected in detail. However, it is essential that the inspector observes all aspects of the bridge, so he can be confident that his recording of administrative, geometric and other data is correct, that his assessment of condition of the main components of the bridge is correct, and that he has not overlooked any problems which render the bridge unsafe and which require emergency action :

- observe the bridge under traffic, for excessive deflection and vibration
- check for damaged, missing, deformed, corroded or decayed members, and assess significance
- check bearings and seismic buffers
- check underside of concrete deck for cracking, adequacy of cover to reinforcement, evidence of corrosion in reinforcement etc.
- check for missing, damaged or decayed timber deck members
- check and observe riding quality of running surface, particularly at the joint between the abutment headwall and the deck, in order to identify defects which contribute to excessive impact or which restrict the flow of traffic
- check drainage on the deck and approach roads, including vegetation and debris which may cause ponding of water
- check expansion joints and deck seals
- check for damaged, loose, missing or corroded railing
- check for damaged end-blocks
- check other bridge furniture such as signs, utilities and make notes if required
- check for scouring around embankments, abutments and piers
- check for subsidence, slippage or settlement of embankments
- check condition of piles for corrosion, cracking decay or settlement
- check for previous movement or settlement of abutments
- check for cracking in concrete and masonry wingwalls, abutments and piers
- check for corrosion or decay in columns

2.4 DETAILED INSPECTIONS IN GENERAL

The items listed for inspection in Section 2.3 are also checked in Detailed Inspections. However, a more thorough level of inspection is required. The defects noted may be the result of significant underlying problems, which must be detected and identified.

The following sections summarise what the inspector should look for as signs of defects or damage during a Detailed Inspection, for the three main components listed in Section 2.2.

More detail about individual elements and defects is included in Part 2 of the Bridge Inspection Manual.

2.5 WATERWAY/EMBANKMENT

Many failures of bridges in Indonesia are caused by scour undermining foundations and abutments. Usually the scour is caused by excessive stream velocities which are result of insufficient waterway area (bridge length). Quarrying upstream and downstream of the bridge can also cause scour around bridge foundations, and is a major problem in many rivers.

Deficiencies in foundation design and construction, including the use of the wrong type of foundations (e.g. well foundations instead of piles), foundations constructed too high because of difficulties in excavation, and improperly located piers, can also result in scour.

It is essential that deficiencies of this type are detected early and corrective action taken immediately to avoid a possible bridge collapse.

- check for undermining and scour around piles, abutments, approach embankments and scour protection, and evidence of quarrying in the river bed.

- check for abnormal settlement or slippage of approach embankments, especially around the abutments.

- check for excessive vegetation or remains of other structures blocking the waterway beneath the bridge.

- check for evidence of flooding or excessive build-up of water (afflux) upstream of the bridge which may indicate inadequate waterway area and potential for further scouring.

- check for damaged scour protection.

- check for erosion of embankments.

2.6 SUBSTRUCTURE

The substructure includes the foundations, abutments, wing walls, retaining walls, piers and columns. Certain inspection procedures apply to them all, such as examination for excessive or abnormal movements, the incidence of cracking and the occurrence of accidental damage in the form of distortion, buckling and removal of structural material.

2.6.1 Foundations

Most foundation problems are the result of unforeseen movements. Most foundations undergo small movements, which if they remain small and uniform, cause no damage to the structure. Movements of large magnitude, especially if they are differential movements, cause damage to nearly all structures, unless specific provisions have been made during design. Such movements can result from settlement or failure of foundation material, development of cavities in rocks, scour, and changes in the water table. The start of foundation movement may be difficult to detect unless periodic instrumental surveys have been carried out. Usually, the first indication of trouble is a visual one, such as a variation from the proper geometry of the structure, excessive or unusual movements at bearings and expansion joints, and cracking of abutments, wing walls and the ends of beams.

Another problem in foundations is deterioration of the structural material. It is necessary to examine timber piles for insect attack and fungal deterioration. Steel piles can suffer from corrosion and concrete piles from cracking and splitting. In all cases, the environment of the pile depends on its position with respect to soil, mud and water level. Particularly vulnerable areas are the tidal zone and the splash zone which fortunately are relatively easy to inspect. Inspection below the water level may require the use of diving techniques. Inspection below the soil level is extremely difficult unless instruments have been built into the pile before or during construction. Otherwise removal of soil and underpinning may be necessary. These will normally require Special Inspections.

The deterioration of foundations of all types can be considerably accelerated if the ground water is chemically aggressive. Sampling of the ground water may sometimes establish a serious level of risk, but a visual inspection may provide the only adequate degree of reassurance.

2.6.2 Abutments and Piers

- check for cracks between adjoining wing walls or in the abutment itself, and inadequate or abnormal clearance between the back wall of the abutment and the end beams or diaphragms of the superstructure.

- determine whether drains and weep holes are clean and functioning properly.

- check for deteriorating concrete in areas which are exposed to tidal influence and to roadway drainage.

- check stone masonry for mortar cracks, vegetation, water seepage through the cracks, loose or missing stones, weathering and spalled or split blocks.

2.7 SUPERSTRUCTURE

Details which need to be observed during inspection of superstructures are the existence of excessive or abnormal deformation and vibration, adequacy of clearances, and signs of damage by impact from vehicles and vessels. These details are best described in terms of what to look for in particular components and materials.

2.7.1 Concrete Beams and Girders

- **spalling concrete** - special attention should be given to points of bearing where friction and high edge pressures can cause damage.
- **cracking** - a map of cracking in main members should be produced, so that implications in terms of strength and durability can be carefully examined. Diagonal cracks may indicate an incipient shear failure, whereas vertical cracks may indicate an excessive degree of stress in flexure. The size and distribution of the cracks should be noted and some attempt made to determine their depth if cracking is severe. The advice of an Engineer may need to be sought to determine whether or not the cracking is structurally significant.
- **cover** to reinforcement is usually checked by a cover meter but sometimes indications of inadequacy of cover appear as rust stains on the surface of the concrete caused by corrosion of the reinforcing steel. In extreme cases, reinforcing bars can become exposed.
- **prestressed concrete bridges** should be given special attention and the possibility of the following defects should be investigated :

  a) longitudinal cracks in the flanges may indicate insufficient transverse reinforcement, whilst transverse cracks in beams are an indication of either a serious loss of prestress or of wrong positioning of the prestressing cables.

  b) spalling or cracking of concrete may occur in soffits near curved cable ducts due to inadequate resistance to radial forces.

  c) unfortunately, the most important details relating to the condition of prestressed concrete beams cannot be assessed by visual inspection. These are the position and condition of the cable, the uniformity and density of grouting of the cable ducts, and the fracture of strands of the cable. Some of these factors could be checked by boring small holes into the concrete, but usually radiographic techniques have to be employed to obtain more reliable information (Special Inspection).

- **loose plastering** particularly on soffits and edge beams.

2.7.2 Steel Beams, Girders and Trusses

- **corrosion** is probably the most important factor affecting the condition of a steel structure. It is important to assess its magnitude, location and the form that it is taking. An attempt should be made to assess the loss of effective structural section and to identify the cause of the corrosion. Junctions of steel work with masonry, concrete and other structural materials should be given particular attention.

- **condition of the protective system** - paint systems suffer various forms of deterioration and it is beneficial to detect the early stages because of the substantially reduced amount of maintenance that is involved in correcting defects. Coupled with inspection of the protective system should be a search for the accumulation of debris and an assessment of the general cleanliness of the structure.

- **fracture** is apparent as breaks in members and elements and the ease of detection is directly related to the scale and size of the defect. It may be due to a variety of causes such as overloading, brittle fracture, stress corrosion or fatigue.

- **cracking** usually occurs in welds and adjacent metal and is caused by stress fluctuation and stress concentration. Members and connections subject to high stress fluctuations and stress reversals in service are most susceptible. Poor quality welding and sudden changes in the cross section of the member are potential problem areas.

- **excessive vibration and noise** - these factors in themselves may not be structurally damaging, unless the vibrations are setting up resonance. They can be general indicators of the health of the structure, particularly if vibration and noise have increased since a previous inspection.

- **deformation and deflection** - excessive deformation or deflection under load is one of the best indicators of the state of the structure. Small movements due to heavy traffic loading can usually be detected visually.

- **buckling, kinking, warping and waviness** - these terms usually refer to a form of deformation associated with members in compression. If present to a significant degree, they can considerably reduce resistance to compressive forces.

- **loose bolts and rivets** - these are defects which require close inspection to detect, unless there are some accompanying movements or noise. Occasionally tell-tale cracks appear in the paint films between coverplates and main members, particularly in the case of friction grip-bolted connections.

- **excessive wear** can be present in members accommodating movement, such as pins in joints of trusses.

2.7.3 Timber Members

- **condition of protective treatment** - deterioration due to weathering, chemical attack, fungus attack. Deterioration from these causes ranges from staining of the surface to extensive decay of the member, as a result of which the timber has become soft, spongy, fibrous or crumbly. Particular attention must be paid to connections, bolts holes, splices and support points.

- **vermin attack** - a variety of termites, beetles, ants and borers can attack timber in various environments. Most of the damage is internal and to assess its scale, core samples may have to be drilled.

- **fire damage** - the effects of fire damage are readily apparent. The inspection procedure should also aim to identify potential fire hazards.

- **accidental damage** - severe collisions usually result in shattering or splitting of timber.

- **excessive vibration, deflection or deformation** - sound timber will usually undergo substantial deflection or deformation under conditions of overloading before failure takes place. The geometry of a member is therefore a useful guide to its reserve of strength.

- **rusty or loose bolts and unplugged holes** - these defects lead to gradual deterioration and should be identified for remedial treatment as soon as possible.

2.7.4 Masonry and Brick Arches

- **deterioration and crumbing of exposed surfaces** - due to weathering leading to spalling and splitting of stones and bricks in more severe cases.

- **opening of joints and movement of supports** will cause loss of bedding mortar between components of an arch and displacement of bricks and stone blocks. Many masonry and brick arch bridges have a reserve of strength that they have been able to carry modern traffic without collapsing. However, the vibration effects of modern traffic may cause a gradual loosening of stones and displacement of mortar which will seriously undermine the strength of an arch if allowed to continue.

- **drainage of fill materials between spandrel walls** - fill materials have the potential to store a substantial volume of water, increasing the load on the arch and spandrel walls accelerating deterioration of materials.

- **accumulation of debris and vegetation** - because of the likehood of accumulation of soil in various parts of the structure, a large amount of vegetable material can be supported on the bridge. The root systems can cause damage.

- **overall alignment and geometry** - undesirable changes of shape can sometimes be detected visually before the structure becomes unserviceable.

2.7.5 Suspension Bridges

The inspection of cables and their connecting members such as strand shoes and sockets, anchorages, saddles, cable bands, hangar rods, suspender ropes and wrapping wires follows the general procedures for steel structures. In addition the following factors may require special attention :

- **displacement or slippage of strand shoes**, strand sockets, saddles and cable bands may result in uneven distribution of loads between members and are an indication of some degree of failure of the connection between the cable and the particular element which is being displaced.

- **broken wires in large strands**, which may be fully wrapped and protected on the outside, will be difficult to detect until there is some visual evidence in the outer casing. However, in the anchorage zone the continuity of unwrapped wires between strand shoes and splay saddles can be tested and this will reveal the presence of broken wires for some distance past the splay saddle under the wrapping.

- **condition of protective systems should be** checked to ensure that there are no loose wrapping wires or cracks where water can enter and cause corrosion of the main cables. Cable bands, saddles and splay casting need to be inspected for water seepage.

- **relative tension of hangers or cables on suspension bridges** - a check on the uniform distribution of load between adjacent hangers is possible by comparing the angular displacement of the cable at each cable band. However, to obtain a more precise indication, some form of load indicating instrument will be required (Special Inspection).

2.7.6 Concrete Decks and Slabs

- **cracking** - a map of cracking patterns should be prepared and information collected on the size, distribution and depth of cracks. A photographic record is desirable. The causes of cracking are numerous; sometimes the cause is obvious from the form and the nature of the cracks. In other cases, the causes are complex and can only be assessed after careful examination of records and drawings, accompanied by calculations. Cracking can be symptomatic of characteristics of material and workmanship, e.g. shrinkage cracking, but in other cases, it can have serious structural implications, which can vary from failure of reinforcement or prestressing tendons to shear of main seatings and anchorages. A Special Inspection may be required.

- **scaling** - this is the gradual and continuous loss of surface mortar and aggregate. The depth and size of the area should be recorded, so as to monitor the progression of this defect. It is most commonly experienced on horizontal surfaces exposed to the weather and to traffic, but it can occur elsewhere.

- **spalling** - is defined as loss of concrete between fracture surfaces, and is caused by poor quality concrete or corrosion of reinforcement which causes it to expand forcing the concrete to crack and fall out.

- **corrosion of reinforcement** - is difficult to detect in early stages, but gradually leads to discolouration of the surface of the concrete and in extreme cases to spalling.

- **leaching** - the leakage or seepage of water through cracks and voids in concrete may dissolve out calcium hydroxide and other constituent materials. Its effects are usually evident on the soffits of decks in the form of staining, efflloresence or incrustation. In time it can cause corrosion of reinforcement, because of the gradual loss of alkalinity of the concrete.

- **porous or pervious concrete** - can facilitate the ingress of water leading to corrosion of steel.

- **wear of deck surface** - if the deck forms the running surface for traffic, it will be subject to erosion and polishing.

- **excessive deformation, deflection or vibration** - these factors may be indicators of the condition of support of the deck as well as of the deck itself. A Special Inspection may be warranted.

- **accidental damage** - this can take a variety of forms including damage to overpass bridges by tall vehicles, and local damage to truss members, expansion joints and kerbs by vehicles.

- **chemical attack** - in certain aggressive environments, concrete may be subject to chemical attack which causes surface crumbling of material. Similar forms of deterioration can occur in less aggressive environments due to defective materials or workmanship.

2.7.7 Running Surfaces

Running surfaces are applied on bridges with concrete, steel and timber decks to protect the deck, to provide a renewable wearing layer and to give adequate resistance to skidding.

The defects most commonly experienced are :

- **cracking** - the cracking can take many forms depending on the nature of the failure and on the characteristics of the particular surfacing material. The most commonly used materials, such as asphalt, are thermoplastic and are therefore prone to cracking. In some cases, the cracking is an indication of failure of the surfacing material, whilst in others it indicates excessive movement or deterioration of the underlying deck. With time, crumbling of the surfacing material along the edges of the cracks takes place and the ingress of water may lead to loss of adhesion between the surfacing and the deck.

- **excessive deformation** - this will take place due to the combined effects of traffic and warm weather. When the deformation becomes excessive, it impairs riding quality and this in turn can substantially increase the dynamic loading and vibration from moving vehicles.

- **sliding surfacing material occurs** because of weakness in shear or loss of adhesion at the interface with the deck. This can lead to deformation and sometimes the accumulation of surfacing material to form bumps at expansion joints.

- **loss of skid resistance occurs** because of polishing under traffic. The surfacing will become more slippery with time and replacement of the surface will be required to restore resistance to skidding.

2.7.8 Joints

Expansion joints are generally considered as weak points in bridges which are subject to rapid deterioration because of the onerous conditions to which they are subjected.
The main defects to be considered are :

- **loosening or movement of the joint and its components** - this is the most common form of failure and may be accompanied by rattling and by breaking of bolts, joint components and seatings. The onset of some form of loosening can usually be detected by a crack developing between the joint and the adjoining surfacings. Eventually a series of cracks will develop in the surfacing itself. Adhesion or tie-down of the joint to the seating can usually be checked by the ringing note when the joint is tapped with a hammer.

- **freedom of movement, clearance and alignment** - there should be adequate space for the joint to function under the prevailing temperatures. Clearance may be lost because of unforseen or accidental movement taking place in the foundations, substructure or superstructure. It may also result from wrong setting of the joints during construction. This defect may lead to restriction of movement of the joint which introduces stresses into the structure, or the gap in the joint may become excessively large, thereby presenting a hazard to traffic.

- **irregularity of vertical profile** - one part of a joint may become displaced relative to the other and if this displacement is excessive it will cause additional impact forces under traffic and may present a hazard to the safety of small and two-wheeled vehicles.

- **drainage of water through joints** - in many cases joints are designed with open gaps through which water and debris can fall. In such cases, the adequacy of the drainage system should be checked.

- **asphalt overlay over joint** - leading to deterioration of the overlay and increased impact loading.

2.7.9 Bearings

The geometry and condition of the bearings and bearing seatings are important indicators not only of the condition of the bearing itself, but sometimes of the general condition of the bridge. They are usually at points where articulation is intended to take place, so that magnitude of movement at bearings is usually significant and can be measured with relatively simple equipment.

- **condition of bearing and bearing plates.** These should be free of corrosion and debris which can impair movement and cause excessive frictional forces between superstructure and substructure. The adequacy of lubricating materials should be inspected.

- **the position and alignment of bearings, and the uniformity of the distribution of load between bearings,** should be inspected to ensure that there is complete contact across the bearing surface and that key-ways and thrust plates are properly engaged and not binding.

- **bearings** should be seated so that there is adequate freedom of movement.

- **tightness of anchor bolts and nuts should be checked**

- **some characteristics of elastomeric bearings require particular attention.** These should be examined for splitting, tearing or cracking of the outer casing and for bulging and distortion caused by excessive compressive forces and/or shear movements. The first signs of distress in elastomeric bearings are usually in the form of horizontal cracks near the junction of the rubber pad and the steel laminate. The bearings should also be examined for excessive rotation of the superstructure, which is usually indicated by difference in thickness between the back and the front of the bearing.

- **bearing seatings** should be inspected for signs of movement between the seating and the supporting structures. This is particularly important when dowels or anchor bolts have not been used to locate elastomeric bearings.

- **the seating of the superstructure** on the bearings and of bearings on the substructure should be carefully inspected for signs of cracking. Cracking is usually caused by a concentration of loads along edges, and can lead to reduction in the performance of the seating and to deterioration of reinforcement in concrete.

- **concrete or freyssinet hinge-type bearings** can be subject to splitting of the concrete in the neck of the hinge. This may be an indication of excessive rotation, bad initial design, or defective materials.

- **simple sliding bearings** used in many old bridges may become resistant to movement with age and, in the case of some materials such as lead and bitumen, they may not function at all. In such cases, there may be cracking or spalling of the concrete in the area of the bearing seating.

2.7.10 Railings and Furniture

- **damage due to traffic impact** - the nature and extent of the damage should be recorded and the various components inspected carefully for signs of inadequacy
- **corrosion** - parapets and guard rails are subject to splash from road vehicles and may be in an aggressive corrosion environment.. The condition of the protective system should be checked and signs of deterioration or corrosion noted. Special attention should be paid to the base of supporting posts
- **tightness of bolts** - should be checked, taking into account provision for expansion.
- **quality of welding** - should be checked to ensure that welds are adequate in transferring forces between members
- **condition of signs, gauges and utilities** should be checked

2.7.11 Drainage

Drainage is an important item for inspection because trapped, ponded, flowing or splashing water can cause a large amount of damage over a period of time and present a hazard to traffic.

The main defects to be checked are :

- **water stains** on beams, slabs, piers, columns and abutments may indicate leaky pipes, filled gutters or inadequate drainage systems.
- **clogged or inadequate drainage gulleys and pipes** will be evident from ponding around the inlet after a storm. Staining of concrete is an additional sign of inadequacy.
- **drain outlets (scuppers)** should be checked to ensure that water is not discharged on other components of the structure, and does not cause erosion of fill and embankment material.
- **damaged pipes** - pipes should be inspected for damage and leakages. Water staining and accumulation of debris are evidence of problems.
- **slope of surfacing and deck** - the drainage of water to gulleys should be checked to ensure that original levels are satisfactory and that they have not been adversely affected by resurfacing operations.
- **road drainage** - should not be discharged so as to cause erosion.

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

BRIDGE INSPECTION MANUAL

SECTION 3

BRIDGE REFERENCE SYSTEM

FEBRUARY 1993

DOCUMENT No. BMS2-M.E

TABLE OF CONTENTS

3. BRIDGE REFERENCE SYSTEM

3.1 DEFINITION OF A BRIDGE

For the purpose of registration in the BMS Database, a *Bridge* is defined as a bridge, flood-crossing, rail crossing, ferry crossing or culvert, where the total length or width of span (in the case of culverts) is greater than 2.0 meters.

3.2 BRIDGE NUMBER

The *Bridge Number* is generally a nine-digit number which is unique to an individual bridge. An example is shown in Figure 3.1.

Sometimes, the Bridge Number includes extra digits in the form of a *Link Suffix*. The Link Suffix is included when the Link on which the bridge is located has been divided into smaller sections in the Interurban Road Management System (IRMS), so that a more accurate traffic count (AADT) can be measured for each section or *sub-link* (Refer Section 3.2.1).

											LINK SUFFIX	
Bridge No.	7	0	0	1	2	0	0	2	4		2	
	Province No.		Road Link No.			Bridge Sequential No.			Suffix			

Figure 3.1 - Bridge Number

The Bridge Number identifies a bridge by sequential position along the Road Link.

The first two digits identify the Province.

The second three digits identify the Road Link.

The next three digits identify the particular Bridge.

Bridges are numbered sequentially, starting with the bridge closest to the origin of the Road Link, which is allocated the Bridge Sequential Number 001.

The final digit in the nine-digit number (the Suffix) is used to identify additional bridges which have been constructed, previously unregistered bridges which were overlooked when the initial bridge database was established, and to distinguish between duplicate bridges e.g. on a dual carriageway. The suffix can be numerical or alphabetic (Refer Sections 3.2.2 and 3.2.3)

The Province Number, Road Link Number and Link Suffix are derived from the Interurban Road Management System (IRMS), and can be obtained from the IBMS Report IBMS-IR1-Link and Traffic Data Report.

3.2.1 Link Suffix

Use of the Link Suffix to identify sub-links commenced several years after the bridge database was established, and the Link Suffix could not easily be incorporated into the original nine-digit Bridge Number in its most appropriate location, ie. adjacent to the Link Number. It was therefore incorporated separately, attached at the end of the original nine-digit number.

The correct Link Suffix must be used in all inspection reports, otherwise the BMS MIS will not allocate correct IRMS Data to the bridge. The Link Suffix has already been allocated to all bridges in the database.

Each sub-link has defined km start and end points. The km for the location of the bridge (Refer Section 3.3) must be nominated correctly so as to correspond with the Link Suffix. If the km location is outside the km limits for the sub-link, the BMS MIS will not recognize the bridge.

Sub-links within urban areas have a two-digit alpha-numeric Link Suffix in the form K1, K2 etc. Sometimes, sub-links in the IRMS are not on the actual Link. They could be a by-pass road or a branch road off the main Link, as shown in Figure 3.2.

Inspectors should consult with the BMS Supervisor if problems are experienced with allocation of Link Suffixes.

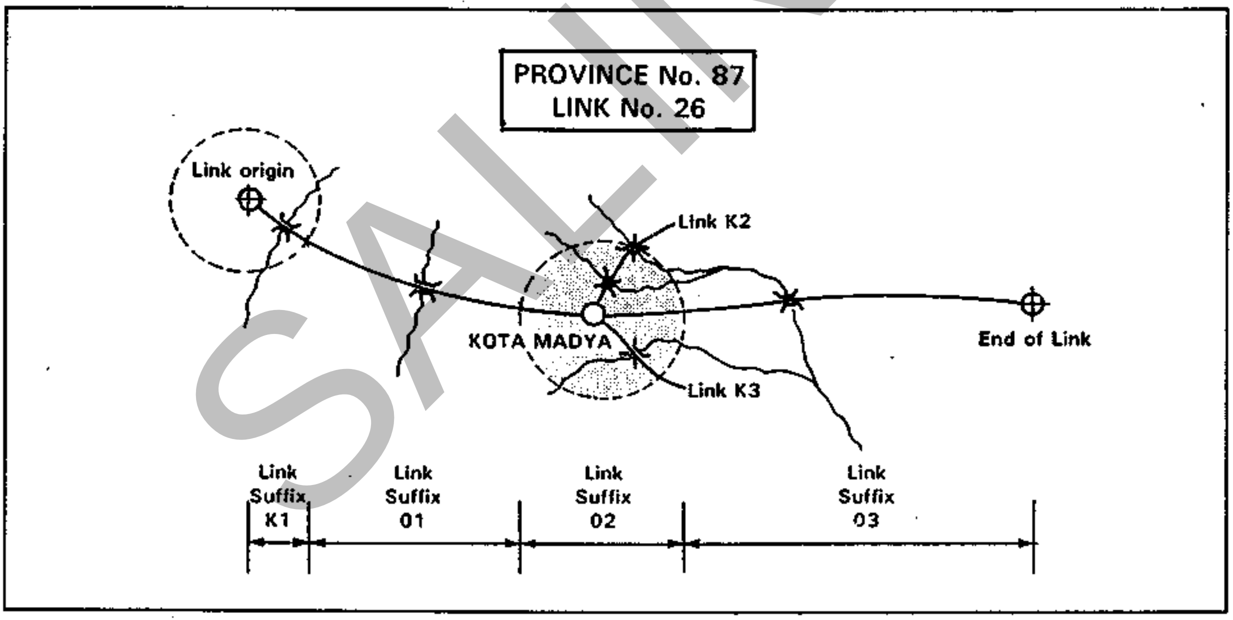


Figure 3.2 - Use of Link Suffix to Identify Sub-Links on a Road Link

3.2.2 Additional Bridges/Previously Unrecorded Bridges

Additional and unrecorded bridges are identified by a numerical suffix.

The value of the suffix represents the distance between the additional bridge and the adjacent previously-recorded bridge closest to the origin, expressed as a decimal proportion of the total distance between previously-recorded bridges each side of the additional bridge. Multiple additional bridges are identified in the same manner.

The suffix has a whole-number value between 1 and 9; therefore up to nine additional bridges between two previously-recorded bridges can be included.

The additional bridges are assigned the same Bridge Sequential Number as the adjacent previously-recorded bridge closest to the origin.

In Figure 3.3, bridges over S. Satu, S. Dua, the Railway and Jalan Besar have been recorded in the BMS Database previously, and therefore have sequential Bridge Numbers (001 to 004).

An additional bridge (S. Tambahan) has been found between S. Dua and the Railway, after the initial BMS Database was established. S. Tambahan is allocated a suffix of 4, because the distance between S. Tambahan and the adjacent bridge closest to the origin (S. Dua) is *four*-tenths of the distance between S. Dua and the Railway Bridge.

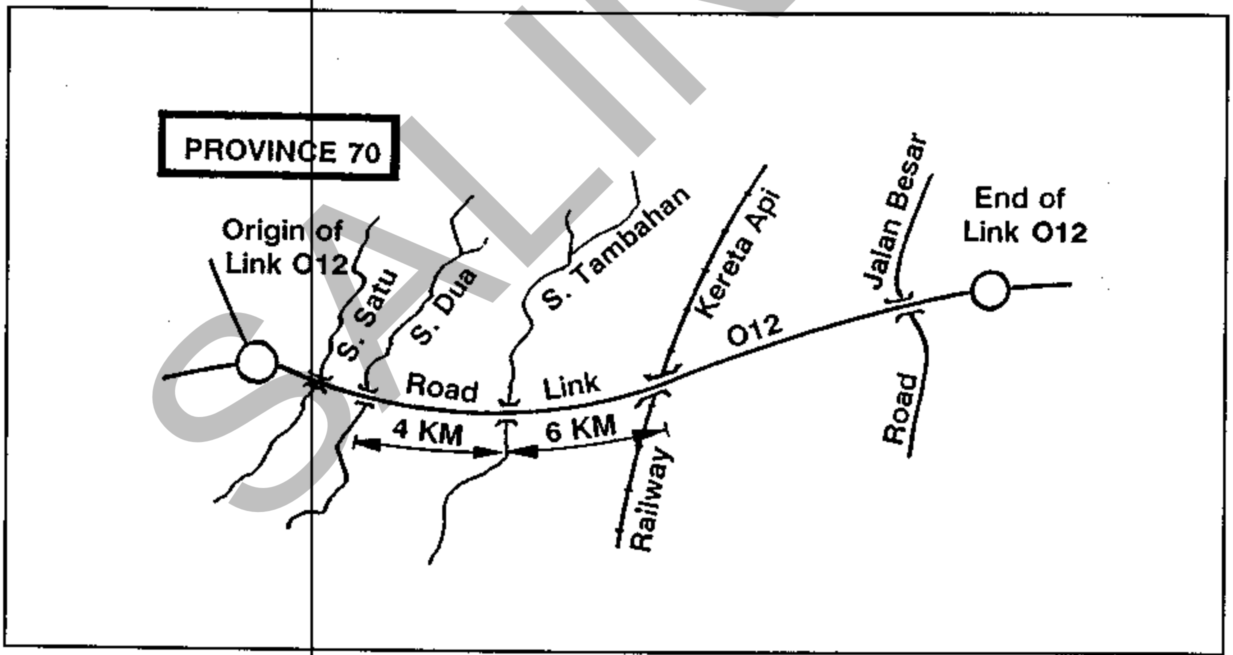


Figure 3.3 - Allocation of Bridge Number

The Bridge Numbers for the five bridges on Link 012 in this example are as shown in Figure 3.4.

	Province No.	Road Link No.	Bridge Sequential No.	Suffix	Link Suffix
S. Satu	7 0	0 1 2	0 0 1	0	
S. Dua	7 0	0 1 2	0 0 2	0	
S. Tambahan (additional bridge)	7 0	0 1 2	0 0 2	4	
Kereta Api	7 0	0 1 2	0 0 3	0	
Jalan Besar	7 0	0 1 2	0 0 4	0	

Figure 3.4 - Use of Suffix to Identify Additional Bridge

3.2.3 Overpasses

Road bridges which overpass a railway line are recorded in the normal manner.

Road bridges which overpass a road are recorded on the upper road link only.

Railway bridges which overpass a road are normally the responsibility of the Rail Authority, and are not recorded in the BMS Database. If there is doubt about responsibility for any bridge including rail overpasses, then the Bridge Inspector should consult the BMS Supervisor.

3.2.4 Duplicated Bridges

If a road is duplicated e.g. on a dual carriageway, separate bridges are usually constructed on each carriageway over the same river or railway line. An example is shown in Figure 3.5.

Duplicated bridges are identified by an alphabetic suffix.

Suffix A - is used for the bridge on the left carriageway, carrying vehicles travelling away from the link origin.

Suffix B - is used for the bridge on the right carriageway

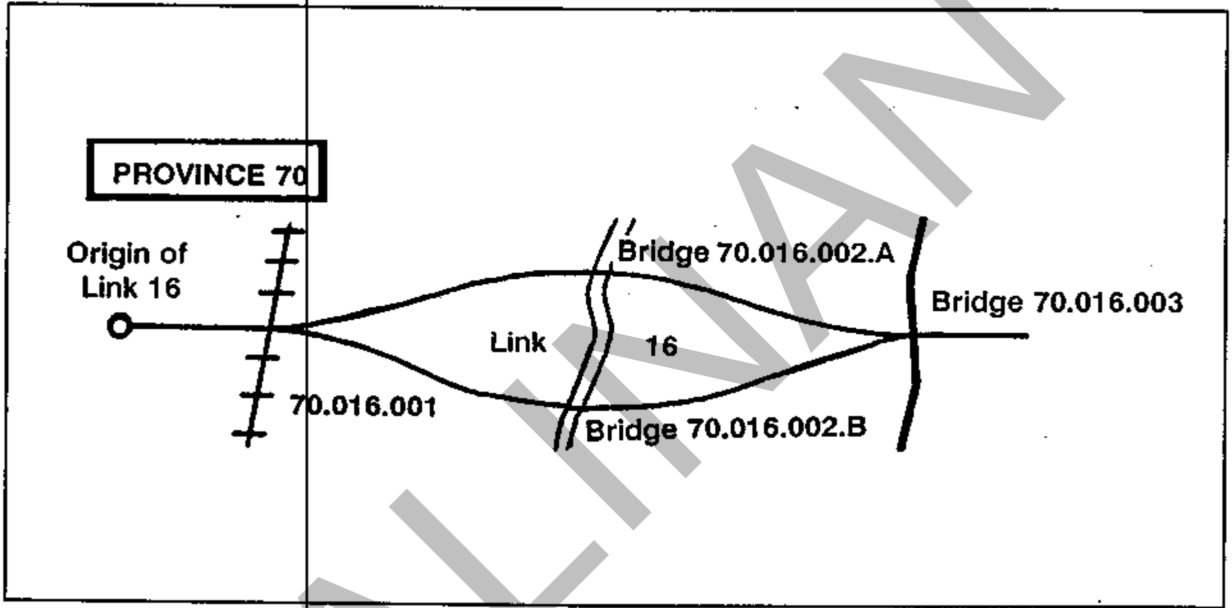


Figure 3.5 - Use of Alphabetic Suffix to Identify Duplicated Bridges

3.3 BRIDGE LOCATION

Bridges are located in terms of distance from a *Base Town* which is normally the origin of the Road Link. Each Base Town has been allocated a three-letter alphabetic Code e.g. JKT, BDG, etc. The distance is measured in kilometres, usually by vehicle odometer.

It is important that each bridge is registered once only. Initially, each inspection is started from the Base Town and bridges are inspected sequentially along the link, to avoid double registration. The odometer reading is recorded at the starting point in the Base Town. This reading is required for determining the bridge location.

If the bridge is being added to the database, then it can be measured from the previous bridge or kilometre post, and the distance from the Base Town calculated.

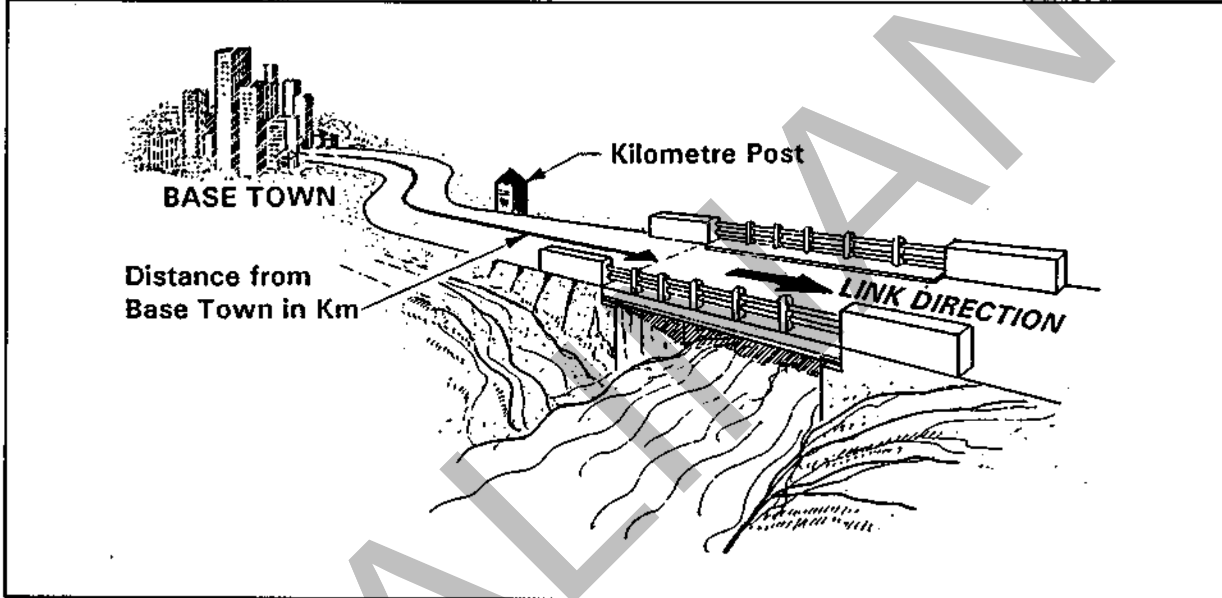


Figure 3.6 - Bridge Location

3.4 BRIDGE COMPONENT AND ELEMENT NUMBERING

In order to record the condition of the major components of a bridge or to record the location of defects in individual elements or groups of elements, it is necessary to have a *component and element numbering system.*

3.4.1 Major Component Numbering

Three *major components* are used to help define the location of elements and defects.

These are the *abutments, piers and spans.* which are assigned a two-digit alphabetic-numerical code e.g. A1, P1, B2. These codes are used in all types of inspections.

The major components are each numbered sequentially, starting from the component closest to the Base Town, as shown in Figure 3.7.

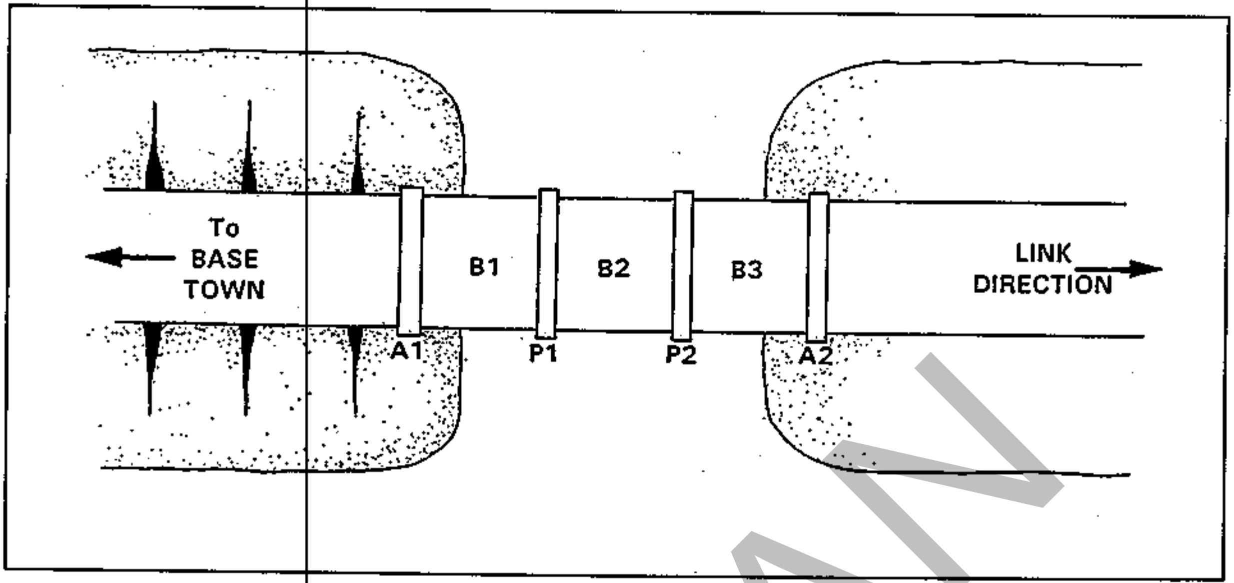


Figure 3.7 - Major Component Numbering

3.4.2 Element Numbering

Element Numbering is used to locate defective elements only in Detailed Inspections.

Individual elements such as girders, columns and trusses, and parts of elements such as chords and diagonals, are numbered longitudinally, transversely and vertically.

These elements are numbered on the X, Y, and Z axes respectively as shown in Figure 3.8.

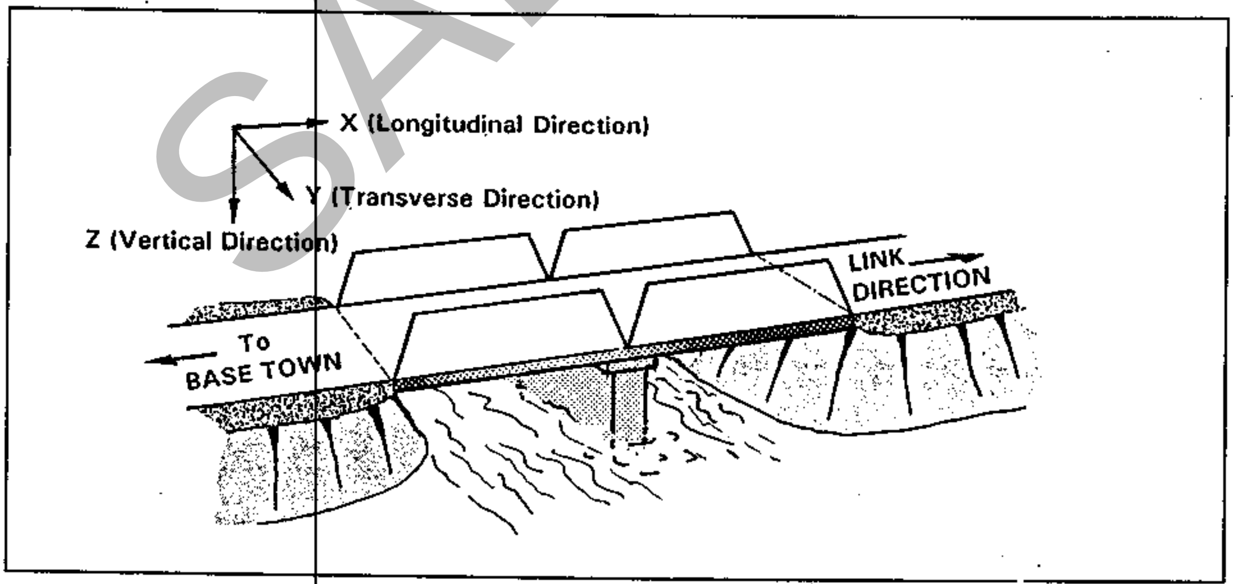


Figure 3.8 - Element Numbering

Elements in the longitudinal direction are numbered sequentially, starting from the element closest to Abutment 1 (A1) as shown in Figure 3.9.

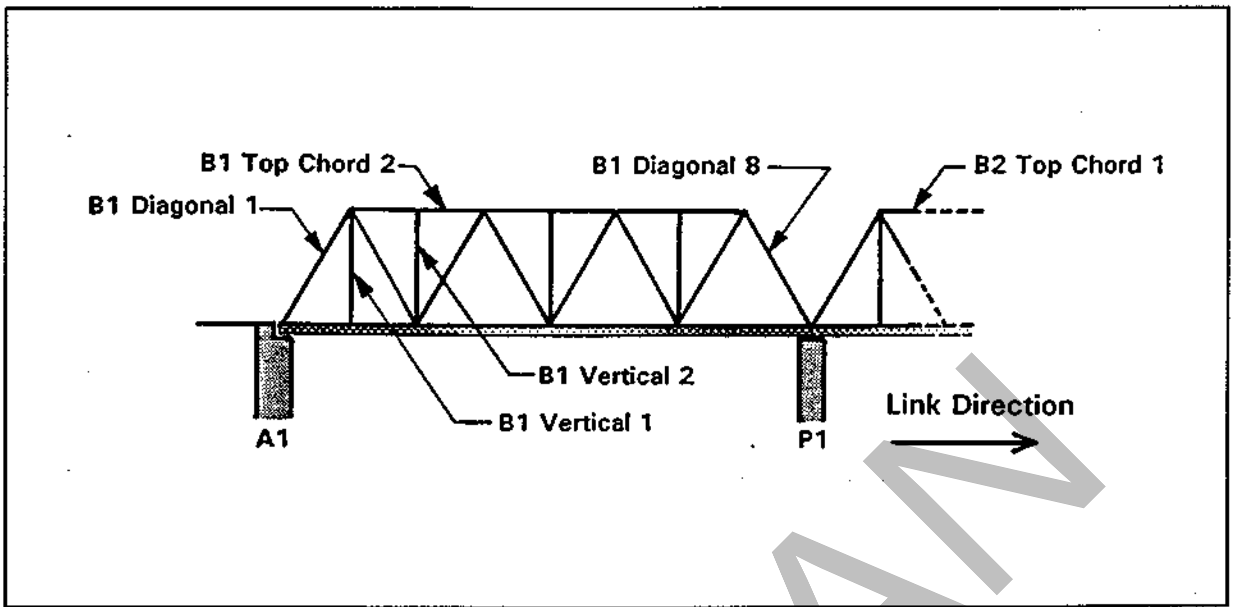


Figure 3.9 - Element Numbering - Longitudinal Direction

Elements in the transverse direction are numbered from left to right when looking away from A1 as shown in Figure 3.10.

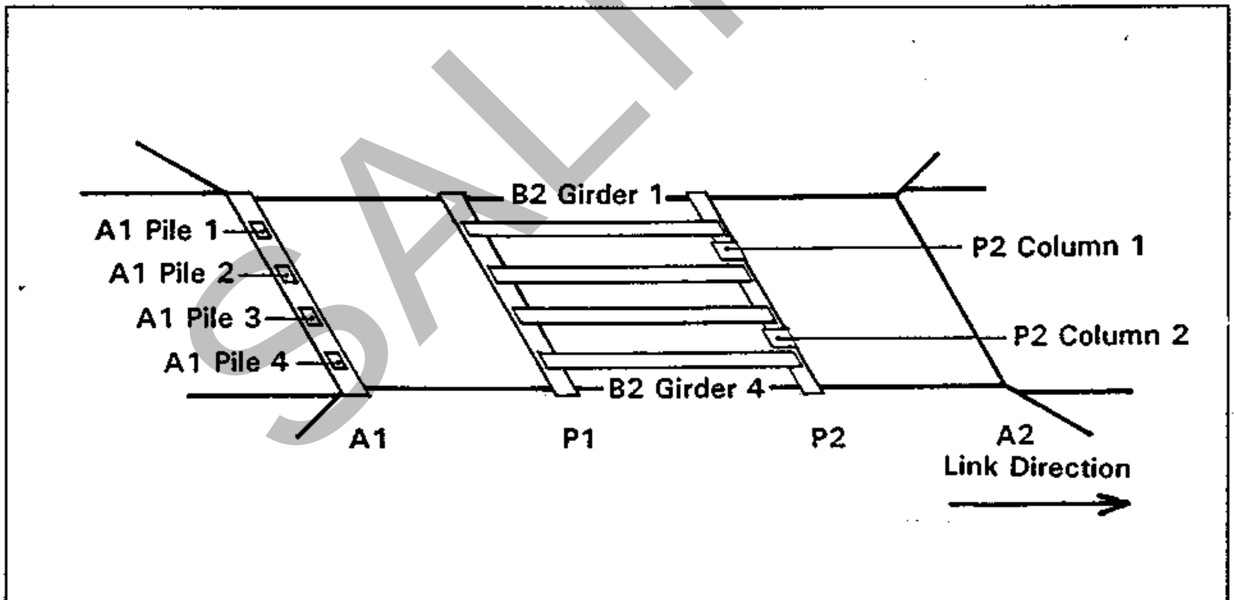


Figure 3.10 - Element Numbering - Transverse Direction

Numbering in a vertical direction normally only applies to parts of an individual structural element e.g. in a truss. These are numbered from top to bottom as shown in Figure 3.11.

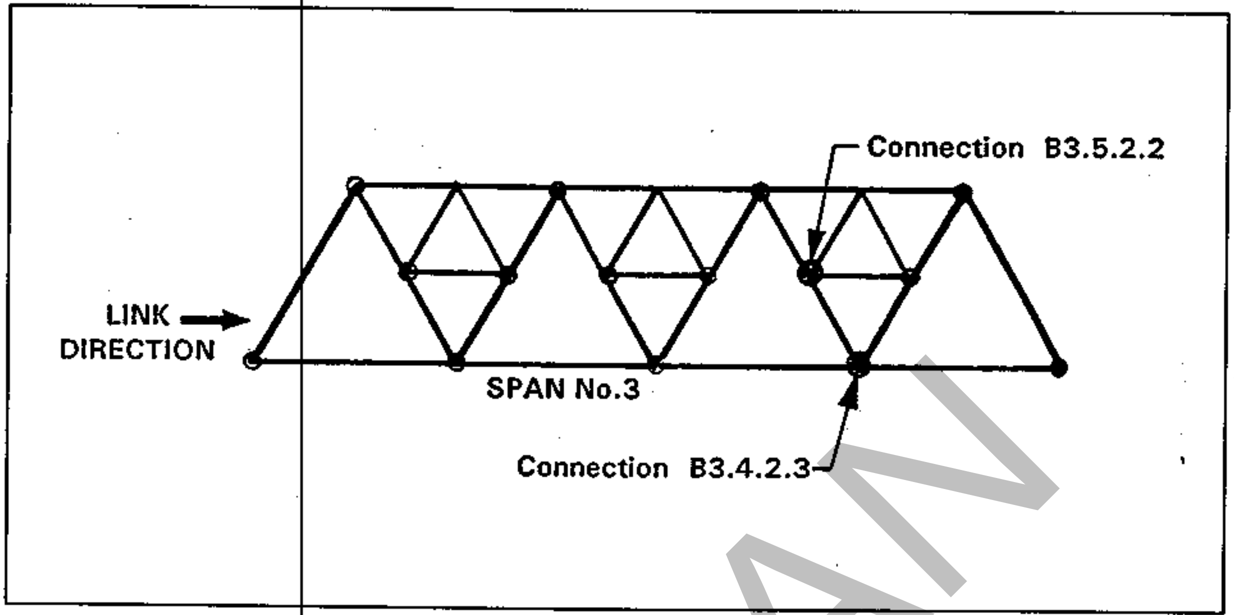


Figure 3.11 - Element Numbering - Vertical direction

3.5 SEQUENCE OF INSPECTIONS

All Inspections should start at the left side of abutment 1 (A1), as shown in Figure 3.12.

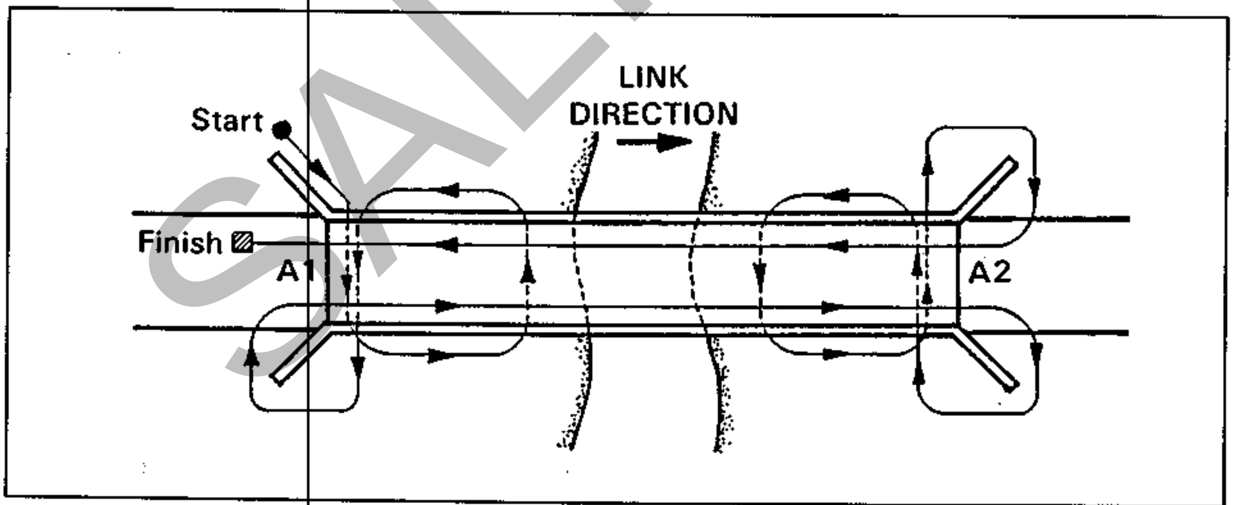


Figure 3.12 - Sequence of Inspection

This sequence is applicable to both single and multi-span bridges, with the abutments and end spans being inspected before the internal spans.

Naturally, the sequence may need to be varied to suit different bridges because of access problems, traffic problems, pier location and waterway characteristics.

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

BRIDGE INSPECTION MANUAL

SECTION 4

INVENTORY INSPECTIONS

BRIDGE MANAGEMENT SYSTEM
BMS
A PROJECT JOINTLY FUNDED BY INDONESIA AND AUSTRALIA

FEBRUARY 1993

DOCUMENT No. BMS2-M.E

TABLE OF CONTENTS

4. INVENTORY INSPECTIONS

4.1 GENERAL

Inventory Inspections are carried out to register administrative, dimensional, material and condition data of each bridge in the Bridge Management System. All bridges, railway level crossings, flood crossings, ferrys and culverts 2 metres or more in total length must be registered.

More specifically, the Inventory Inspection is carried out to :

- register the bridge or site in the Bridge Management System by Bridge Number and Location
- measure and record the overall dimensions of the bridge and each span
- identify the type of bridge or crossing, the major components and the date or year of construction
- rate the condition of the major components of the bridge superstructure and substructure
- record load limits or other existing functional restrictions on the bridge
- assess and record the effect of the existing bridge width on traffic flow
- record details of available detours in the event of a bridge closure
- record the highest known flood level, date of occurrence and source of information
- record whether the bridge plans are available and if the bridge is a standard type

4.1.1 Personnel

At least one trained Bridge Inspector is required to carry out an Inventory Inspection, accompanied by other assistants.

4.1.2 Equipment and Materials

The inspectors need the following equipment to carry out an Inventory Inspection :

- *Inventory Inspection Report* forms
- paper for sketches or notes
- pens
- vehicle with a functioning odometer

- measuring wheel
- 30m tape measure
- shovel
- machete
- calculator
- camera and film
- small white-board and non-permanent marking pens (to display bridge name and number in photographs)

4.1.3 Reference Material

Prior to carrying out the Inventory Inspection, the inspectors need to collect the following material :

- Field Handbook for Bridge Inspections
- map showing provincial road links (PETA PERANAN JALAN)
- Link and Traffic Data Report IBMS - IR1 for the Province

4.1.4 Inspection Sequence

Each bridge should be inspected in the following sequence :

- check and record the administrative data on Pages 1 and 3 of the Inventory Inspection Report - bridge name, location, Cabang etc.
- walk around the bridge to establish the general layout of the structure
- record the crossing type and measure and record the geometric data on Page 3 of the Report - number of spans, total length, skew angle etc.
- measure and record the span dimensions on Page 3 of the Report - length, width between kerbs, footways width etc.
- determine and record the type, material, source and condition of the major components in the superstructure and substructure on Page 3 of the Report
- determine and record the bridge ancillary data on Page 4 of the Report - existing functional restrictions, traffic flow, detour and diversion, etc.
- record on Page 1 of the Report whether *Emergency Action* is recommended and the reason why

- make any necessary notes in the Remarks section on Page 1 of the Report

During the inspection the inspector should take photographs of the structure showing :

- side elevation of the bridge
- the bridge deck taken along the road centreline
- the bridge taken at an angle of 45° from the road centreline
- any other points of interest including defects and problems requiring attention

Sketches should be drawn to clarify the report if necessary

4.2 INVENTORY INSPECTION PROCEDURE

A standard inspection procedure is used to ensure that Inventory Inspections are carried out in a consistent and systematic manner.

4.2.1 Administrative Data

Administrative data is recorded in the boxes on Pages 1 and 3 of the Inspection Report, as shown in Figure 4.1. It is important that the boxes on both pages are filled in, because photocopies of each may be made and used subsequently for different purposes.

Bridge No.										LINK SUFFIX	

Bridge Name		*Cabang*
Bridge Location	*from* name of Base Town	*km* distance from Base Town
Date of Inspection	*Inspector's Name*	*NIP*

Figure 4.1 - Administrative Data

Bridge No.

Bridge No. is determined as in Section 3.2.

Bridge Name

The *Bridge Name* could be marked on a nameplate or plaque or it could be available from previous surveys. If it is not known, the bridge name can be determined by asking local people. It is best to check the accuracy of their advice by asking separate groups of people. Where more than one bridge has the same name, number subscripts can be used. Correct spelling should be established.

Cabang

Self-explanatory

Bridge Location

The *Bridge Location* (distance from Base Town in kilometres) is determined as in Section 3.3.

Date of Inspection, Inspectors Name, NIP

Self-explanatory

4.2.2 Crossing Type and Geometric Data

This data is recorded in the boxes on Page 3 of the Inspection Report Form, as shown in Figure 4.2.

Crossing Type *(enter, S, KA, JN, L)*		*Number of spans*	
		Total Length (m)	
Year Built		*Skew Angle (degrees °)*	

Figure 4.2 - Crossing Type and Geometric Data

Crossing Type

Crossing type is recorded using one of the following codes :

S	River (Sungai)
KA	Railway (Kereta Api)
JN	Road Overpass (Jalan)
L	Other (Lain)

"Other" includes pedestrian tunnel, water-pipe, etc.

Number of Spans

Self-explanatory.

Total Length (m)

Total length is the length of the bridge measured between expansion joints at abutments as shown in Figure 4.3. The total length is recorded to the nearest 0.1 metre measured along the bridge centreline.

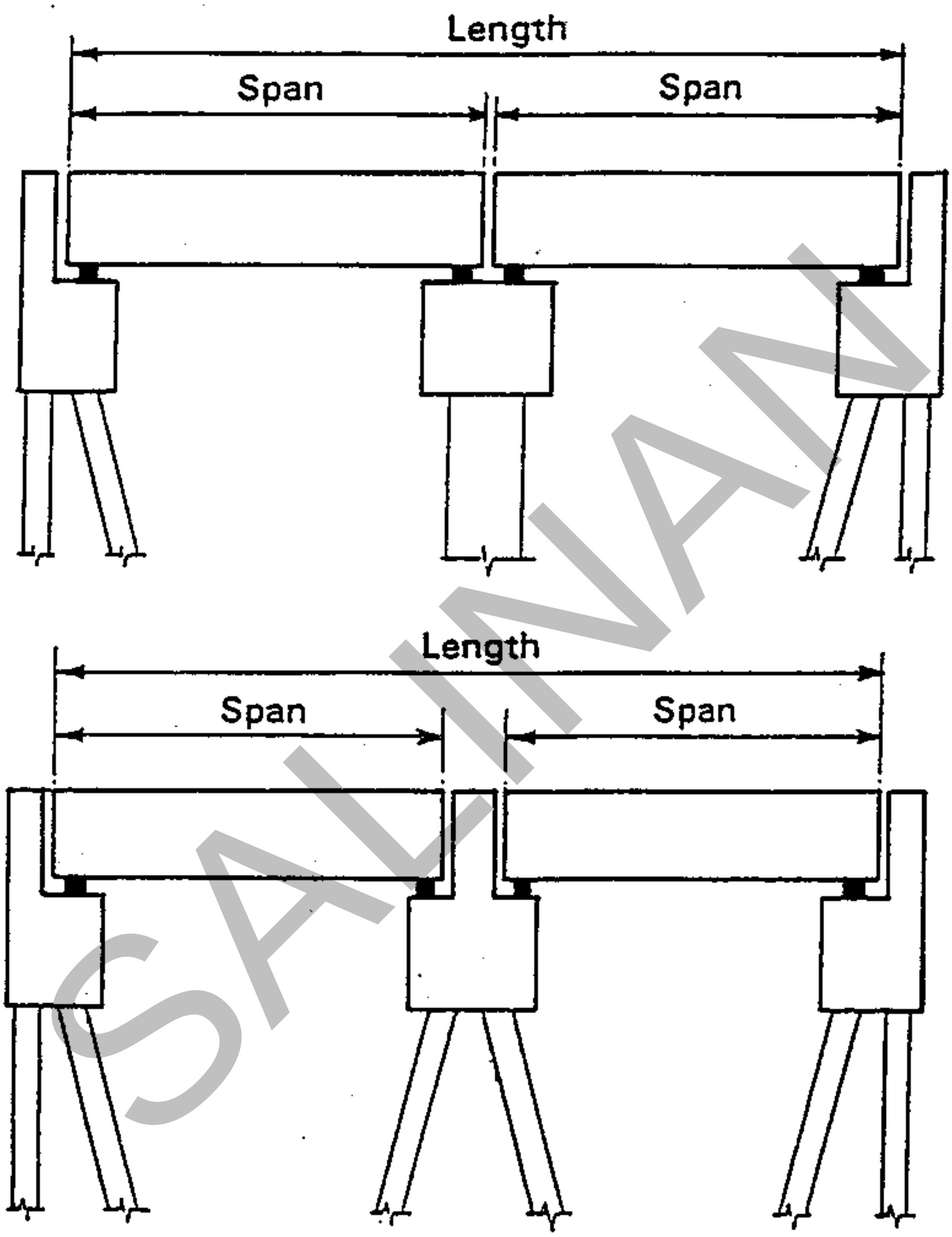
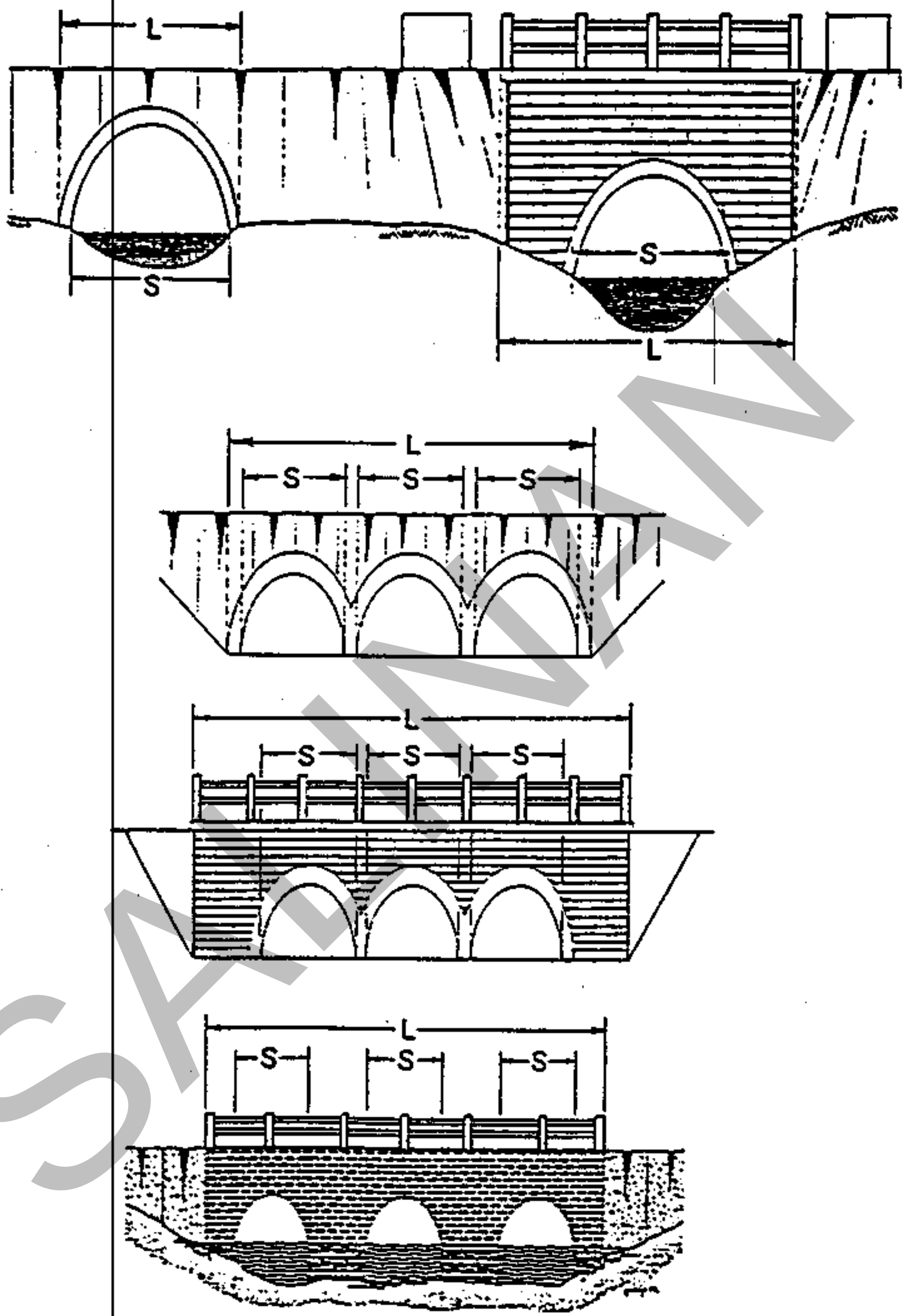


Figure 4.3 - Measurement of Total Length and Span Length for Normal Bridges

Arches are a special case and are measured as shown in Figure 4.4



L = Length, S = Span

Figure 4.4 - Measurement of Total Length and Span Length for Arches

Skew Angle (degrees °)

Where a bridge is not perpendicular to the road, it is called a "skew" bridge. The *skew angle* is the angle between the line of the pier/abutment and a line perpendicular to the road centreline.

The skew angle can be positive or negative as shown in Figure 4.5.

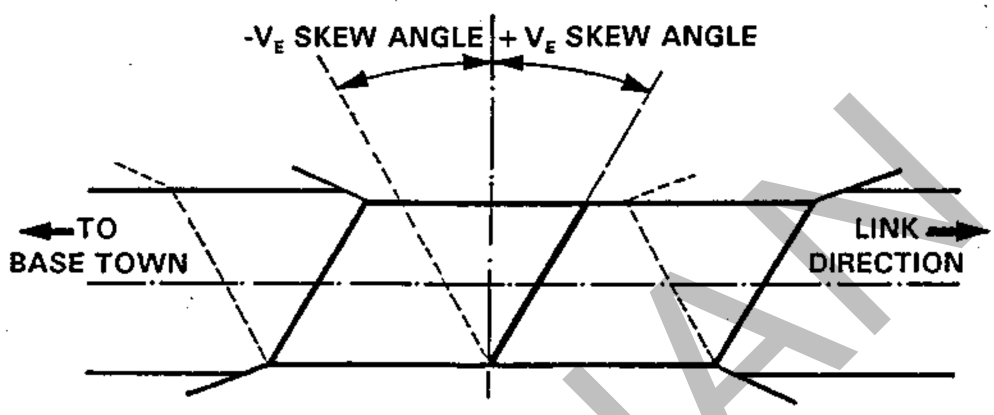


Figure 4.5 - Skew Angle on Bridges

Where a curved bridge is constructed on a curve, the bridge is not a skew bridge and is recorded as *busur tikungan* or *BK.* Figure 4.6 shows a curved bridge.

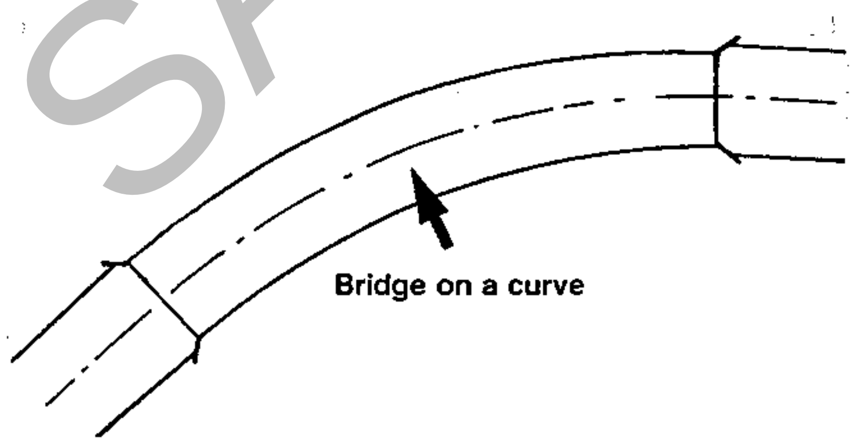


Figure 4.6 - Curved Bridge on a Curve

Year Built

This information may be readily available from the name plate or plaque. Sometimes the year of construction is recorded on the end blocks or end truss members. If not, local people may be able to advise. The approximate year of construction can be recorded if no information is available.

4.2.3 Span and Major Component Data

Historically, only two main components of a bridge, i.e. Superstructure and Substructure, have been considered during Inventory Inspections. For the purpose of Detailed Inspections, it was decided to include a third main component i.e. Waterway/Embankment, for grouping of bridge elements. However, for consistency of data analysis, Superstructure and Substructure only have been retained as the main components for the purpose of Inventory Inspections.

Data on five major components of the Superstructure and Substructure, as described in sub-Section 4.2.3.b, is gathered during Inventory Inspections.

The Inventory Inspection Report allows for data on up to 10 bridge spans to be recorded on the one sheet as shown in Figure 4.7. If there are more than 10 spans a second sheet is used.

Span Data					Superstructure										Substructure						
					Support Structure				Deck/Running Surface			Railing				Foundations			Abutment or Pier		
Span No.	Span Length (m)	Width between Kerbs (m)	Footway Width (m)	Vertical Traffic Clearance (m)	Type	Material	Source	Condition	Material	Material	Condition	Material	Material	Condition	Abutment or Pier No.	Type	Material	Condition	Type	Material	Condition
					A	B	C	F	B	B	F	B	B	F		D	B	F	E	B	F
B1															Abutment A1						
B2															Pier P1						
B3															P2						
B4															P3						
B5															P4						
B6															P5						
B7															P6						
B8															P7						
B9															P8						
B10															Pier P9						
															Abutment A2						

Figure 4.7 - Span and Major Component Data

a. Span Data

Span Length (m)

The *Span Length* is normally measured from the expansion joint on the abutment to the centreline of the pier, or from pier centreline to pier centreline as shown in Figures 4.3. and 4.4. Span length is measured to the nearest 0.1 metre.

Width between Kerbs (m)

Width between Kerbs is measured to the nearest 0.1 metre (as shown in Figure 4.8). Where the width is the same on each span, there is no need to measure every span.

Footway Width (m)

Footway Width is the total clear width of both footways (where there are more than one), measured to the nearest 0.1 metre.

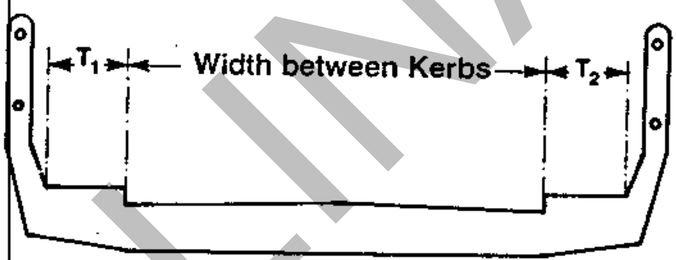


Figure 4.8 - Measurement of Width between Kerbs and Footway Width

Vertical Traffic Clearance (m)

Vertical Traffic Clearance is the vertical distance between the road and any overhead obstruction measured to the nearest 0.1 metre (as shown in Figure 4.9). Many bridges do not have any restriction. In many truss bridges, the vertical traffic clearance is restricted by the top lateral braces or lighting systems.

If there is no restriction, then "—" is recorded.

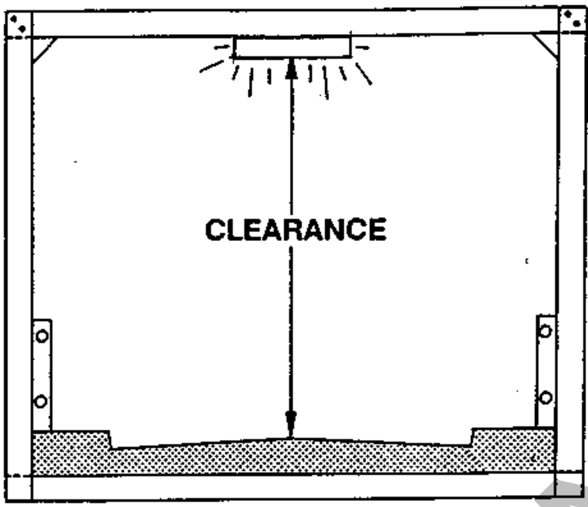


Figure 4.9 - Vertical Traffic Clearance

b. Component Type and Material Data

This data is recorded for five major components of the superstructure and substructure in each span of the bridge, as follows :

Superstructure :

- support structure i.e., truss, girder, etc.
- deck/running surface
- railing

Substructure :

- foundations
- abutments and piers

In addition, the *source* or country of origin of the support structure is recorded if appropriate.

This data is recorded using alphabetic codes which are listed on Page 2 of the Inventory Inspection Report, and which are shown in Figure 4.10.

A. Superstructure Type	B. Material	C. Superstructure Source	D. Foundation Type	E. Abutments and Piers
B box culvert *Y pipe culvert* *A pipe arch culvert* *T suspension* *C cable stayed* *G girder* *M composite* *P plate* *L beam arch* *E arch* *R truss* *S temporary* *F ferry* *K railway level crossing* *W wet crossing* *U other*	*K timber* *S masonry - brick* *M masonry - stone* *G gabions, etc.* *H stone pitching* *D concrete - unreinforced* *T concrete - reinforced* *P concrete - prestressed* *B steel* *U steel trough deck* *Y steel tube - concrete fill* *J aluminium* *E neoprene / rubber* *F teflon* *V PVC* *N geotextile* *O common soil / clay or fill* *A asphalt* *R gravel / sand* *W macadam* *X natural material* *L other*	*W Acrow/Bailey* *A Australia (permanent)* *P Australia (semi permanent)* *T Australia (temporary)* *B Holland (new type)* *D Holland (old type)* *I Indonesia* *U Callendar Hamilton (UK)* *J Japan* *R Austria (permanent)* *S Austria (semi permanent)* *X no structure* *L other*	*CA cakar ayam* *LS spread footing* *TP driven pile* *PB bored pile* *TU screw pile* *SU caisson* *LL other*	*Abutments* *A cap* *B retaining wall* *K special abutment* *Piers* *C pile cap* *P solid wall* *S single column* *D two column* *T three or more columns* *L other*

Figure 4.10 - Codes for Superstructure and Substructure Components

Superstructure

Support Structure

The *Types* of support structure usually found in Indonesia are shown in Figure 4.11. Codes are selected from Column A in Figure 4.10.

The *Material* of construction for most support structures is readily determined by visual inspection. Codes are selected from Column B.

The *Source* of the support structure is usually apparent, particularly for standard truss and girder bridges. Drawings of Standard Bridge Superstructures are shown in Appendix 3, to assist in recognition of the Source of bridge support structure and selection of code from Column C.

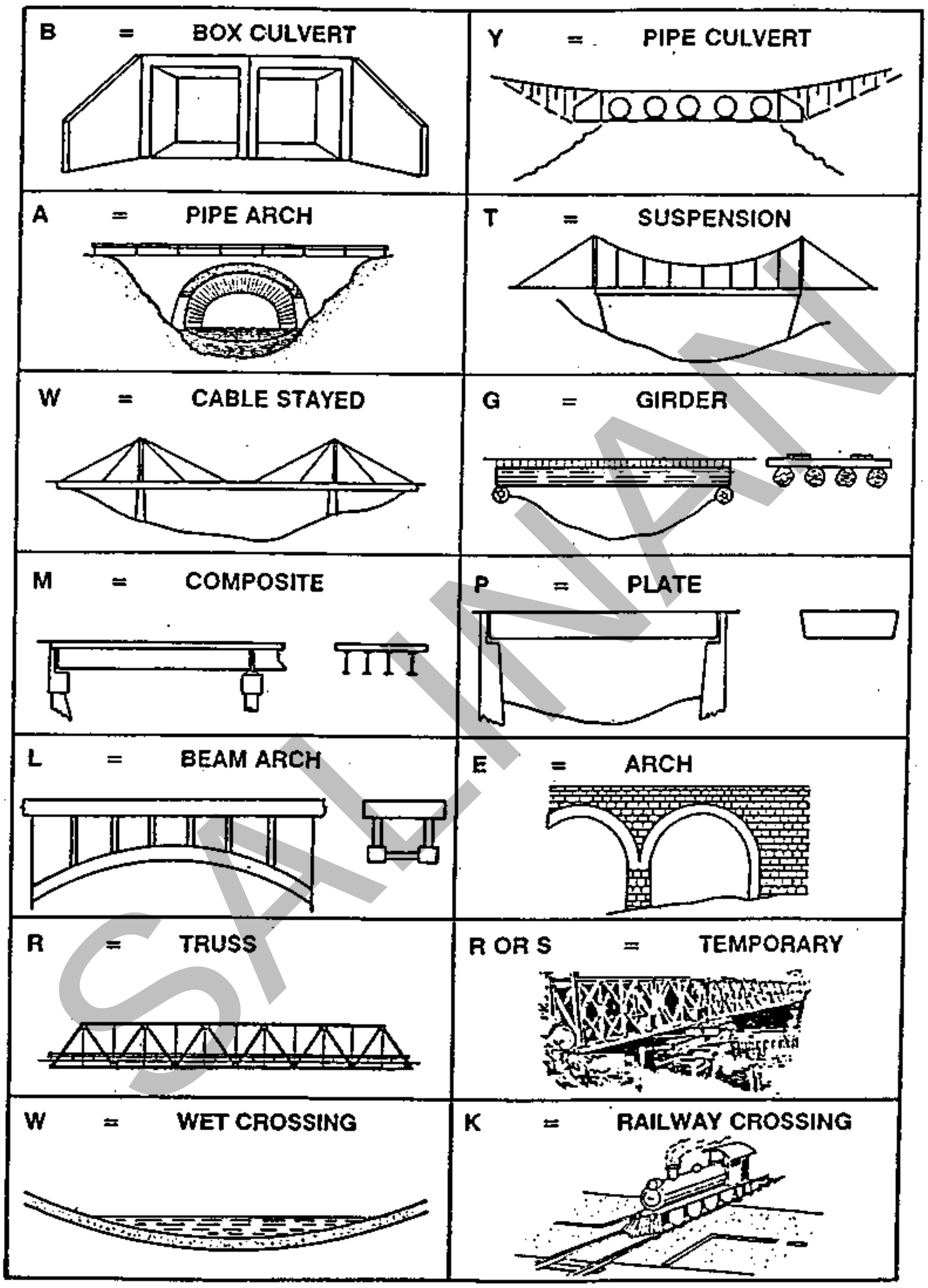


Figure 4.11 - Types of Superstructure

Following registration in the database, the BMS-MIS combines the Type, Material and Source codes into a 3-letter code which identifies the type of bridge structure or crossing type for use in BMS reports, e.g :

RBA	Australian Steel Truss
RBL	Steel Truss (other)
GBJ	Japanese Steel Girder
KXX	Railway Crossing
WXX	Wet Crossing
FXX	Ferry Crossing

Deck/Running Surface

The *Deck* and *Running Surface* are each recorded by the use of separate material codes from Column B. The deck material is recorded in the first column and the running surface material is recorded in the second column.

Railing

The *Railing* includes the handrail, guard-rail and posts. The material code for the railing itself is recorded in the first column and the material code for the posts is recorded in the second column.

Substructure

Foundations

Generally, the *Type* of foundation cannot be determined in the field, unless the foundations have been exposed by scouring and the river bed is dry.

The information could be available from design drawings or construction records. If no information is available, the record is left blank. Otherwise, codes are selected from Column D in Figure 4.10.

The same applies to *Material*. If information is available, codes are selected from Column B.

Abutments and Piers

The *Types* of abutments and piers usually found in Indonesia are shown in Figure 4.12. Codes are selected from Column E in Figure 4.10.

The *Material* of construction is readily determined visually. Codes are selected from Column B.

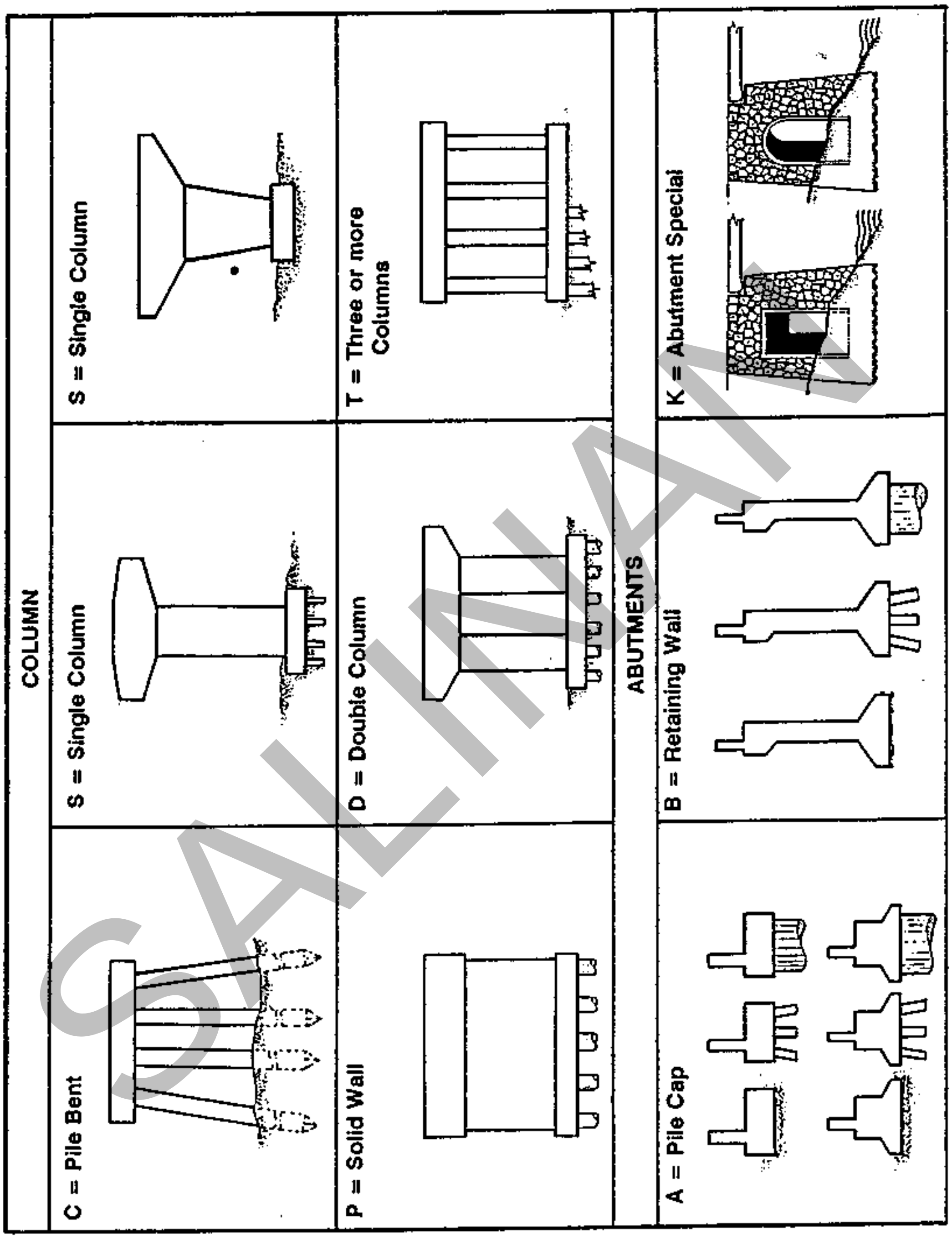


Figure 4.12 - Types of Abutments and Piers

c. Component Condition Data

In an Inventory Inspection, the condition of the components of the bridge is determined on a subjective basis i.e. the inspector uses his engineering judgement and experience to determine the overall condition of the five major components of the superstructure and substructure in each span as listed in sub Section 4.2.3.b.

Each of the major components is assigned an *Inventory Condition Mark*, selected from the table on page 2 of the Inspection Report. This table is reproduced in Figure 4.13.

The condition of the waterway, i.e. the presence of scour, can be included in the overall condition mark for each pier or abutment. The condition of the embankment can be included in the condition mark for each abutment.

Eventually, the Inventory Condition Mark will not have any significance in the BMS, but until a Detailed Inspection is carried out on each bridge and more accurate data on bridge condition is available, the BMS MIS converts the Inventory Condition Mark to an equivalent Bridge Condition Mark for comparison with bridges which have had a Detailed Inspection.

F. INVENTORY CONDITION MARK	
	Note
0 as new with no defects 1 very minor defects 2 defects which require monitoring or maintenance in the future 3 defects which require attention soon 4 critical condition 5 component broken or no longer functioning	Inventory Condition Mark in this table to be used only if Detailed Inspection is not being carried out at the same time as the Inventory Inspection

Figure 4.13 - Inventory Condition Mark

4.2.4 Guidelines for Assignment of Inventory Condition Marks

Inventory Condition Marks are assigned according to the guidelines in Figure 4.14.

Condition Mark 0	- -	as new condition with no defects self-explanatory. Bridge element is in good condition
Condition Mark 1	- -	very minor defects (defects can be treated by routine maintenance, and do not affect safety or function of bridge) examples are minor scour, surface corrosion, loose or missing bolts, loose timber planks
Condition Mark 2	- -	defects which require monitoring or maintenance in the future examples are minor rot in timber members, deteriorated mortar in masonry elements, extensive rubbish or soil build-up around bearings, signs which need replacement
Condition Mark 3	- -	defects which require attention soon (defects which may become serious within 12 months) examples are concrete members with minor cracks, rotted timber members, potholes in running surface, bumps in running surface at abutments, moderate scour at piers/abutments, corroded steel members
Condition Mark 4	- -	critical condition (serious defect requiring immediate attention) examples are failed members, extensive cracking or spalling of deck, undermined foundations, concrete members with exposed and corroded reinforcement, missing handrail/guardrail
Condition Mark 5	- -	element broken or no longer functioning examples are collapsed superstructures, washed-out embankments

Figure 4.14 - Guidelines for Assignment of Inventory Condition Mark

4.2.5 Ancillary Data

This section of the Inventory Inspection Report is used to provide general information about the bridge, to assist in the preparation of treatment strategies for the bridge.

Existing Functional Restrictions

Most restrictions on bridges relate to a load limit. Any posted or axle or vehicle load limit is recorded in the box on Page 4 of the Report as shown in Figure 4.15. Other restrictions such as speed limit, closed lanes etc., are recorded under *other restrictions*.

If there is no posted load or other limit, a "—" is recorded.

Posted axle or vehicle load limit (tonnes)	
Other restrictions (please specify)	

Figure 4.15 - Existing Functional Restrictions

Traffic Flow

The effect of the existing bridge width on traffic flow is assessed and recorded as shown in Figure 4.16.

Is existing bridge width with regards to present traffic flow :		*enter 1,2, or 3*
1. Adequate	*- vehicles travel freely over bridge*	
2. Just wide enough	*- vehicles reduce speed due to congestion on bridge*	
3. Too narrow	*- vehicles have to stop and queue*	

Figure 4.16 - Traffic Flow

Detour and Diversion

This section records alternative routes or side tracks which are available if the bridge is closed to traffic, as shown in Figure 4.17.

If bridge is closed to traffic at any time, can traffic be diverted to an alternative route or side track ? *(please circle correct answer)*	YES	NO
If Yes, what is extra travel distance (km)		

Figure 4.17 - Detour and Diversion

Highest Flood Data

The highest known flood level in relation to the deck, and the source of the information is recorded as shown in Figure 4.18. This data may be used when determining the deck level of a replacement bridge. Figure 4.19 shows the method of measurement.

Highest known flood level: enter + if above deck or - if below deck (m)	
Date of highest flood (month, year)	
Source of information	

Figure 4.18 - Highest Flood Data

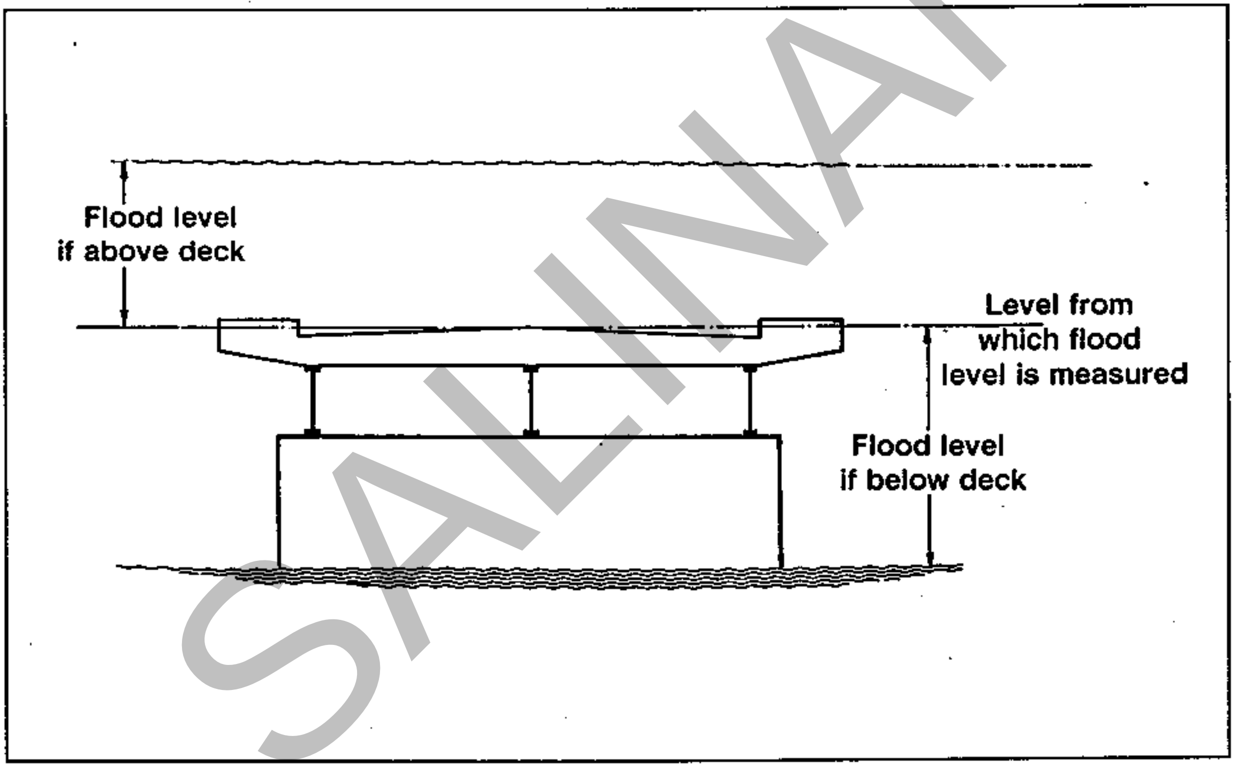


Figure 4.19 - Flood Level Measurement

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

BRIDGE INSPECTION MANUAL

SECTION 5

DETAILED INSPECTIONS

FEBRUARY 1993

DOCUMENT No. BMS2-M.E

TABLE OF CONTENTS

5. DETAILED INSPECTIONS

5.1 GENERAL

Detailed Inspections are carried out to accurately assess the condition of a bridge. All components and elements of the bridge are inspected and significant defects identified and recorded.

More specifically, the Detailed Inspection is carried out to :

- identify and record all significant defects in elements of the bridge
- rate the condition of elements and groups of elements of the bridge, by objectively determining a Condition Mark
- report whether Emergency Action is required and the reason why
- report whether a Special Inspection is required and the reason why
- report on whether effective routine maintenance is being carried out

The data from Detailed Inspections is entered into the BMS Database. The BMS MIS is able to process the data and recommend overall treatments for each bridge to return it to a specified condition and level of serviceability.

5.1.1 Personnel

At least one certified Provincial Bridge Inspector is required to carry out a Detailed Inspection of a bridge, assisted by one or more trained inspectors from Dinas, sub-Dinas, or Cabang Dinas Bina Marga.

Other assistants and labour may be required depending on the circumstances, such as the location of the bridge, complexity of the structure and traffic conditions.

5.1.2 Equipment and Materials

The Inspectors need the following equipment to carry out a Detailed Inspection Basic Equipment and Materials :

- *Detailed Inspection Report* Forms
- paper for sketches and notes
- clipboard
- pens, pencils and eraser
- camera with flash and film
- calculator
- vehicle with a functioning odometer
- measuring wheel
- 2 m and 30 m tape measure
- small white-board and non-permanent marking pens (to display bridge name and number in photographs)
- binoculars

- torch and batteries
- white chalk
- shovel
- machete
- hammer
- screw driver
- plumb bob and line
- steel brush
- small broom
- mirror
- pocket knife
- protractor
- crack gauge
- straight edge
- callipers - in and out
- cold chisel
- feeler gauge set
- spanner set
- crow bar
- ground sheet
- ladder

Additional Equipment (as required) :

- boat
- waders
- scaffolding
- water sampling bottles

Safety Equipment :

- safety vests and caps
- signs
- traffic cones
- buoyancy vests
- tether lines

5.1.3 Reference Material

Prior to carrying out a Detailed Inspection, the inspectors need to collect the following material

- Field Handbook for Bridge Inspections
- map showing Provincial Road Links (PETA PERANAN JALAN)
- Link and Traffic Data Report IBMS-IR1 for the Province

- Detailed Inspection Paket Report IBMS-DI2 listing all bridges which will be inspected
- current Bridge Inventory Data Report IBMS-BDI for each bridge which will be inspected
- previous Detailed Inspection Data Report IBMS-BD3 for each bridge which will be inspected

5.1.4 Selection of Bridges for Detailed Inspection

Detailed Inspections are generally carried out at a maximum interval of five years. The Detailed Inspection Paket Report IBMS-DI2 is generated by the BMS, which uses the following criteria for selection of bridges for inspection :

- Condition Mark 3 or higher, and previous Detailed Inspection more than two years ago;
- Previous Detailed Inspection more than 4 years ago, and
- Major bridgework recently completed, and Detailed Inspection is now required to establish new Inventory and condition data.

Bridges are not selected for Detailed Inspection if they are less than 6m in length, or if they are in a current Works Program. Wet crossings are not inspected.

After finalisation of the Detailed Inspection Paket, the current Inventory Data Report IBMS-BD1 and the previous Detailed Inspection Report IBMS-BD3 can be prepared for each bridge in the Paket, for use in the Inspections.

5.1.5 Inspection Sequence

Each bridge should be inspected in the following sequence :

- confirm the bridge site and record the administrative data on Page 1 of the Detailed Inspection Report - bridge name, location, Cabang, etc.
- check the Bridge Inventory Data on the Inventory Data Report IBMS-BD1, and record the correctness or otherwise on Page 1 of the Inspection Report. Correct the Data Report if necessary.
- walk around the bridge and obtain an overall impression of the structure
- systematically inspect the bridge from foundations to the deck and record elements with defects, location of the defective elements and Condition Marks, on Page 2 of the Inspection Report
- record other data on Page 3 of the Report

- derive the Condition Mark of the higher - level elements as required, and record on Page 3 of the Inspection Report

- record on Page 2 of the Inspection Report which items require Routine Maintenance

- record on Page 1 of the Report whether a Special Inspection or Emergency Action is required and the reason why.

During the Inspection, the Inspector should take photographs and draw sketches to clarify the report if necessary.

5.2 DETAILED INSPECTION SYSTEM

5.2.1 General

The basis of the Detailed Inspection System is the rating of the condition of elements and groups of elements according to the presence and significance of defects.

For the purpose of Detailed Inspection and evaluation of the overall condition of the bridge, the structure of a bridge is divided into a *hierarchy of elements* containing 5 Levels. The highest level is Level 1 which contains only the bridge itself and the lowest level is Level 5 which refers to individual minor elements and parts of the bridge.

The Detailed Inspection aims at rating the condition of elements at the highest possible Level at which all elements in that Level are in the same condition. The highest level at which elements are rated is Level 3. In most situations, it is necessary to rate elements at Level 4 or Level 5.

In order to simplify the inspection procedure only defects which are *significant* are recorded during a Detailed Inspection. If there are minor defects which can be corrected during Routine Maintenance, these should only be reported in the Routine Maintenance Section on Page 2 of the Report.

For each element where significant defects are present, 5 *marks* are determined viz :

- Nature Mark
- Extent Mark
- Degree Mark
- Function Mark
- Implication Mark

Each of these is scored as either 0 or 1, which assists to remove subjectivity from the inspection, leading to greater consistency of assessment.

Elements or groups of elements are rated by assigning a *Condition Mark* of between 0 and 5 to the element or group, which represents the sum of the five marks determined above.

Following rating of elements at Levels 5, 4 or 3, the Condition Mark for elements at higher Levels in the hierarchy is determined by evaluating the extent of the defects in elements at a lower Level in relation to the elements at the next higher level, whether or not these elements are able to function, and whether other elements at the same (higher) level are influenced by the defects.

The Condition Mark for Level 3 elements relevant to a particular bridge is determined by the inspector in the field in this manner, and recorded on the Inspection Report. The BMS MIS uses the Condition Marks at Level 3 to derive a Condition Mark for the bridge at Level 1 and to determine an overall treatment strategy for the bridge. The recommended treatment could be replacement of the bridge if it is in a critical condition and the cost of repair is too great, rehabilitation of the bridge involving major repairs or replacement of major components of the bridge, repair of individual elements, or routine maintenance only.

5.2.2 Element Hierarchy and Codes

Bridges are considered to consist of a hierarchy of elements in five Levels. Each Level contains a number of elements or groups of elements, each of which has a four-digit *Element Code*. The use of Codes is essential for recording and processing by the BMS MIS.

The highest Level is Level 1 which contains only the bridge itself. This has an Element Code 1.000 - Bridge.

Level 2 contains 3 elements as follows :

2.200 -	Waterway/Embankments	-	the stream and environs including approaches
2.300 -	Substructure	-	foundations, abutments and piers
2.400 -	Superstructure	-	support structure, deck and miscellaneous elements above deck level

Each of these is further subdivided into major elements at Level 3, e.g. Element 2.300 is subdivided as follows :

3.310 -	Foundations	-	all foundations of all abutments and piers
3.320 -	Abutment/Piers	-	all abutments and piers

These are further subdivided into groups of elements at Level 4, e.g. :

4.321 -	Pile Caps	-	all pile caps in the bridge
4.322 -	Pier Wall/Columns	-	all piers
4.323 -	Abutment Walls	-	both abutment walls
4.324 -	Wing Walls	-	all wing walls, both abutments

etc.

The complete list of Element Codes, arranged in hierarchical Levels, is shown in Figure 8.1 in Part 2 of the Manual. There is no listing of Level 5 elements as these are merely individual items of Level 4 elements, and thus they have the same Element Code.

If it is necessary to distinguish between elements at Level 4, then the defective element is reported at *Level 5* and the appropriate *location* is recorded.

Thus Level 5 is used to rate *individual* minor elements. In this case, it is always necessary to record the location of the element, as described in Section 5.3.4.

Elements at Level 3 and Level 4 in the hierarchy include all similar elements in the bridge e.g. Element 3.450 - Truss includes all trusses in the bridge, Element 4.461 - Top Chord includes all top chords in all trusses in the bridge.

5.2.3 Defect Codes

For the purpose of recording, defects are allocated a 3-digit *Defect Code*. The defects normally found in bridges in Indonesia are described in Part 2 of the Manual.

Defects are normally *material* - related or *element* - related.

Examples of material - related defects are :

- spalling in concrete (Code 201)
- corrosion in steel (Code 302)
- rot in timber (Code 401)

Table 9.1 in Part 2 lists material - related defects.

Examples of element - related defects are :

- scour in waterway (Code 503)
- scour in embankment (Code 515)
- movement in abutment (Code 601)

Table 10.1 in Part 2 lists element - related defects.

5.2.4 Element Rating System

The *Element Rating System* for defective elements consists of a series of 5 questions about the defects present.

These questions are concerned with the following :

- *Nature* - whether the defect is *harmful* or *harmless*
- *Degree* - the degree to which the defect has developed i.e. *heavy* or *light*
- *Extent* - whether the defect is *extensive* or *not extensive* i.e. does it exist in *more* or *less* than 50 % of the element by length, area or volume
- *Function* - is the element still functioning
- *Implication* - is the defective element seriously influencing other elements or the flow of traffic

A score of either 1 or 0 is allocated to the element in respect of each defect present, according to the criteria shown in Figure 5.1

Mark	Criteria	Score
Nature Mark (S)	harmful	1
	harmless	0
Degree Mark (R)	developed to a heavy degree	1
	developed to a light degree	0
Extent Mark (K)	extensive - 50 % or more is affected by the defect	1
	not extensive-less than 50 % is affected by the defect	0
Function Mark (F)	element is not functioning	1
	element is functioning	0
Implication Mark (P)	other elements influenced	1
	other elements not influenced	0
CONDITION MARK (NK)	NK = S + R + K + F + P	0 - 5

Figure 5.1 - Determination of Condition Mark

The Condition Mark is assessed at either Level 5, Level 4 or Level 3 using this system. If the initial assessment of an (individual) element is made at Level 5, then the *group* of similar elements is then assessed at the higher levels i.e. Level 4 and Level 3, by asking the same questions about the group of elements as a whole, as described in Section 5.3.5.

Guidelines for assessing the *nature* and *degree* of typical defects are shown in Appendix 2.

5.2.5 Significant Defects

Only elements with *significant* defects are recorded, in order to simplify the inspection procedure and reduce the number of the elements reported.

A significant defect is defined as follows :

- the defect is *harmful* and developed to a *heavy* degree, or
- the defect is *harmful* and *extensive*, or
- the defect is *harmful, heavily-developed* and *extensive*

This means that elements with significant defects will have a Condition Mark of at least 2.

If an element has a Condition Mark less than 2 (i.e. 0 or 1), then it is in good condition or has defects which are minor and of limited extent. These elements either do not require treatment, or they can be treated by Routine Maintenance.

An element with a Condition Mark of 2 has extensive minor defects or major defects of minor extent. The condition of these elements requires monitoring, generally with a view to carrying out repair or maintenance in the future.

5.3 DETAILED INSPECTION PROCEDURE

5.3.1 Administrative and Inventory Data

The identification of the bridge must be established to ensure that it is the bridge intended for inspection. This can be done by checking the details recorded on the name plate on the bridge if any, its location and the basic structure of the bridge. These details are checked against those shown on the current Inventory Data Report IBMS-BD1 and any necessary corrections made to missing or incorrect data using a red, waterproof pen.

The Administrative Data is recorded in the normal manner, as described in Section 4.2.1.

The correctness or otherwise of the current Inventory Data is recorded in the box on Page 1 of the Inspection Report, as shown in Figure 5.2.

INVENTORY DATA

Is Inventory Data correct ?	(circle answer)	YES	NO
If any data is incorrect, please show corrections on Inventory Data Report with red pen			

Figure 5.2 - Verification of Inventory Data

The corrected Inventory Data Report is submitted to the BMS Supervisor for amendment of the existing data in the BMS database, following completion of the Detailed Inspection.

5.3.2 Overall Impression

In order to gain an overall impression of the bridge, the inspector should walk around and under the bridge and observe its general form, overall condition and performance under traffic. This should take about 10-15 minutes for a single span bridge, but it must include the observation of the passage of at least one heavy vehicle.

During this preliminary inspection, the inspection should note those elements of the bridge which are defective and which differ in appearance or condition from other parts or elements of the structure in the same hierarchical level. This will assist the inspector to plan his overall inspection and determine the level at which the rating of elements should commence.

This is conveniently carried out by referring to the list of elements at Level 3 on the Inspection Form, selecting those which are relevant to the bridge being inspected, and observing the sub-elements of each Level 3 group in turn, i.e at Level 4, to determine whether they are in similar condition. Until the inspector is familiar with the hierarchy of Elements, he will find it necessary to refer to the list of Level 4 Elements itself in order to carry out this activity.

If all the sub-elements of a Level 3 element (i.e. at Level 4) are in the same condition with the same or no defects, then that particular Level 3 element can be rated without recording the defects in lower Level elements.

If the sub-elements of the Level 3 element are in different condition or have different defects, then those defects must be recorded for these sub-elements and rating carried out at either Level 4 or Level 5.

5.3.3 Listing of Defective Elements

The bridge should be systematically inspected and each *defective element* and the *defect* listed on Page 2 of the Inspection Report, according to its Element Code and Defect Code. Provision is made for recording the description of elements and defects, but this is not essential.

Examples of the listing of defective elements and defects are shown in Figure 5.3.

Where more than one significant defect exists in the same element, each defect is recorded.

Where a Detailed Inspection is carried out following rehabilitation or major repair then all previously - recorded defective elements must be re-inspected to ensure the work carried out has been effective, and a new assessment of condition made.

Defective Element		Defect		Location				Level 5 Condition						Level 3 - 4 Condition					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.462	BOTTOM CHORD	302	CORROSION																
4.461	TOP CHORD	302	CORROSION																
4.463	DIAG. NORMAL	302	CORROSION																
4.612	BEARINGS	712	DEFORMATION																
3.210	WATERWAY	503	SCOUR																

Figure 5.3 - Listing of Defective Elements

5.3.4 Location of Defective Elements

Location of defective elements is specified according to the *Element Number System* described in Section 3.4.2.

The location of defective elements is only recorded for elements rated at Level 5.

Examples of the use of the element numbering system to locate defective elements are shown in Figure 5.4.

In particular, the table shows the use of the location to record single elements, i.e. 4.320 Abutment and 4.450 Truss, where the defect affects the whole of these elements, but not other similar elements. These elements are recorded at Level 5, using the element code and location.

By comparison, the single elements 3.210 Waterway and 4.505 Running Surface do not have a location recorded, which indicates that the entire element is affected by the defect.

Element 4.612 Bearings is recorded with location *A1* only, which indicates that all bearings at A1 are defective.

Defective Elements		Defect		Location				
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	YZ	
4.462	BOTTOM CHORD	302	CORROSION	B 5		2		Span 5, all bottom chord segments, RH Truss
4.461	TOPCHORD	302	CORROSION	B 5	1	1		Span 5, 1st segment top chord, LH Truss
4.463	DIAG. NORMAL	302	CORROSION	B 5	7	1		7th Diagonal, LH Truss
4.463	DIAG. NORMAL	303	DEFORMATION	B 5	7	1		7th Diagonal, LH Truss
4.622	RAILING	302	CORROSION	B 5		1	1	Span 3, LH Truss, Bottom Rail (entire)
4.612	BEARINGS	604	DEFORMATION	A 1				Abutment 1, all bearings
3.210	WATERWAY	503	SCOUR					Waterway (entire)
4.505	RUNNING SURFACE	903	HEAVING					Running Surface (entire)

Figure 5.4 - Location of Defective Elements

5.3.5 Assignment of Condition Mark

After recording the defective elements and the defects, the Condition Mark is assessed using the element rating system described in Section 5.2.4.

Assessment at Level 5

e.g. In Figure 5.4, Element 4.462 has Defect 302 in one bottom chord only, the chord in the RH truss in B5.

The defect (corrosion) is harmful and has developed through more than 10 % of the cross-section of the chord. Therefore the Nature and Degree Marks S and R are each 1.

The corrosion extends over the entire element, therefore the Extent Mark K is 1.

The chord is still functioning; therefore the Function mark is 0.

The corroded chord is not affecting the performance of other elements, therefore the implication mark is zero.

The Condition Mark of this element at Level 5 is therefore 3, as shown in the column marked "Level 5" in Figure 5.5.

Assessment at Level 4

After an individual element has been rated at Level 5, the Condition Mark of the group of all similar elements is assessed and recorded at Level 4.

eg. Element 4.462 - there is no corrosion present in any other bottom chord in any truss in the bridge, so the Extent Mark is 0 (less than 50 % of all the bottom chords in the bridge).

The Nature and Degree marks S and R remain at 1, because the defect is harmful and developed through more than 10 % of the cross-section of the RH bottom chord in B5.

Obviously, the Function and Implication Marks remain at 0.

The Condition Mark at Level 4 of Element 4.462 (**all** bottom chords in the bridge) is 2, as shown in the column marked "Level 3-4".

Similarly, Elements 4.461, 4.463 and 4.472 are assessed, firstly at Level 5 and then at Level 4, as shown in Figure 5.5

Where there is more than one defect in the same element, then the defect which has the highest combination of Nature, Degree and Extent Marks is used to assess that element's Condition Mark. If the defects have the same score for these 3 Marks, then if one of the defects has an influence on other elements or the flow of traffic (i.e. Implication Mark of 1), then that defect is used to determine the Condition Mark of the element.

eg. Defect 302 in Element 4.463 is used to determine the Condition Mark of all the Diagonals, because the sum of the Nature, Degree and Extent Marks is 3 for Defect 302 and only 2 for Defect 303.

Defective Element		Defect		Location				Level 5 Condition Mark						Level 3 - 4 Condition Mark					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.462	BOTTOM CHORD	302	CORROSION	B5		2		1	1	1	0	0	3	1	1	0	0	0	2
4.461	TOP CHORD	302	CORROSION	B5		1		1	1	1	0	0	3	1	1	0	0	0	2
4.463	DIAG.NORMAL	302	CORROSION	B5	7	1		1	1	1	0	0	3	1	1	0	0	0	2
4.463	DIAG.NORMAL	303	DEFORMATION	B5	7	1		1	0	1	0	0	2						
4.622	RAILING	302	CORROSION	B5		1	1	1	1	0	0	0	2	1	1	0	0	0	2
4.612	BEARINGS	712	DEFORMATION	A1		1		1	1	1	0	0	3	1	1	1	0	0	3
		712	DEFORMATION	A1		2		1	1	1	0	0	3						
3.210	WATERWAY	503	SCOUR											1	1	1	0	1	4
4.505	RUNNIG SURFACE	303	HEAVING											1	1	1	0	1	4

Figure 5.5 - Assignment of Condition Marks at Level 5 and Level 3-4

Assessment at Level 3

After groups of elements have been rated at Level 4, the Condition Mark is assessed at Level 3, and recorded on Page 3 of the Inspection Report.

eg. in the example in Figure 5.5, there are no defects in any truss in the bridge other than the trusses in B5. The trusses in B5 are part of Element 3.450 - Trusses.

All the defective elements in these trusses must be considered in the derivation of the Condition Mark for Element 3.450 at Level 3, ie. Elements 4.461, 4.462 and 4.463.

In fact, these elements have the same Condition Mark, so it does not matter which defect is used to determine the Condition Mark for Element 3.450.

The Nature and Degree marks remain at 1, and the Extent, Function and Implication Marks remain at 0.

The Condition Mark at Level 3 of Element 3.450 (all trusses in the bridge) is 2, as shown in Figure 5.6.

Similarly, other major elements which have defects are rated and recorded at Level 3.

e.g The Condition Mark at Element 3.620-Railing is derived from the Condition Mark of Element 4.622-Horizontal Railing, and remains at 2.

The Condition Mark of Element 3.610-Bearings is derived from the Condition Mark of Element 4.612-Rubber Bearing and remains at 3.

The Condition Mark of Element 3.500-Deck System is derived from the Condition Mark of Element 4.505-Running Surface. In this case, the Running Surface is considered to be less than 50 % of the Deck System, and therefore the Extent Mark for Element 3.500 is 0. The Condition Mark is then 3.

LEVEL 3		Condition Mark (Must complete)					
Code	Element	S	R	K	F	P	NK
3.210	Waterway						
3.220	Scour Protection						
3.230	Embankments						
3.310	Foundations						
3.320	Abutments/Piers						
3.410	Girder System						
3.420	Flat Slab						
3.430	Arch						
3.440	Beam Arch						
3.450	Trusses	1	1	0	0	0	2
3.480	Suspension System						
3.500	Deck System	1	1	0	0	1	3
3.600	Deck Joints						
3.610	Bearings	1	1	1	0	0	3
3.620	Railing	1	1	0	0	0	2
3.700	Furniture						
3.80	Culvert						

Figure 5.6 - Assignment of Condition Marks at Level 3

5.3.6 Other Data

Other data is also required to be recorded against each defective element on Page 3 of the Inspection Report as shown in Figure 5.7.

Sketch Y/T	Photo Y/T	Quantity	Unit	Emergency Action	Special Inspection

Figure 5.7 - Other Data

Sketch, Photo

Record Y (yes) or T (no) as to whether a *sketch* has been drawn or a *photograph* taken of the defective element.

Quantity and Unit

Record the *Quantity* (amount) of the defect present and the *Unit* of measurement.

This information can be used subsequently to estimate the cost of repair/replacement.

Emergency Action

If the Inspector considers a major defect requires Emergency Action, it should be noted in the box against the element and defect (record "yes" or leave blank), and then transferred to the "EMERGENCY ACTION" Section on Page 1 of the Report, where the reason for the Emergency Action is recorded.

Special Inspection

If the Inspector considers a defective element requires a Special Inspection, it should be noted in the box (record "yes" or leave blank), and then transferred to the "SPECIAL INSPECTION" Section on Page 1, where the reason for the Special Inspection is recorded.

5.3.7 Routine Maintenance

The effectiveness of the Routine Maintenance carried out on the bridge is assessed by the Inspector, and recorded in the Routine Maintenance Section on page 2 of the Inspection Report.

Minor defects, such as excessive vegetation, blocked scuppers etc, are not recorded in the main list of defective elements, where only significant or serious defects are recorded.

Elements with minor defects, such as those referred to in the Routine Maintenance Section, can be usually be rectified by the Routine Maintenance workforce, and do not required complex repair or rehabilitation.

The Routine Maintenance Section is completed as described in Section 6.2.

5.3.8 Notes and Sketches

Notes and sketches should be made by the Inspector to clarify the nature, extent and location of particular defects and defective elements, on Page 4 of the Inspection Report.

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

BRIDGE INSPECTION MANUAL

SECTION 6

ROUTINE INSPECTIONS

BRIDGE MANAGEMENT SYSTEM
BMS
A PROJECT JOINTLY FUNDED BY INDONESIA AND AUSTRALIA

FEBRUARY 1993

DOCUMENT No. BMS2-M.E

TABLE OF CONTENTS

6. ROUTINE INSPECTIONS

6. ROUTINE INSPECTIONS

6.1 GENERAL

Routine Inspections are carried out to ensure that any sudden or unexpected changes in overall bridge condition which occur between *Detailed Inspections* are detected and reported so that appropriate action can be taken.

In particular *Routine Inspections* :

- ensure that the bridge is stable and safe
- determine whether *Effective Routine Maintenance* is being carried out
- specify if *Emergency Action* is required

Routine Inspections are carried out at least on an annual basis, but may be carried out more frequently depending on the circumstances or preference of each Province.

6.1.1 Personnel

At least one trained Bridge Inspector is required to carry out a Routine Inspection, assisted by at least one other person.

6.1.2 Equipment and Materials

The inspector will need the following equipment to carry out a Routine Inspection :

- *Routine Inspection Report* forms
- Inventory Inspection Forms (for previously - unrecorded bridges)
- pens and writing equipment
- vehicle with a functioning odometer
- 30m tape measure
- camera and film
- small white board and non-permanent marking pens

6.1.3 Reference Material

The inspector will need to collect the following material prior to carrying out Routine Inspections :

- Field Handbook for Bridge Inspections
- map showing Provincial Road Links (PETA PERANAN JALAN)
- Link and Traffic Data Report IBMS-IR1 for the Province
- Routine Inspection Paket Report IBMS-DI1 listing all bridges which will be inspected
- current Bridge Inventory Data Report IBMS-BD1 for each bridge which will be inspected

Note : *The purpose of the Routine Inspection is described in Section 6.1 above.*

It is not intended that the condition of the bridge or elements is rated during a Routine Inspection, only that the bridge is stable and safe.

However, until the accuracy of the condition marks for all bridges in the database is known to be accurate, updating and checking of the condition marks is to be carried out in conjunction with the annual Routine Inspections.

The Inventory Data Form IBMS-D15, which includes all Inventory Data including Condition marks for each bridge span, is used for this purpose, instead of Report IBMS-DI1.

6.1.4 Selection of Bridges for Routine Inspection

Bridges requiring a Routine Inspection in a particular year are listed on Report IBMS-DI1 - Routine Inspection Paket.

This Report lists all bridges in the bridge database. Bridges which are not to have a Routine Inspection have one of the following codes in the "NOTES" column :

- TAK - inspection not required (bridge is less than 6 m in length)
- DET - inspection not required (bridge is included in Detailed Inspection Paket)
- PGM - inspection not required (bridge is included in a current Works Programme)

All other bridges are to have a Routine Inspection in the current year.

Obviously, the Routine Inspection Paket should be determined after the finalisation of the Detailed Inspection Paket and the current Annual Works Programmes for Bridge Replacement and Rehabilitation.

After preparation of the Routine Inspection Paket, Bridge Inventory Data Reports IBMS-BD1 (or Inventory Data Form IBMS-DI5) can be prepared.

6.1.5 Inspection Sequence

Each bridge in the Paket should be inspected in the following sequence

- establish the identity of the bridge and record the Bridge Number and Administrative Data in the boxes provided,
- walk around the bridge and obtain an impression of the condition of the main components and major elements of the bridge
- record if Emergency Action is required and the reason why
- record if Routine Maintenance is required and the reason why

During the inspection the inspector should take photographs and draw sketches to clarify his report if necessary. Notes and sketches can be made on Page 2 of the Routine Inspection Report.

6.2 ROUTINE INSPECTION PROCEDURE

Record the Bridge Number and Administrative Data in the boxes provided, as described for Inventory Inspections in Section 4.2.1. This information can be taken from the Inventory Data Report, but should be subjected to a cursory check to establish that it is correct.

Inspect the bridge and observe the condition of the main components of the bridge as follows :

- Waterway/Embankment/Foundations
- Abutments and Piers
- Superstructure
- Deck/Running Surface
- Railings

The purpose of the inspection is only to check if the bridge is in a safe condition or whether *Emergency Action* or *Routine Maintenance* is required. Therefore, the elements of the bridge are not inspected in detail, but particular aspects of the bridge should be observed as follows :

- observe the bridge under traffic, for excessive deflection and vibration
- check for damaged, missing, deformed, corroded or decayed members, and assess significance
- check bearings and seismic buffers
- check underside of concrete deck for cracking, adequacy of cover to reinforcement, evidence of corrosion in reinforcement etc.
- check for missing, damaged or decayed timber deck members
- check and observe riding quality of running surface, particularly at the joint between the abutment headwall and the deck, in order to identify defects which contribute to excessive impact or which restrict the flow of traffic
- check drainage on the deck and approach roads, including vegetation and debris which may cause ponding of water
- check expansion joints and deck seals
- check for damaged, loose, missing or corroded railing
- check for damaged end-blocks
- check other bridge furniture such as signs, utilities and make notes if required
- check for scouring around embankments, abutments and piers
- check for subsidence, slippage or settlement of embankments

- check condition of piles for corrosion, cracking decay or settlement
- check for previous movement or settlement of abutments
- check for cracking in concrete and masonry wingwalls, abutments and piers
- check for corrosion or decay in columns

Emergency Action

Emergency Action is necessary if repair of a problem is required urgently and the work cannot be delayed for inclusion in an annual bridge rehabilitation project ie. the bridge is in danger of structural failure or traffic cannot safely pass over the bridge.

Emergency action is required in the following circumstances :

- scouring around embankments, abutments or piers
- debris (eg. large trees) which is placing excessive horizontal loads on piers or siltation and vegetation which is dangerously restricting the waterway.
- bridge columns or beams which are damaged, missing, deformed, corroded or decayed such that they are in danger of failure.
- holes in the bridge deck which may make the bridge unsafe for pedestrians, bicycles, motorcycles and other vehicles.
- settlement or movement of abutments or piers which may indicate potential bridge collapse.
- slipping of approach embankments, particularly around the abutments.

If Emergency Action is required, details of the components or elements requiring the action are recorded, by component or element name and location, and the reason for the emergency action is described, as shown in Figure 6.1

EMERGENCY ACTION

Is Emergency Action required ? *(circle answer)*		YES	NO
Elements for Emergency Action			
Component/element	*Location*	*Reason for Emergency Action*	
e.g. WATERWAY	A 1	HEAVY SCOUR	
e.g. TRUSS	B 2	MISSING BOLTS	
e.g. PIER	P 2	COLLISION DAMAGE	

Figure 6.1 - Emergency Action

Routine Maintenance

If Routine Maintenance is required, the particular aspects which require attention are recorded, as shown in Figure 6.2.

ROUTINE MAINTENANCE

1	*Is there accumulation of debris in the waterway?* *(circle answer)*	Yes	(No)
2	*Is there accumulation of dirt and debris on the bridge?*	(Yes)	No
3	*Is there excessive vegetation?*	(Yes)	No
4	*Is deck drainage indequate?*	(Yes)	No
5	*Is drainage of approaches inadequate?*	Yes	(No)
6	*Are there potholes and rough surfaces?*	Yes	(No)
7	*Do handrails need painting?*	(Yes)	No
8	*Is the number plate on bridge wrong or missing?*	(Yes)	No
9	*Is the name plate on bridge wrong or missing?*	Yes	(No)

Figure 6.2 - Routine Maintenance

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

BRIDGE INSPECTION MANUAL

SECTION 7

SPECIAL INSPECTIONS

FEBRUARY 1993

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TABLE OF CONTENTS

7. SPECIAL INSPECTIONS

7.1 GENERAL

Special Inspections are carried out when the inspector lacks the resources, training or experience to correctly assess the condition of a bridge.

A Special Inspection is carried out to :

- analyse materials or monitor the performance of specific components in which defects or movements have been detected, using specialised equipment.
- access locations normally not able to be inspected by visual or normal methods available to inspectors.
- supplement a Detailed Inspection.

Special Inspections may require the use of advanced techniques and equipment, but will still require the use of visual techniques and engineering knowledge and judgement.

7.2 PERSONNEL

Special Inspections are carried out by experienced bridge engineers who have a good knowledge of bridge design and construction, material techniques and repair methods.

In most cases, specialist advice should be requested from the sub-Directorate of Bridge Design in the Directorate of Planning in DGH.

The advice of staff from PUSLITBANG JALAN is also available to engineers in carrying out Special Inspections and testing.

7.3 SPECIAL INSPECTION TECHNIQUES

Techniques and equipment should be selected in relation to the number of bridges to be inspected, the expertise available and the level and type of inspection.

Destructive or partially destructive testing is undertaken to determine the compliance of physical, chemical, mechanical or other properties with the requirements of Standards or Specifications. However, this type of testing is normally the exception.

Most testing used in bridge inspection is of the non-destructive type. These techniques are well-established and have a direct relevance to inspection practices. There are a great variety of reliable techniques and methods which have been developed to suit the assessment of movements, strains, stresses, pressures and dynamic properties of materials and structures. Figure 7.1 is indicative of the wide range of possible methods of assessment.

Assessment of	Possible Method 3
Concrete	
strength	"Schmidt-hammer"
quality	ultra-sonic; vibration; radiographic;
lamination	sounding
cover	magnetic detector
detecting and determining of location reinforcement bars	magnetic detector
Steel	
cracks	ultra-sonic; acoustic crack detector; magnetic crack definer; dye penetrant; magnetic flux;
cable/wire failure	inductive/magnetic; radiographic; acoustic spying;
corrosion	electrical halfcell potential; inductive/magnetic;
Global behaviour	
movements	surveying instruments; photogrammetry; inductive transducers; clinometers; dial gauges;
extensometric measurements	strain gauges; strain meters; extensometers;
forces/pressures	mechanical/hydraulic/electrical devices; pressure transducer; load cells;
Miscellaneous	
thickness of coatings	paint film gauge; radiometric devices;
waterproofing membranes	electrical resistance
chloride in concrete	wet chemical analysis for total chloride

Figure 7.1 - Possible Methods of Assessment

7.3.1 Methods of Assessment of Materials

a) Cursory Assessment of Concrete Strength

The rebound-hammer (Schmidt-hammer) is used for non-destructive cursory assessment of concrete strength. It is a mechanical device working with a calibrated spring and is applied on the appropriately prepared surface. The rebound force is measured and can be read off the instrument. A table gives the corresponding concrete strength. At least three measurements are usually taken and the average value is used. The instrument gives indicative rather than exact values.

b) **Assessment of the quality of in-situ concrete**

Ultra-sonic methods are helpful to assess the following problems :

- assessment of homogeneity of concrete,
- localising of possible defects (e.g. presence of foreign substances, cracks, insufficient density),
- assessment of thickness of concrete members with access to only one face (e.g. arches, abutments),
- assessment of concrete strength immediately after setting (gives satisfactory results between one and ten days after setting).

The methods are based on the measurement of the propagation of ultra-sonic waves.

c) **Non-destructive dynamic testing**

This technique is used in assessing piles. At the surface of a pile head an electro-dynamic vibrator is attached, supplied by external sinusoidal current with a frequency ranging from 20 up to 1,000 Hz. The energy transmitted to the pile-head runs in a vertical direction towards the pile-tip from which part of it is reflected back to the pile-head. The force transmitted to the pile head is kept constant. The velocity is dependent as the ratio between the energy input and the reflected energy output. An interpretation of the velocity frequency relationships will give information about the quality of the piles (stiffness, continuity, possible defects).

d) **Corrosion assessment**

Corrosion assessment in reinforced concrete can be accomplished by electrical halfcell potential measurements using a saturated copper sulphate halfcell. Measurements are usually taken on a grid pattern (approximately 1.2 m). This method appears to be effective in indicating the extent of corrosion of the reinforcing steel. It can be concluded in general terms, however, that the more extensive the area of active potentials, the greater amount of corrosion.

Cables, strands or wire ropes can be checked for corrosion and deterioration by an inductive-magnetic measurement technique. It requires external power supply of relatively high frequency. The technique has been applied on cables of suspension bridges and found to give results approximately 75 percent reliable. More research is anticipated to further develop this method.

e) **Detection of cracks in structural steel**

Dye penetration and magnetic particle methods are conventional and useful means for search and detection of cracks.

Ultra-sonic techniques are frequently and successfully used in the search for and detection of cracks. Hidden cracks can be discovered by the ultra-sonic technique. They normally require specific surface preparation, the use of a couplant, a cathode ray tube display and skilled interpretation.

Special acoustic and magnetic detection devices are also available.

Radiography can give excellent results. However, this method is normally confined to defining cracks rather than searching for them.

Experience has shown none of the various methods are fully reliable. The use of more than only one method is advisable in cases where reliable results are required.

"Accustic spying" utilises the fact that normally a wire breakage causes something like a "sonic bang". This "sonic bang" is received and recorded by specially designed receivers attached to structural components, e.g. : cables, ropes, prestressing wires, cables or rods. The method can be applied on steel bridges as well as on prestressed concrete bridges, but should be considered as a qualitative rather assessment than an exact quantitative method.

f) **Detection of cable or wire failure**

Cable or wire failure can be detected by three different methods :

- Inductive-magnetic measurement technique
- "Acoustic spying"
- Radiographic methods

The inductive-magnetic measurement technique is basically the same as described in d) above

g) **Use of radiography on concrete structures**

Radiography methods i.e. X-ray or gammagraphy, which were originally developed for quality control during the construction process, are also useful for assessing concrete structures, especially bridge decks in prestressed concrete. The analysis provides various data on the condition of the structure, such as :

- quality of the concrete (homogeneity, cracks, etc.)

- defects in normal reinforcing bars or in prestressed wires (errors in positioning, abnormal deformations, cable fractures, corrosion, lack of bond);

- quality of grouting (and, if necessary, definition of those parts needing re-injection).

The thickness of concrete components which can be investigated is less than 50 centrimentres using the means normally employed (gammagraphy). A thickness of one metre can be assessed if high energy X-ray sources are used.

The dimension of the pictures imposes limitations on the use of this method as the data obtained is essentially localised.

7.3.2 Methods of Assessing Global Behaviour Under Load

a) Measurement of movements

Surveying instruments ranging from conventional types to advanced instruments and systems can be considered as an almost universal means for assessing various kinds of movements, e.g. : horizontal and vertical movements, differential vertical movements, rotational movements, deflections, settlements, etc. Since the introducing of Laser techniques, the scope of surveying instruments suitable for assessment of bridges has been broadened.

Photogrammetry has also been applied successfully as a means to measure deflections of web, deck and bottom plates of steel bridges. Areas of approximately 100 m^2 are "documented" on one picture, ready for evaluation of any point at any time. Provided proper access is available, this method is useful for assessing short as well as long-term behaviour under fixed or known conditions.

Inductive transducers connected to recording devices are suitable for short or long-term measurements of various kinds of movements. Rotational movements can be measured by clinometer. Available devices are :

- gravitation pendulum, free hanging or oil dampened;
- optical pendulum, luminous spot pendulum, laser devices;
- electrical clinometers
- direct-current (DC) operated flexure supported torque balance system;
- vibrating wire transducer;
- inclination sensor which is a glassbody with melted-in electrodes and an electrolyte.

When the device tilts, the electrolyte flows from one side to the other, thereby changing the resistance between the central electrode and the outer electrode thereby producing a signal.

Mechanical devices, such as dial gauges are also useful for the measurement of movements.

b) Extensometric measurements

A large variety of strain gauges, instruments and systems are available to suit almost every possible inspection.

Extensometers suitable for inspection purposes are mainly mechanical or mechanical-optical instruments. Both types required a pre-fixed base on the surface of the object measured (concrete, steel or other materials). They are normally temperature compensated using envier steel and can be for short-term as well as for long-term measurements.

A strainmeter - mechanical scratch tensiometer - measures and records static as well as dynamic phenomena and is mainly used for long-term measurements on metals.

c) **Measurement of forces and pressure**

Forces and pressures can be assessed by :

- mechanical devices;
- pressure transducers;
- load cells;
- hydraulic pressure devices.

A variety of suitable instruments, devices and systems are commercially available.

d) **Stress measurements**

Stresses are normally assessed by measuring the strain and calculating the corresponding stresses using the appropriate modulus of elasticity.

e) **Assessment of dynamic properties**

Knowledge of the dynamic properties can give valuable clues to the behaviour of a structure. Electrical measurement techniques are normally applied for the assessment of dynamic properties. Suitable instrumentation is commercially available but sometimes will have to be adapted to the individual requirements. The measurement of frequencies and amplitudes will normally yield the required information.

f) **Methods of loading or overloading**

There are various methods available depending on the kind of load required, e.g. static or dynamic, uniformly distributed, linear or point load, vertical, horizontal or torsional loads.

Conventional methods use materials of almost any kind (solid or fluid), vehicles with various axle and loads, and jacks with various capacities.

Loading and/or overloading together with the assessment of the resulting reactions can give valuable information on overall behaviour.

7.3.3 Miscellaneous Techniques and Equipment

a) Underwater assessment

Instruments, equipment, methods and techniques developed for nautical purposes, commercial and sports diving and for underwater exploration are normally suitable and can be used for assessing structures under the water.

Sounding may be made with rods, plumb-lines, echo-sounders and electronic depth finders.

For an overall assessment, equipment such as underwater cameras, underwater television cameras with or without video tape recorder, are suitable.

b) Measuring the thickness of coatings

Besides the widely used paint film gauge, radiometric devices working with β and γ-rays can be used for assessing the thickness of coatings. A scintillation counter receives the radiation and the output impulses are transformed into a current proportional to the thickness.

c) Measuring concrete cover, detecting reinforcement bars and determining their size

A portable instrument, the "covermeter" can be used to measure concrete cover, to detect reinforcement bars and to determined the bar size. The covermeter is a solid-state magnetic detector operating on the principle of changes in magnetic flux. If no reinforcement is present, the signal pickup in the coil is dependent on the magnetic linkage through air between the two poles of the instruments probe. If reinforcement is present, the presence of the steel bars increases the linkage between poles and the corresponding signal in the coil.

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
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BRIDGE INSPECTION MANUAL

PART 2

BRIDGE ELEMENTS AND DEFECTS

BRIDGE MANAGEMENT SYSTEM
BMS
A PROJECT JOINTLY FUNDED BY INDONESIA AND AUSTRALIA

DOCUMENT No. **BMS2-M.E**

DIRECTORATE GENERAL OF HIGHWAYS
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BRIDGE INSPECTION MANUAL

SECTION 8

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TABLE OF CONTENTS

8. BRIDGE ELEMENTS

8.1 GENERAL

Bridges consist of a large number of *elements* which interact with each other and their environment.

In the BMS Inspection Procedures, the elements of a bridge are considered in a *Hierarchy* of Levels. There are five Levels in the Hierarchy.

Level 1 is the bridge as a whole, which has an *Element Code* 1.000 -Bridge.

Level 2 contains the *main components* of the bridge as follows :

2.200	Waterway/Embankments
2.300	Substructure
2.400	Superstructure

Level 3 divides the main components into *major elements* e.g :

3.210	Waterway
3.220	Scour Protection
3.230	Embankments
3.310	Foundations
etc.	

Level 4 in the Hierarchy divides the major elements into groups of individual elements or parts of similar type e.g. Element 3.220 Scour Protection includes the following Level 4 elements :

4.221	Groynes
4.222	Gabions
4.223	Concrete Lining
4.224	Sheet Piling
etc.	

A Level 4 element includes all the individual elements of that type in the entire bridge. Thus Element 4.224 includes all sheet piling in all locations at that bridge site.

If it is necessary to distinguish between elements of the same type at different locations at the bridge site, the element at each location is referred to as a *Level 5* element. Each "Level 5" element has the same code as its Level 4 *group* i.e. 4 _ _ _ but is allocated a unique *location* to differentiate it from other elements of the same group e.g. Element 4.224 at *A1* means the sheet piling at Abutment 1.

The Location System for Level 5 elements is described in Section 3.4 of Part 1.

The entire Element Hierarchy for bridges is shown in Figure 8.1.

ELEMENT CODES

CODE	LEVEL 1	CODE	LEVEL 2	CODE	LEVEL 3	CODE	LEVEL 4
1.000	Bridge	2.200	Waterway/ Embankments	3.210	Waterway	4.211	Stream Bank
						4.212	Main Channel
						4.213	Flood Plain
				3.220	Scour Protection	4.221	Groyne
						4.222	Gabion
						4.223	Concrete Lining
						4.224	Rock Beaching
						4.225	Sheet Piling
						4.226	Fender System
						4.227	Retaining Wall
						4.228	Riverbed Controller
				3.230	Embankments	4.231	Approach Embankment
						4.232	Embankment Drainage
						4.233	Pavement
						4.234	Approach Slab
						4.235	Reinforced Earth Wall
		2.300	Substructure	3.310	Foundations	4.311	Pile
						4.312	Well Foundation (Caisson)
						4.313	Spread Footing
						4.314	Anchor
						4.315	Arch Thrust-Block
				3.320	Abutments/Piers	4.321	Pile Cap
						4.322	Pier Wall/Column
						4.323	Abutment Wall
						4.324	Wing Wall
						4.325	Crosshead
						4.326	E/Q Restraint Block
						4.327	Bracing
						4.328	Temporary Support
						4.329	Weephole
		2.400	Superstructure	3.410	Girder System	4.411	Girder (Main)
						4.412	Cross Beam (Girder)
						4.413	Diaphragm (Girder)
						4.414	Connection (Girder)
						4.415	Bracing (Girder)
				3.420	Flat Slab	4.421	Slab
				3.430	Arch	4.431	Barrel
						4.432	Spandrel Wall
				3.440	Beam Arch	4.441	Girder (Beam Arch)
						4.442	Arch Beam
						4.443	Vertical (Beam Arch)
						4.444	Cross Beam (Beam Arch)
						4.445	Lateral Bracing (Beam Arch)
						4.446	Connection (Beam Arch)
				3.450	Trusses	4.451	Truss Panel
						4.452	Chord Reinforcement
						4.453	Bracing Frame
						4.454	Raker
						4.455	Panel Pin/Circlip
						4.456	Clamp
						4.461	Chord Top
						4.462	Chord Bottom
						4.463	Diagonal Normal
						4.464	Vertical (Truss)
						4.465	Lateral Bracing Top (Truss)
						4.466	Lateral Bracing Bottom (Truss)
						4.467	Diaphragm (Truss)
						4.468	Cross Beam/Transom (Truss)
						4.469	Connection (Truss)
						4.471	Chord-Middle
						4.472	Diagonal-Minor

Figure 8.1 - Element Hierarchy

ELEMENT CODES

CODE	LEVEL 1	CODE	LEVEL 2	CODE	LEVEL 3	CODE	LEVEL 4
		2.400	Superstructure (Cont'd)	3.480	Suspension System	4.481	Suspension Cable
						4.482	Hanger Cable
						4.483	Sway Cable
						4.484	Pylon Column
						4.485	Pylon Bracing
						4.486	Pylon Saddle
						4.487	Cross Beam (Suspension)
						4.488	Lateral Bracing (Suspension)
						4.489	Connection (Suspension)
				3.500	Deck System	4.501	Stringer
						4.502	Decking
						4.503	Corrugated Steel Trough
						4.504	Edge Beam
						4.505	Deck Running Surface
						4.506	Footway/Kerb
						4.507	Scupper
				3.600	Deck Joints	4.601	Steel Joint
						4.602	Steel Profile Joint
						4.603	Rubber Joint
						4.604	Connection (Joint)
				3.610	Bearings	4.611	Steel Bearing
						4.612	Rubber Bearing
						4.613	Pot Bearing
						4.614	Mortar Pad/Base Plate
						4.615	Hold Down Bolt
				3.620	Railing	4.621	Post
						4.622	Horizontal Railing
						4.623	Railing Support
						4.624	Parapet
				3.700	Furniture	4.701	Gauge
						4.711	Road Sign
						4.712	Road Marking
						4.713	Name/Number Plate
						4.714	Statue
						4.721	Lighting
						4.722	Lighting Post
						4.723	Power Conduit
						4.731	Utilities
		2.800	Culverts	3.801	Box Culvert		
				3.802	Pipe Culvert		
				3.803	Pipe Arch Culvert		
		2.900	Wet Crossing	3.901	Ferry Paved Crossing		
				3.902	Unpaved/River Crossing		

Figure 8.1 - Element Hierarchy (continued)

8.2 TERMINOLOGY

The terminology adopted for bridges in general is shown in Figure 8.2, together with corresponding Element Codes. Terminology for some bridge elements is shown in Figures 8.3, 8.4 and 8.5.

Terminology specific to particular bridge types such as suspension bridges, bailey bridges and masonry bridges is shown in relevant sections.

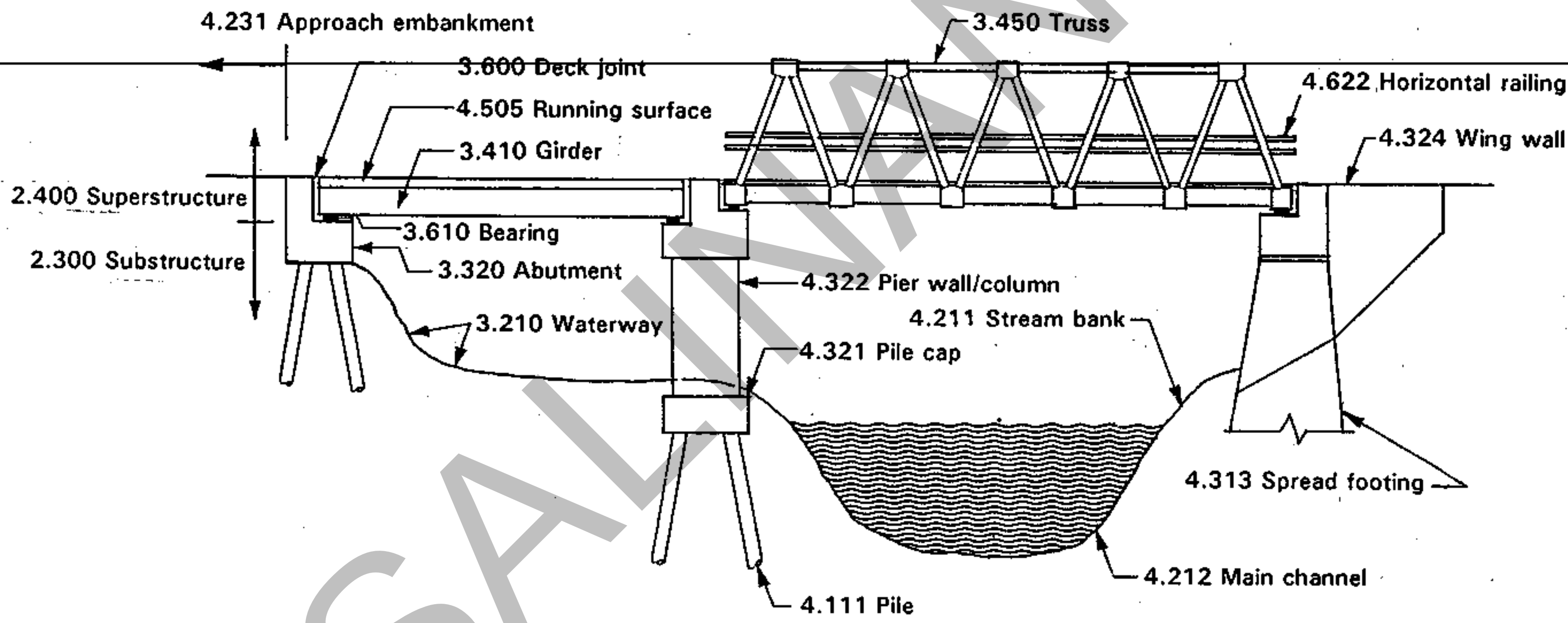


Figure 8.2 - General Terminology For Bridges

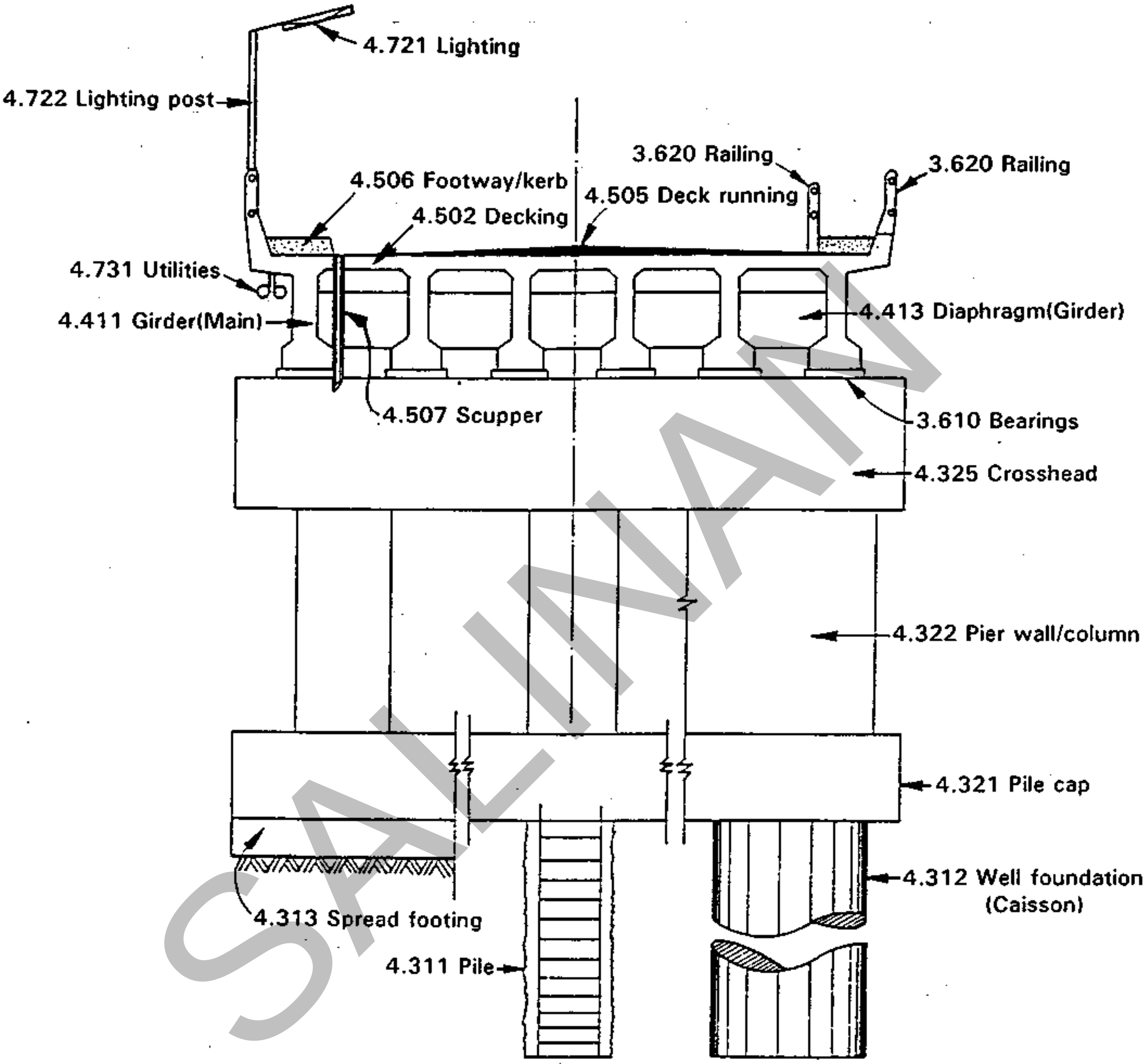


Figure 8.3 - Bridge Elements

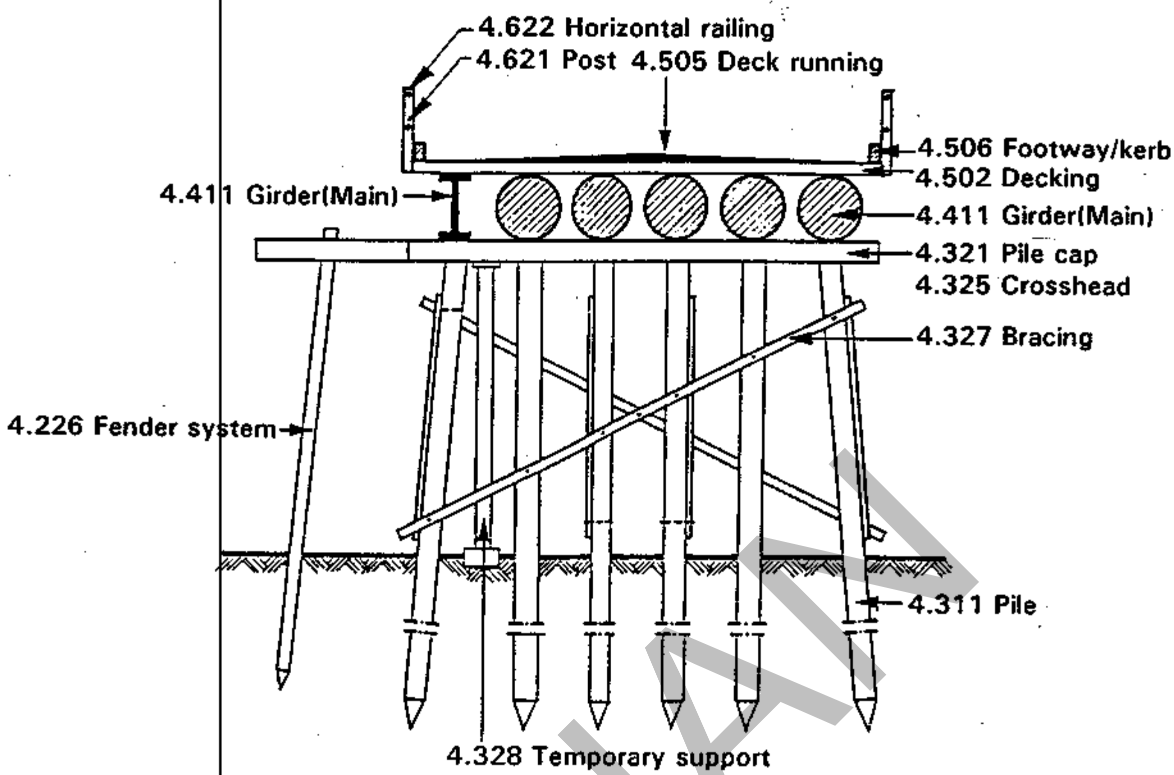


Figure 8.4 - Bridge Elements (continued)

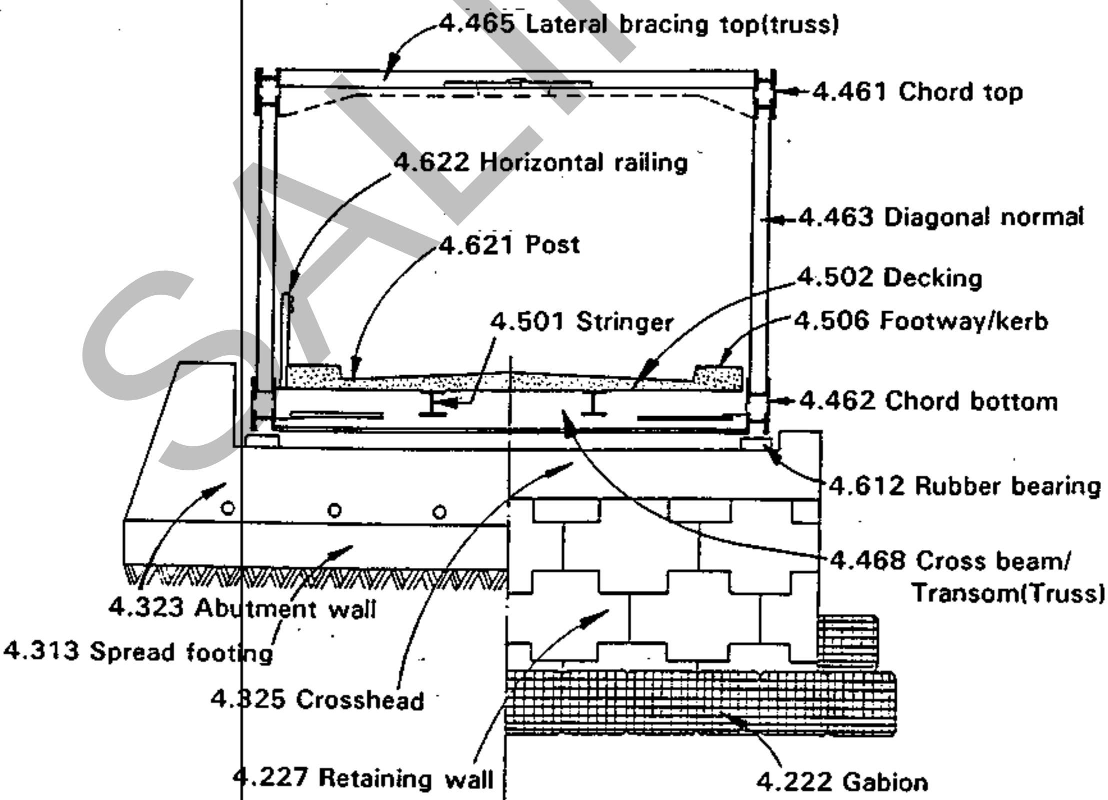


Figure 8.5 - Bridge Elements (continued)

8.3 DESCRIPTION OF BRIDGE ELEMENTS

1.000 BRIDGE

The entire structure and environs including the waterway, approach embankments, substructure and superstructure.

2.200 WATERWAY/EMBANKMENTS (LEVEL 2)

The waterway and embankments include the following Level 3 major elements :

- 3.210 Waterway
- 3.220 Scour Protection
- 3.230 Embankments

3.210 WATERWAY (LEVEL 3)

Waterway includes the following Level 4/5 elements.

4.211 Stream Bank

The banks of the stream can be either man-made retaining walls or natural banks or levees.

4.212 Main Channel

Most waterways have a well-defined, permanent main channel. However, in some rivers the main channel may "migrate" laterally. Foundations can be scoured as a result of a changing river pattern.

Scour, erosion and undermining can be caused by insufficient waterway area, shifting stream patterns or by build-up of debris causing obstruction to the flow. This causes increased flow velocity or localised flow channels.

The remains of old structures (eg. piers) can cause eddying, obstruction of the flow and build-up of debris.

4.213 Flood Plain

The flood plain is the area where flood waters spread when the main river channel cannot cope with the flow, and the river banks are over-topped.

A bridge and approach embankments can restrict the flow on the flood plain and cause flooding upstream if the waterway area is too restricted.

3.220 SCOUR PROTECTION (LEVEL 3)

Scour protection includes all forms of protection. Some of these are :

- groynes
- gabions and mattresses
- concrete lining
- rock beaching
- sheet piling
- retaining walls
- riverbed controller

Scour Protection is an essential part of a bridge. Failure of the protection may precipitate undermining and collapse of the bridge or embankments.

Scour Protection includes the following Level 4/5 elements.

4.221 Groyne

A groyne is man-made embankment constructed to direct the flow away from erodible areas and is usually made from rock. Groynes can be eroded causing loss of rocks. Changes in the stream flow may render them ineffective.

4.222 Gabions

Gabions and rock mattresses are used to stabilize roadway cuttings and for protection of stream banks in the vicinity of bridges.

A gabion or mattress is a wire basket filled with graded, heavy stones. The gabion is held in position by its own weight but is flexible so it can adjust its own shape without damage. The basket prevents smaller stones being washed away.

Scouring around the basket and corrosion of the wire basket are the main problems experienced with gabions.

In some cases, walls are constructed by stacking gabions one on top of the other. If these are not properly secured, bulging or overturning may occur.

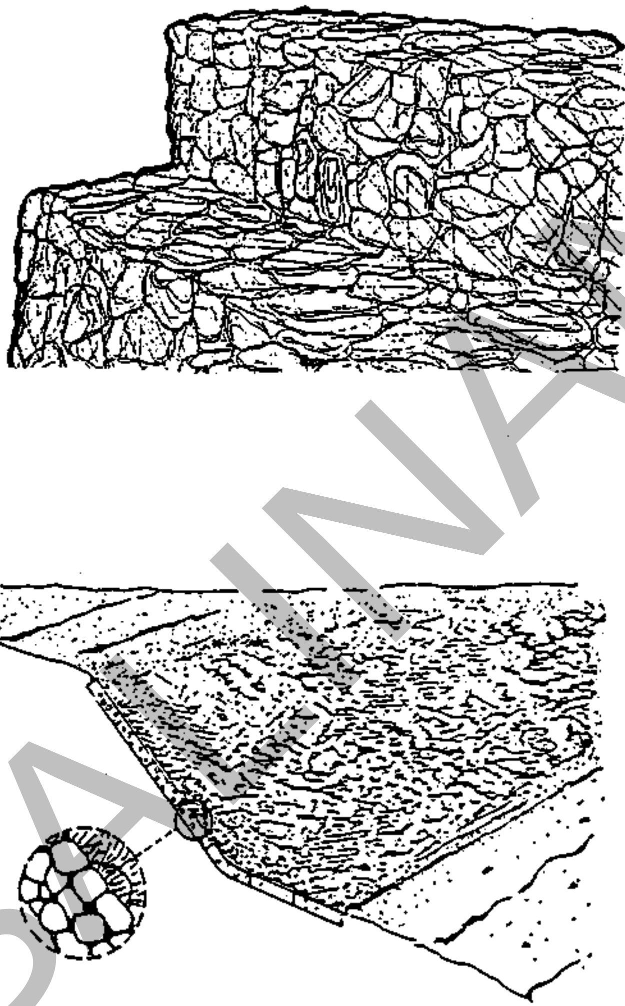


Figure 8.6 - Gabions

4.223 Concrete Lining

Concrete lining is used to protect stream banks and embankments, but is expensive. It often suffers from undermining, resulting in cracking and collapse.

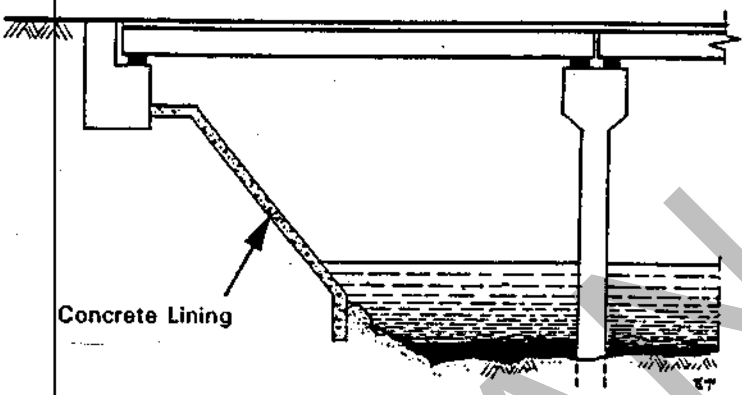


Figure 8.7 - Concrete Lining

4.224 Rock Beaching

Rock beaching consists of graded heavy rock and stones. The stones are heavy and graded to provide mechanical interlock, so that the beaching is resistant to erosion.

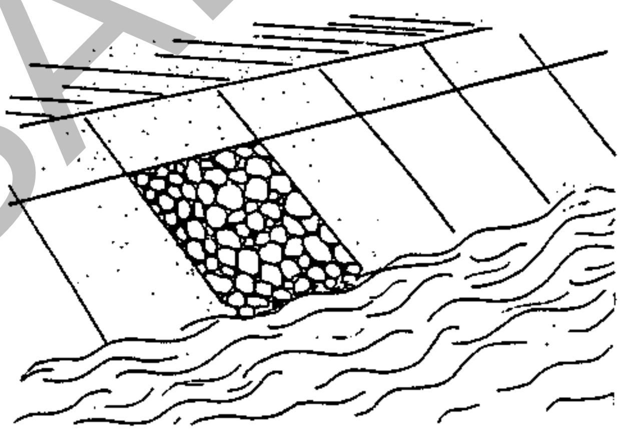


Figure 8.8 - Stone Beaching or Pitching

The stone can be simply placed on the ground, or they can be grouted to provide additional protection. In most cases, a geotextile should be used under the stones to prevent fine materials from being eroded by swirling action.

4.225 Sheet Piling

Sheet piles are special piles which are used for retaining earth fill and for protection against scouring. The most commonly used sheet piles in Indonesia are the type which can interlock together.

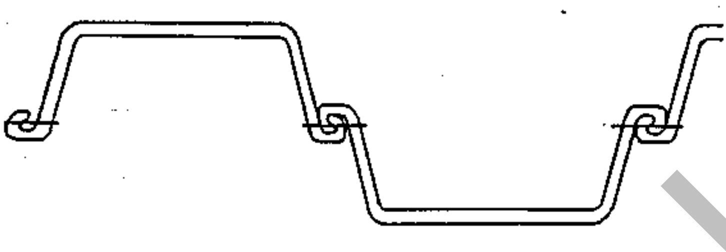


Figure 8.9 - Interlocking Steel Sheet Piling

4.226 Fender System

Fenders are used at or around bridge piers for protection against debris and impact from boats. A single pile on the upstream side of the pier may be used, or it may consist of a number of piles which completely surround the pier.

Sometimes there are boards around the piles as shown in Figure 8.10. This assists to reduce build-up of debris by deflecting the flow of debris around the fender system.

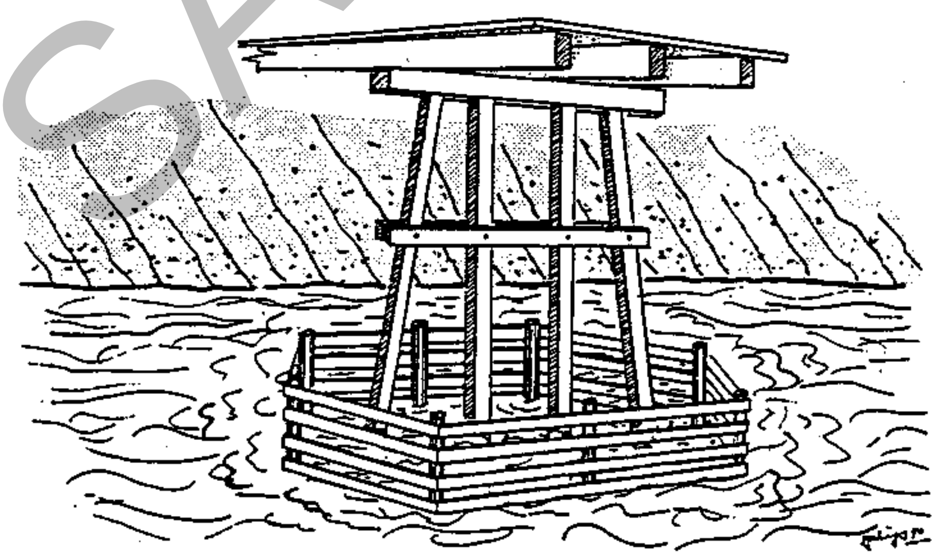


Figure 8.10 - Fender System

4.227 Retaining Wall

Many waterways have masonry or other types of retaining wall along the river banks for protection against scouring.

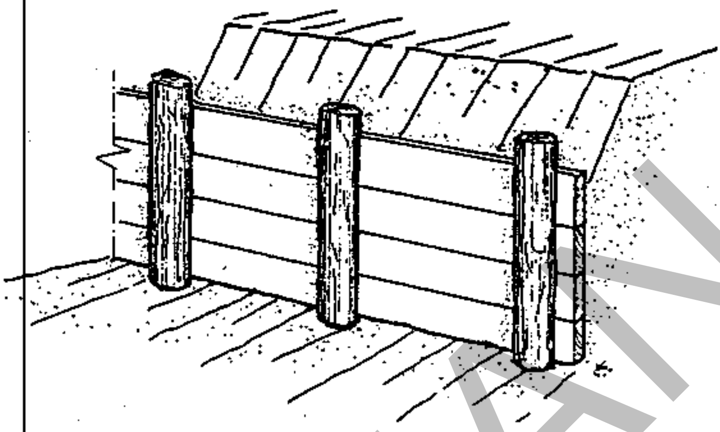


Figure 8.11 - Masonry Retaining Wall

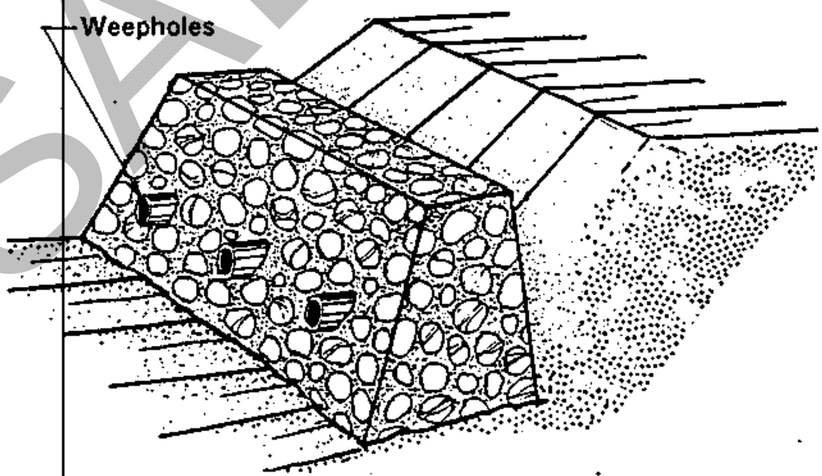


Figure 8.12 - Timber Retaining Wall

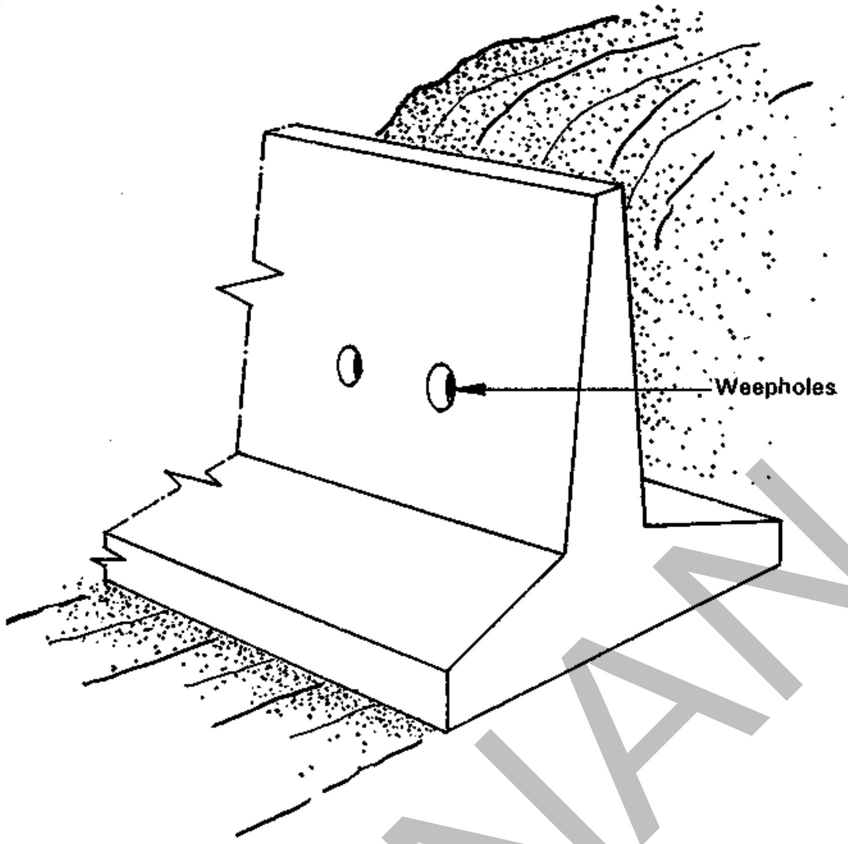


Figure 8.13 - Concrete Retaining Wall

4.228 Riverbed Controller

Riverbed controllers are required when the riverbed suffers degradation or local scouring in the vicinity of piers. When riverbed degradation occurs, a controlling structure can be made which functions so as to cause the riverbed to build up again ie. by building a type of check dam called a CONTROLLER in the area downstream of the bridge. If scouring occurs in the vicinity of piers, then a type of controlling structure can also be built from gabions which are stacked in a shape to prevent further scouring.

3.230 EMBANKMENTS (LEVEL 3)

Embankments include the approach embankments, embankment drainage, the pavement, approach slabs and reinforced earth walls.

Embankments include the following Level 4/5 elements.

4.231 Approach Embankment

Bridge approach embankments can be damaged and this may result in inconvenience to traffic or even total closure of the road. Damage can be caused by :

- eddying
- slip failure
- poor drainage
- settlement

Eddying

Eddying can occur both upstream and downstream causing erosion of the approach embankment.

If the problem is identified early enough, scour protection can be installed to prevent further damage.

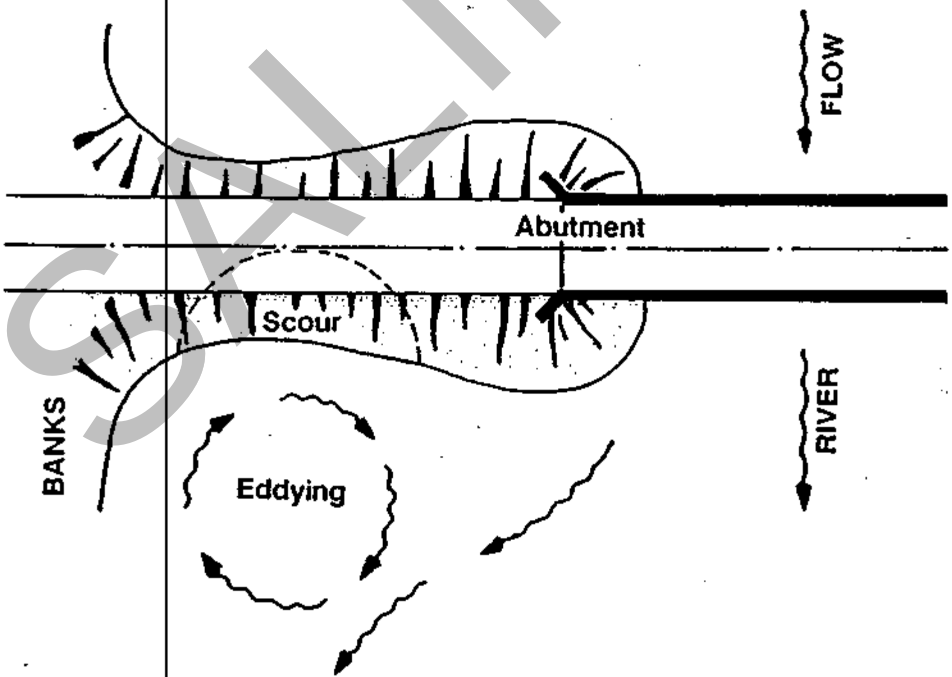


Figure 8.14 - Example of Eddying Effects

Slip Failure

A slip failure can occur when the toe of the approach embankment is eroded. This may result in the failure of the abutment. The first sign of a slip failure is often a depression in the approach roadway. This could be up to 25 metres behind the abutment.

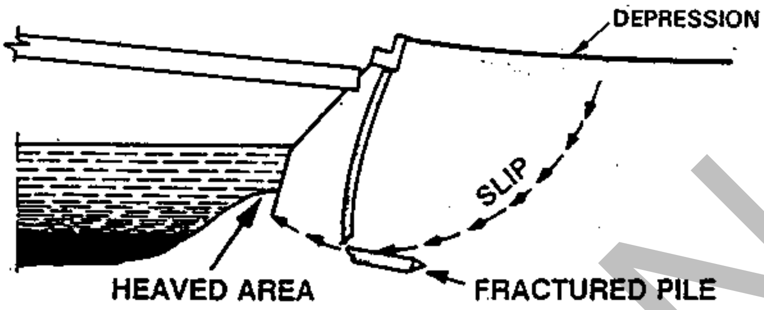


Figure 8.15 - Slip Failure

4.232 Embankment Drainage

Embankment drainage includes :

- side drains and kerbs along top or toe of the embankment,
- drain down the side of the embankment.

4.233 Pavement

The running surface on the approach roads.

4.234 Approach Slab

This is a reinforced concrete slab constructed below the road surface behind the abutment to help avoid settlement at the abutment.

4.235 Reinforced Earth Wall

Reinforced Earth is a technique used for support of earth retaining walls using metal strips anchored in the soil.

Concrete facing panels are used as a retaining wall and to provide an attractive appearance.

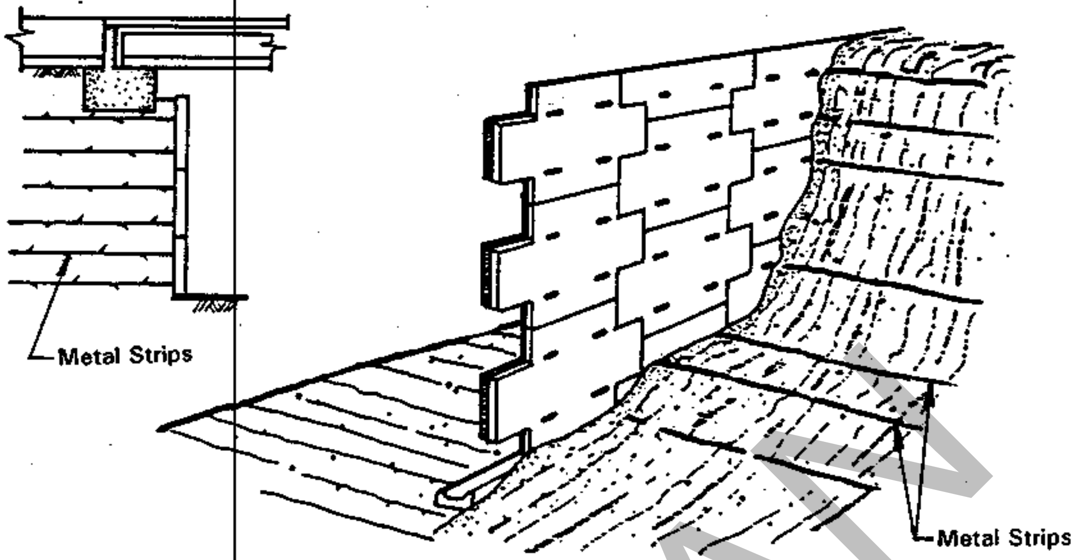


Figure 8.16 - Reinforced Earth Wall

2.300 SUBSTRUCTURE (LEVEL 2)

The substructure includes all components between the waterway/embankments and the bearings, ie. the foundations, abutments and piers.

3.310 FOUNDATIONS (LEVEL 3)

Foundations includes the following Level 4/5 elements :

4.311 Pile

Piles can be driven, bored or screw.

Driven piles can be steel, concrete, steel shell, square or round timber or other types.

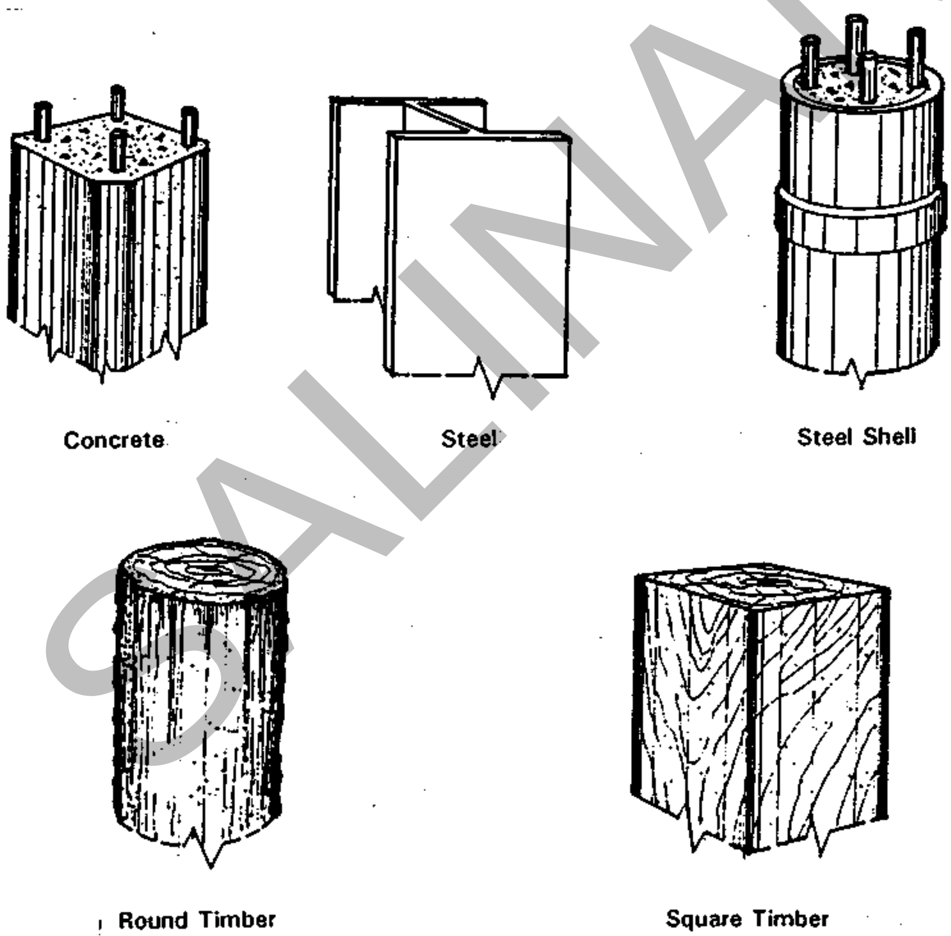


Figure 8.17 - Types of Driven Piles

Bored Piles

Bored piles are constructed by boring a hole and filling it with reinforced concrete. Bored piles are usually 400 to 600 mm diameter.

Bored piles include *displacement piles* such as Franki piles.

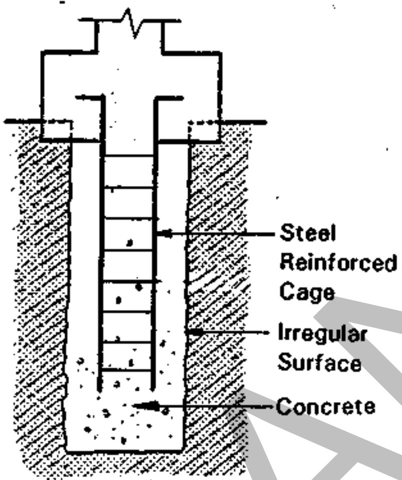


Figure 8.18 - Bored Pile

Screw Piles

There are many screw-pile foundations in Indonesia. They consist of long, slender steel poles which generally extend to cross-head level. The steel poles are approximately 130mm diameter and are ungalvanized. They are normally cross braced below the cross-head.

4.312 Well-Foundation (Caisson)

There are many types of well-foundations. In Indonesia, they are normally hand-excavated. The well-liner follows down as the hole is excavated. Caissons range from 900 mm to 3 m diameter.

There are normally 2 or 3 well-foundations for each abutment or pier.

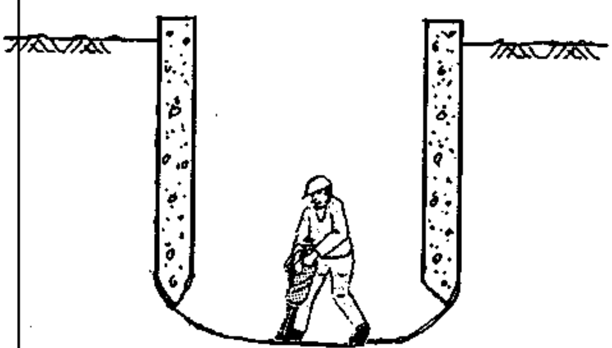


Figure 8.19 - Excavating Inside a Well-Foundation

4.313 Spread Footing

Spread footings are normally used where the foundation material is hard and strong, such as rock. They rely on transfer of the load from the structure to the underlying material. It is therefore important that continuous contact with the ground is maintained, and erosion is prevented.

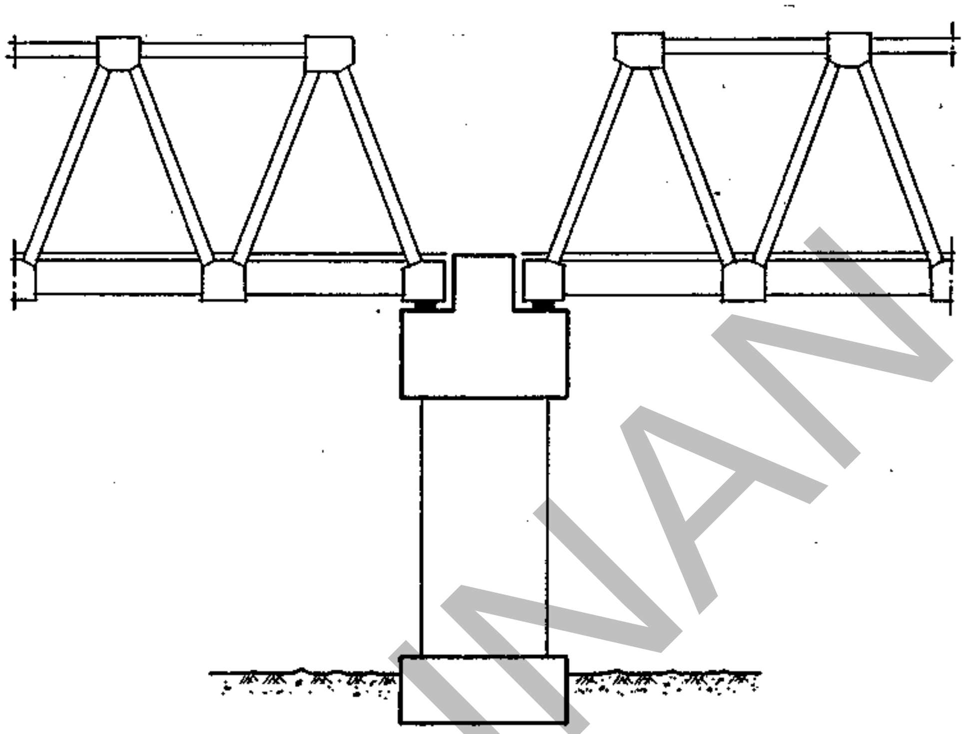


Figure 8.20 - Spread Footing

4.314 Anchor

Anchors are used where a cable, chain or member is held in the ground away from the structure. These are usually associated with suspension bridges and cable-stayed bridges. They can also be found where a bridge has had excessive lateral movement and cables and anchors have been installed to minimize sway.

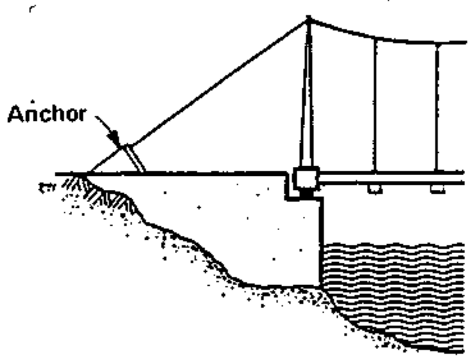


Figure 8.21 - Anchor

4.315 Arch Thrust-Block

In beam arch bridges, there is often a thrust-block which provides additional load-bearing area on the ground for the arch.

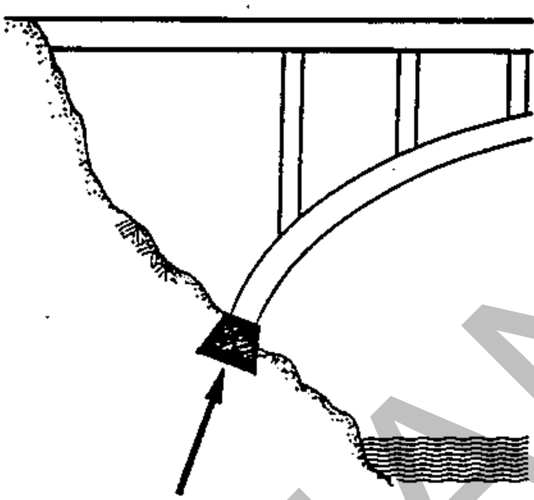


Figure 8.22 - Arch Thrust-Block

3.320 ABUTMENTS/PIERS (LEVEL 3)

The abutments and piers are the major elements of the bridge which transfer the load from the superstructure to the foundations. Figure 4.11 in Part 1 shows common types of abutments and piers.

Abutments/Piers include the following Level 4/5 elements :

4.321 Pile Cap

The pile cap is the element which braces the piles near the water or ground level, as shown previously in Figure 8.4.

4.322 Pier Wall/Column

The columns or walls transfer loads to the pile cap. The columns or walls may be as tall as 40 metres in high bridges. Walls and columns can be constructed from stone, concrete, timber or steel.

4.323 Abutment Wall

Abutment retaining walls are used to contain the embankment fill. Retaining walls can be made of stone, concrete or timber supported by posts.

4.324 Wingwall

Wingwalls are similar to retaining walls and assist to retain the embankment fill at the abutments.

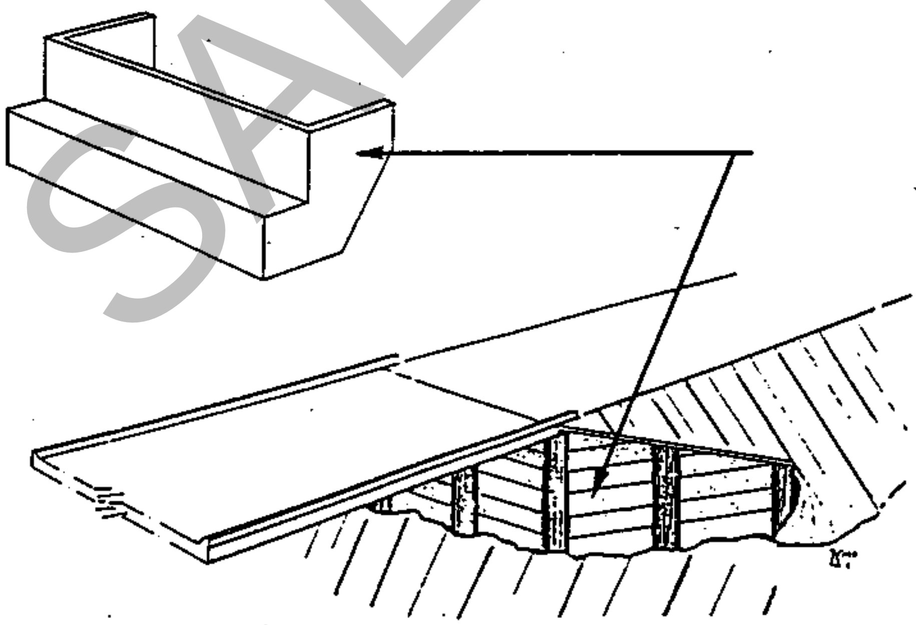


Figure 8.23 - Wingwalls

4.325 Crosshead

The crosshead is also known as a headstock. It is the element at the top of the column which distributes the load from the bearings into the columns.

The headstock can be concrete, steel or timber.

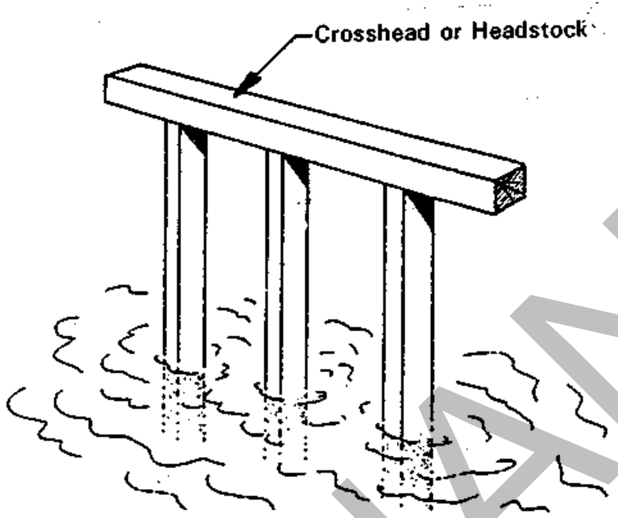


Figure 8.24 - Crosshead

4.326 Earthquake Restraint Block

4.327 Bracing

Bracing systems are normally used in timber or steel substructures. However, there are also reinforced concrete bridges with a bracing system.

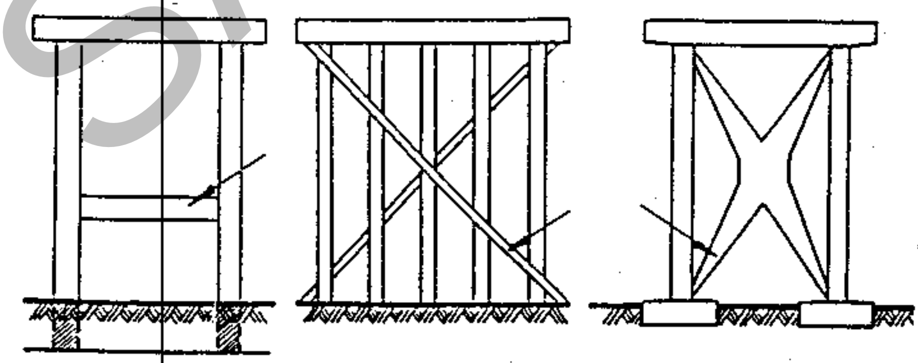


Figure 8.25 - Bracing

4.328 Temporary Support

Temporary supports are sometimes used to strengthen bridges in poor condition. They are considered part of the bridge, which needs to be inspected like any other element.

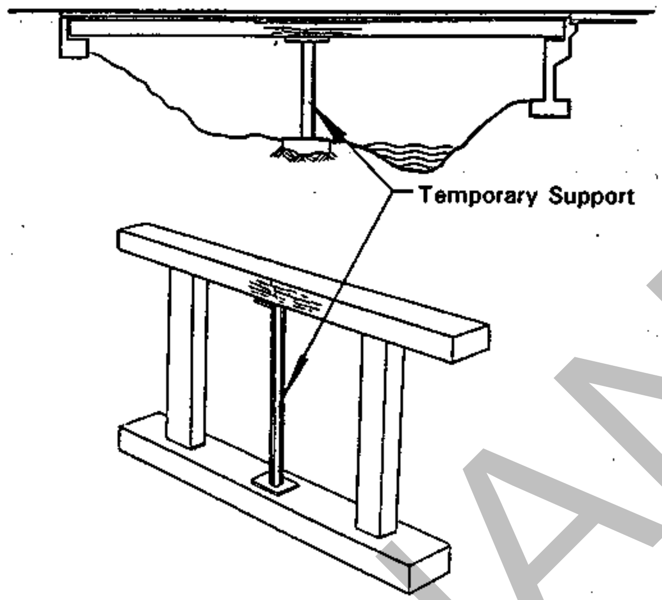


Figure 8.26 - Temporary Support

4.329 Weep Hole

Weep holes are used in abutment or retaining walls to reduce the pressure of water behind the wall. They must be inspected to ensure they are free draining (see Figures 8.11 and 8.12)

2.400 SUPERSTRUCTURE (LEVEL 2)

The superstructure is the main component which spans between the piers and the abutments. It includes the deck and all the elements above the bearings, including the following Level 3 major elements :

- 3.410 Girder System
- 3.420 Flat Slab
- 3.430 Arch
- 3.440 Beam Arch
- 3.450 Trusses
- 3.480 Suspension System
- 3.500 Deck System
- 3.600 Deck Joints
- 3.610 Bearings
- 3.620 Railing
- 3.700 Furniture

3.410 GIRDER SYSTEM (LEVEL 3)

This element includes the girders, cross beams, diaphragms, connections and bracing of the girders, including the following Level 4/5 elements :

4.411 Girder (Main)

Main girders span between the piers and abutments. Girders can be timber, steel, reinforced concrete or prestressed concrete. Defects in the girders must be identified correctly because failure of a girder is very serious. The number of girders in each span normally varies between two and eight.

4.412 Cross Beam (Girder)

Cross beams are often present to transfer the loads to the main girders.

4.413 Diaphragm (Girder)

Diaphragms are provided to give stability to the girders

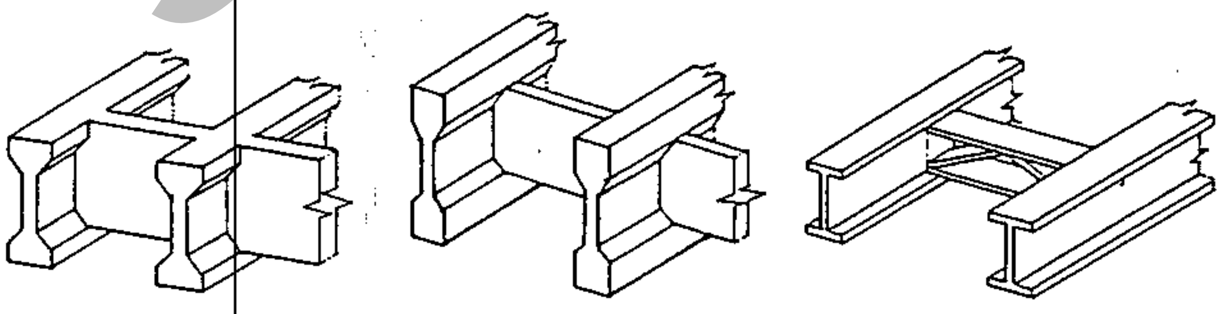


Figure 8.27 - Diaphragms

4.414 Connection (Girder)

4.415 Bracing (Girder)

Bracing reduces lateral sway in a bridge, by tieing the girders together in a rigid frame.

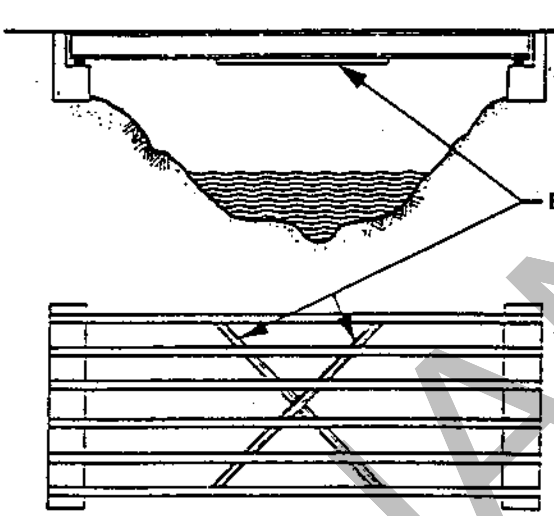


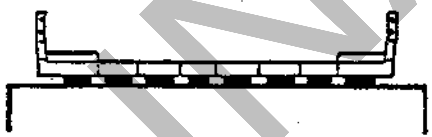
Figure 8.28 - Bracing

3.420 FLAT SLAB (LEVEL 3)

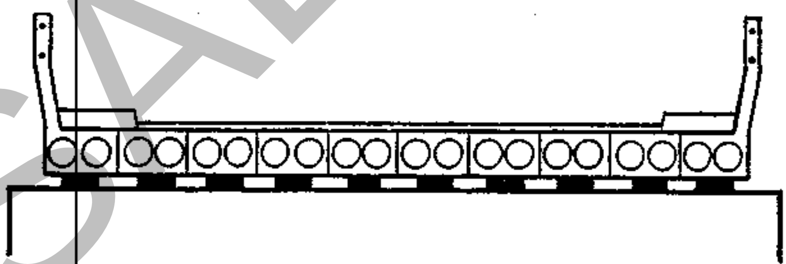
4.421 Slab

In some short span bridges up to about 16 metres in length, there may be no separate girders or trusses. The strength of the slab is adequate to support itself and the traffic loading. These slabs can be either cast-in-situ or precast, as shown in Figure 8.29.

Cast-in-situ Flat Slab Bridge



Flat Plate Bridge with precast slabs



Prestressed Concrete Slab Bridge

Figure 8.29 - Flat Slab Bridges

3.430 ARCH (LEVEL 3)

Arches are a special type of structure which combines the superstructure and the substructure. There are many arch structures in Indonesia. Most of these were built prior to 1940.

The structure depends upon the arching action of the walls for its strength. The area above the arch is normally filled with soil or gravel with a macadam topping for the roadway. In order to relieve water pressure, it is necessary to provide weepholes in the side of the walls and in the arches. These ensure that the pressure of the fill on the walls does not become too great.

The sides of the fill are normally retained by walls parallel to the road centre line. These walls are called Spandrel walls.

Structural soundness of the arch barrel, the foundations and the spandrel walls are essential for stability of the bridge.

Aspects which require inspection on arches are :

- undermining of the foundation
- general shape of the arch
- localised areas where the arch or spandrel walls are cracked or bulging
- correct functioning of drainage or weepholes
- vegetation in joints or cracks which may further weaken the structure

Arches can be made of masonry, concrete or steel.

Concrete arches are similar to masonry, and the parts are similar except there is no keystone.

Steel arches and culverts require special inspection for the following :

- corrosion of steel,
- bolt tightness and buckling of plates.

Where corrosion is serious, a sample of water may need to be taken for testing in case further action has to be taken (for example, concrete lining of the invert). A Special Inspection may be required to establish the appropriate treatment.

Figure 8.30 identifies the elements of masonry arch.

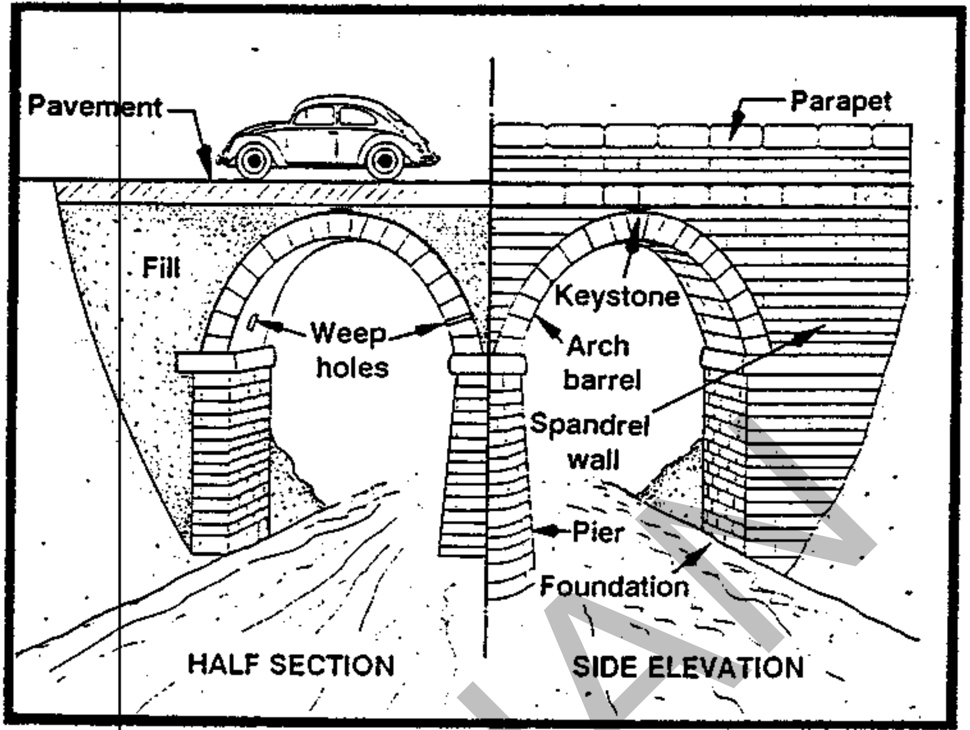


Figure 8.30 - Parts of a Masonry Arch

4.431 Barrel

4.432 Spandrel Wall

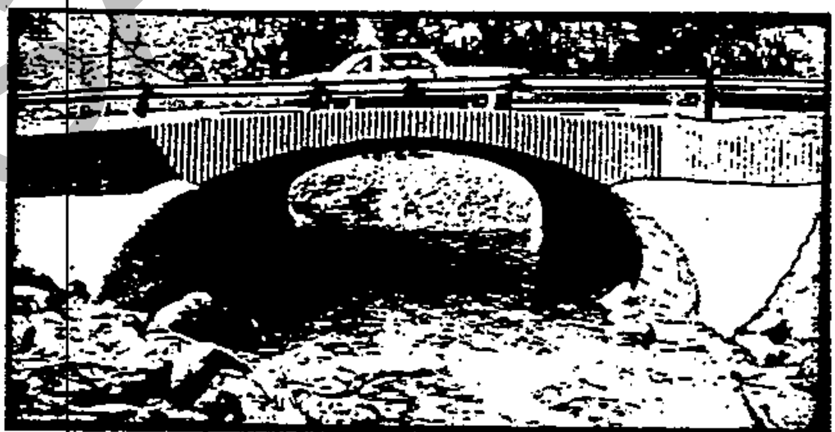


Figure 8.31 - Steel Arch

3.440 BEAM ARCH (LEVEL 3)

Beam arch structures depend on both arching and beaming actions for their strength. The arches can have the beam under the deck as shown in Figure 8.32 or above the deck as shown in Figure 8.33.

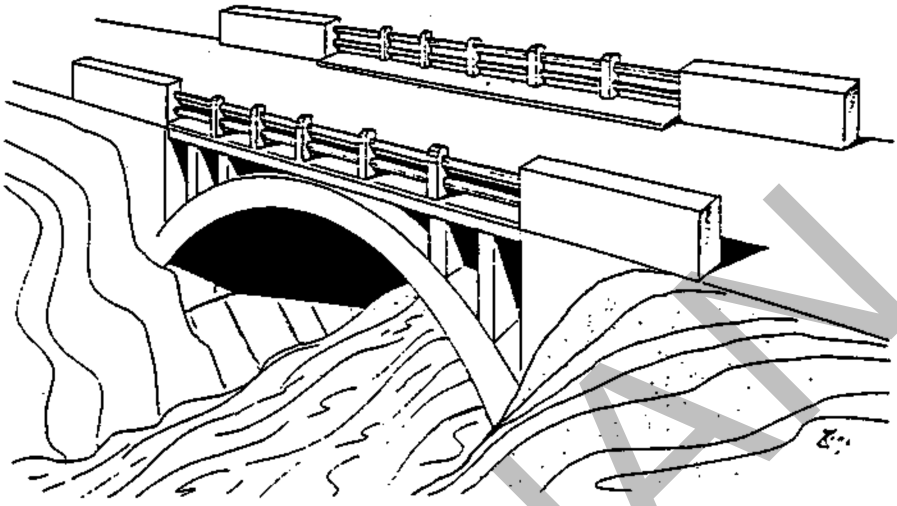


Figure 8.32 - Beam Arch under the Deck

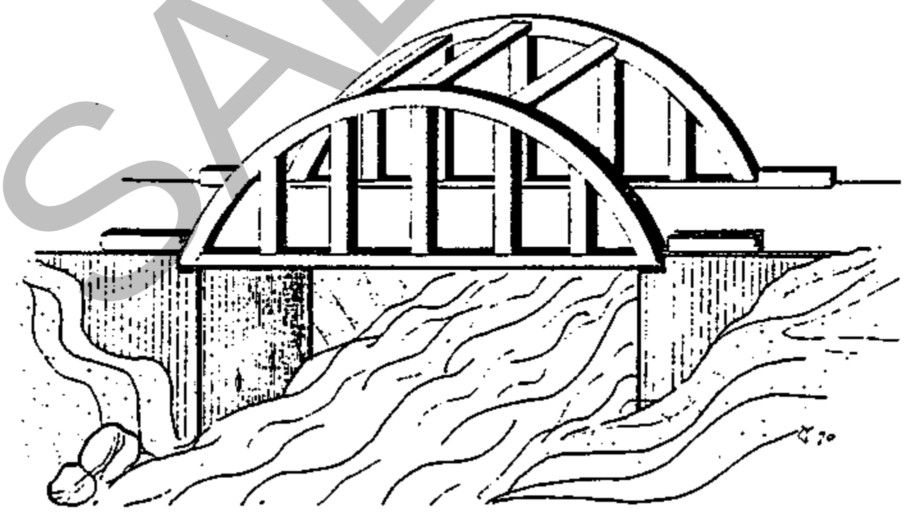


Figure 8.33 - Beam Arch above the Deck

Beam Arch includes the following Level 4/5 elements :

4.441 Girder (Beam Arch)

These transfer the load from the cross beams to the verticals.

4.442 Arch Beam

The arch beam is the main load-carrying element of the bridge.

4.443 Vertical (Beam Arch)

The verticals transfer the load to the arch beam.

4.444 Cross Beam (Beam Arch)

The cross beams transfer loads from the deck to the girders.

4.445 Lateral Bracing (Beam Arch)

4.446 Connection (Beam Arch)

3.450 TRUSSES (LEVEL 3)

There are many truss bridges in Indonesia. They come from many different sources including England, Australia, Holland, Austria etc.

Figure 8.34 shows the different types of truss bridges, as follows :

(a) through trusses tied across the top

(b) through trusses without a top tie

(c) deck type truss bridge

(d) half through truss

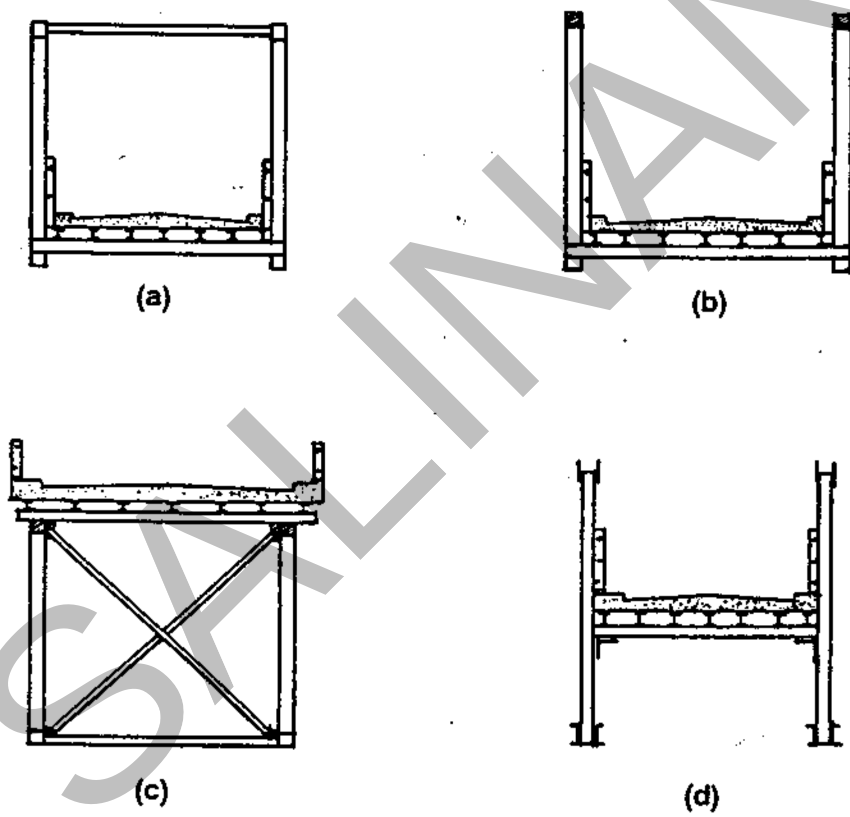


Figure 8.34 - Types of Trusses

There are many elements in a truss including the top and bottom chord, bracing, diagonals etc. Figure 8.35 shows the Level 4/5 elements of trusses. If inspectors find some elements difficult to classify or describe, he/she should sketch the truss and highlight the elements which are the subject of the report.

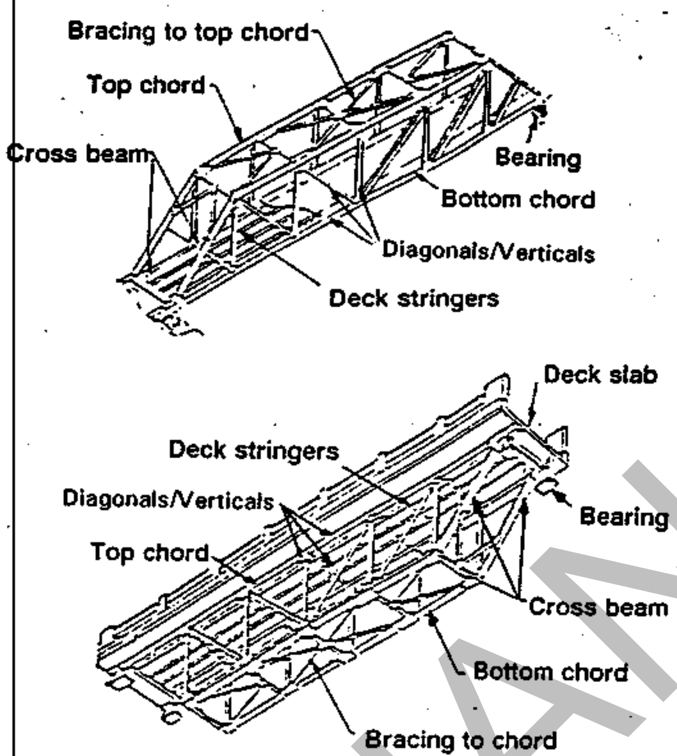


Figure 8.35 - Truss Bridge Nomenclature

A special type of truss bridge is the Acrow/Bailey truss. These are used on semi-permanent or temporary bridge sites. There are special Manuals available for these bridges. Figure 8.36 shows the main components.

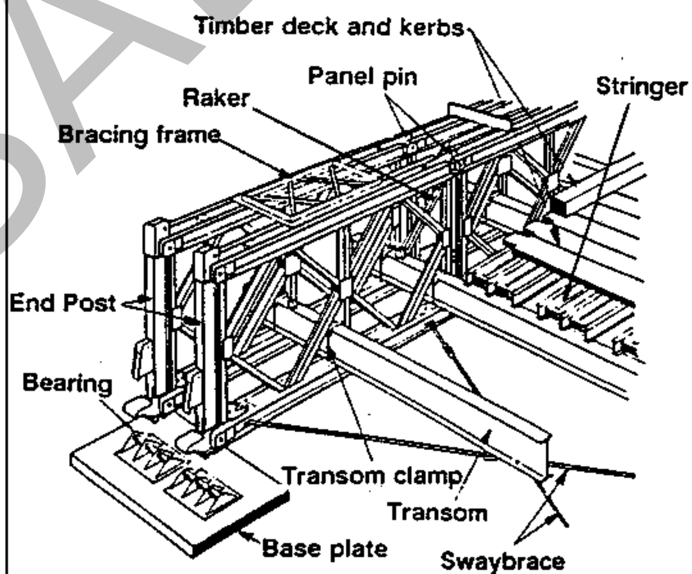


Figure 8.36 - Bailey Bridge Elements

4.451 Truss Panel

Normally panels are either Acrow/Bailey type or Australian Transpanel type.

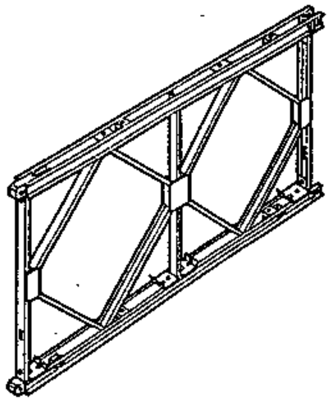


Figure 8.37 - Typical Truss Panel

4.452 Chord Reinforcement

Chord Reinforcement is used on the Acrow/Bailey type bridge to increase the carrying capacity.

4.453 Bracing Frame

The bracing frame is used where more than one Acrow/Bailey panel is used on each side of the bridge. The bracing ties the panels together for stability.

4.454 Raker

4.555 Panel Pin/Circlip

The pin and circlip are found in Acrow/Bailey trusses and Australian Transpanel bridges.

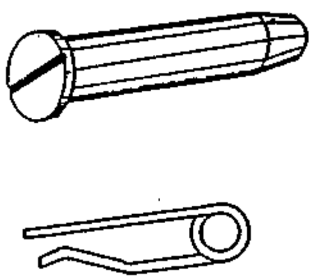


Figure 8.38 - Typical Pin and Circlip

4.456 Clamp

4.461 Top Chord

4.462 Bottom Chord

4.463 Diagonal Normal (Truss)

4.464 Vertical (Truss)

4.465 Lateral Bracing Top (Truss)

4.466 Lateral Bracing Bottom (Truss)

4.467 Diaphragm (Truss)

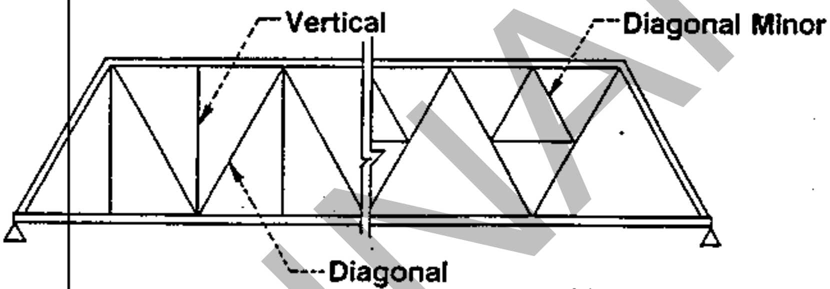


Figure 8.39 - Truss Verticals and Diagonals

4.468 Cross Beam/Transom (Truss)

Cross beams are found in all truss bridges and are used to transfer the load from the deck to the trusses.

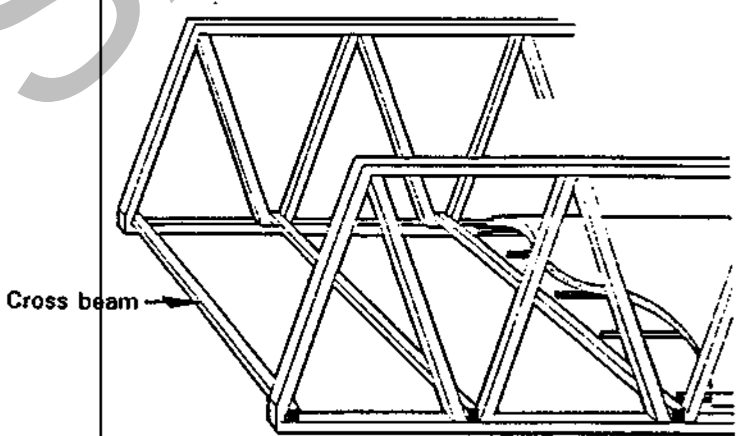


Figure 8.40 - Cross Beam

4.469 Connection (Truss)

Connection include rivets, bolts and gusset plates.

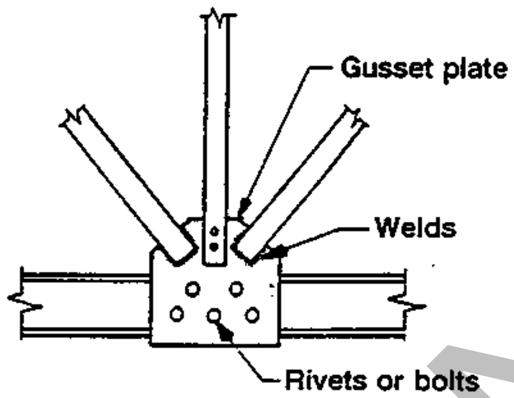


Figure 8.41 - Gusset Plates and Other Connections

4.471 Chord-Middle

4.472 Diagonal-Minor

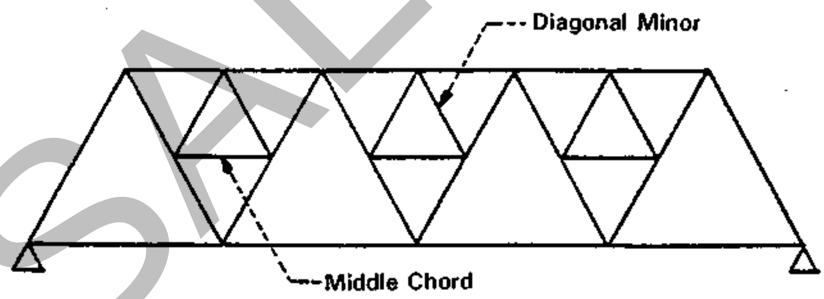
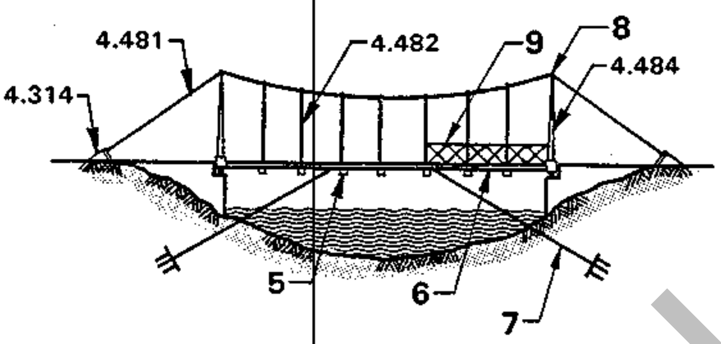


Figure 8.42 - Middle Chord and Minor Diagonal

3.480 SUSPENSION SYSTEM (LEVEL 3)

Suspension bridges are special bridges which utilize steel cables to support the deck through hangers and cross beams. Level 4/5 elements are shown in Figure 8.43.

Note : If a suspension bridge has truss panels for stiffening and/or load carrying purposes, the truss is reported under Element 3.450 and its Level 4 elements.



1. ANCHOR 4.314
2. SUSPENSION CABLE 4.481
3. HANGER CABLE 4.482
4. PYLON COLUMN 4.484
5. CROSS BEAM 4.487
6. SWAY CABLE 4.483
7. PYLON SADDLE 4.486
8. STIFFENING TRUSS 3.450

Figure 8.43 - Suspension Bridge Nomenclature

4.481 Suspension Cable

The suspension cables are made of steel and can vary from a single steel rope to multiple steel cables.

4.482 Hanger Cable

The hangers can be made from cable or from steel rod. The hangers transfer load from the deck and cross-beams to the suspension cables.

4.483 Sway Cables

Sway cables are made of steel and are attached to the bridge near deck level at about the ⅛ of the main span. They minimize lateral sway.

4.484 Pylon Columns

The pylon columns may be single pylons or built-up members.

4.485 Pylon Bracing

Normally the pylon columns are braced.

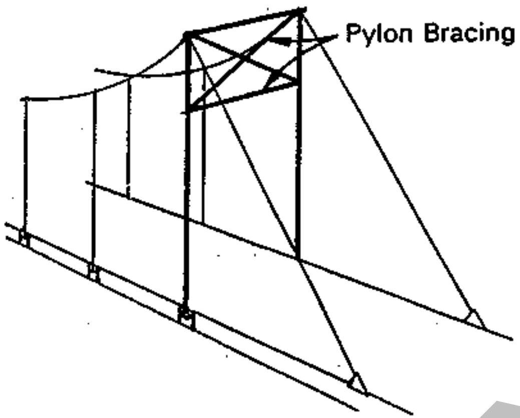


Figure 8.44 - Pylon Bracing

4.486 Pylon Saddle

The pylon saddle carries the suspension cable. This element minimises wear on the cable and changes the direction of the cable over the pylon in a gradual way.

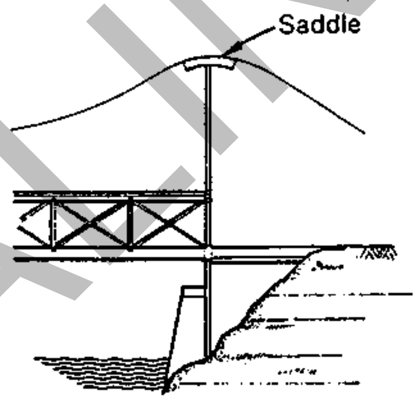


Figure 8.45 - Pylon Saddle

4.487 Cross Beam (Suspension)

Cross beams are used to carry the load from the deck to the sides of the bridge where the load is transferred to a stiffening truss or directly on the hanger cables.

4.488 Lateral Bracing (Suspension)

Most suspension bridges have a form of lateral bracing below the deck to give lateral stability.

4.489 Connection (Suspension)

3.500 DECK SYSTEM (LEVEL 3)

The deck system is the major element which supports the traffic loading directly. There are several Level 4/5 elements which make up the bridge deck system.

4.501 Stringers

Stringers under the deck are commonly found on steel truss and timber bridges. They are used to reduce the lateral span of the deck slab where the cross beams are widely spaced.

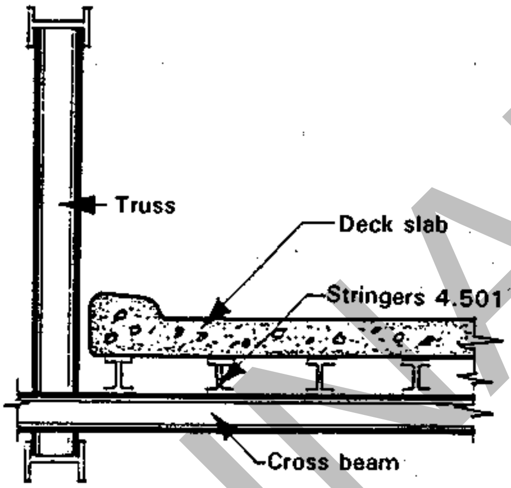


Figure 8.46 - Stringers Under Deck

4.503 Decking

Decking can consist of :

- a concrete slab spanning between the girders or cross beams
- timber planks
- steel plate

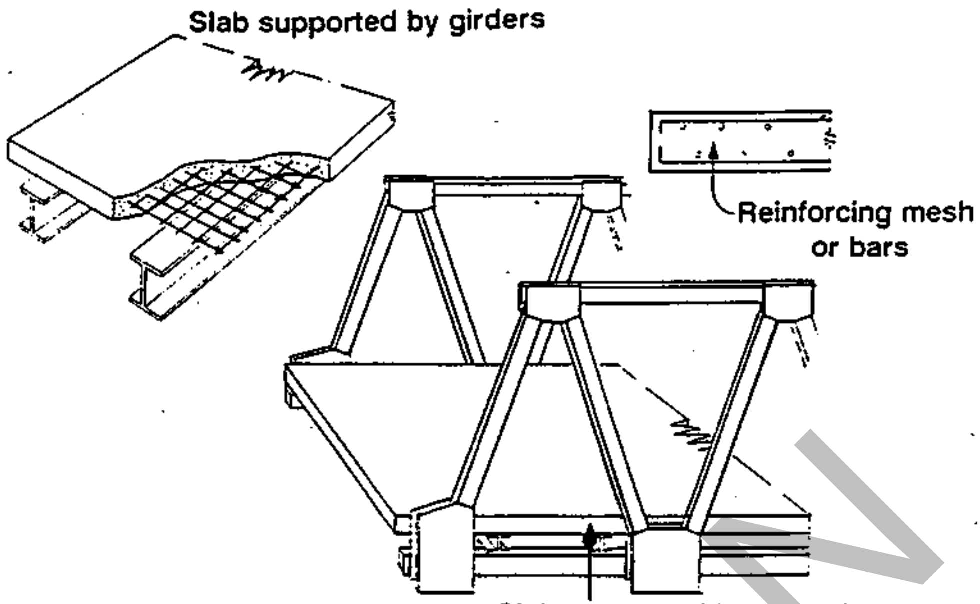


Figure 8.47 - Concrete Deck Slab

4.503 Corrugated Steel Trough

Corrugated steel trough and concrete slab is deck system which is becoming popular for Indonesian bridges. It gives additional strength to the deck as well as providing strong formwork for the deck concrete.

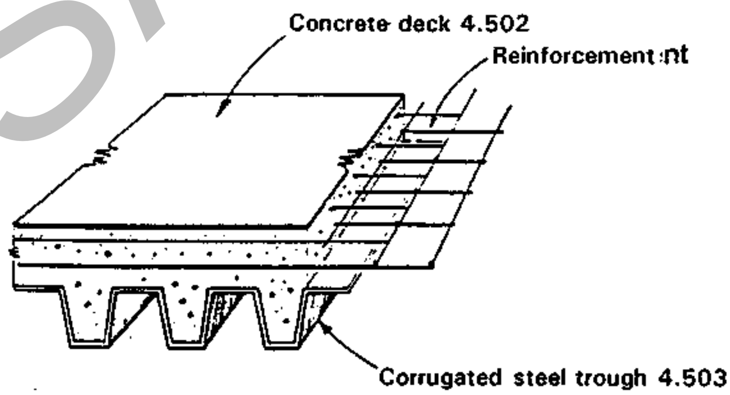


Figure 8.48 - Corrugated Steel and Concrete Slab Decking

4.504 Edge Beam

Where the section of a concrete deck is thickened to act as a structural element, the thickened section is called an edge beam. These are often found on Callender Hamilton through-truss bridges.

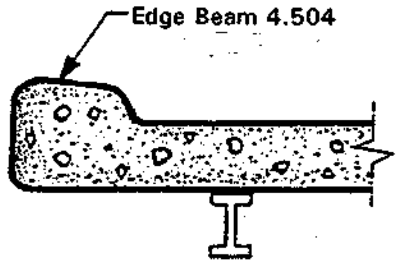


Figure 8.49 - Edge Beam

4.505 Running Surface

The running surface can be :

- an asphaltic layer over the bridge deck
- timber running planks

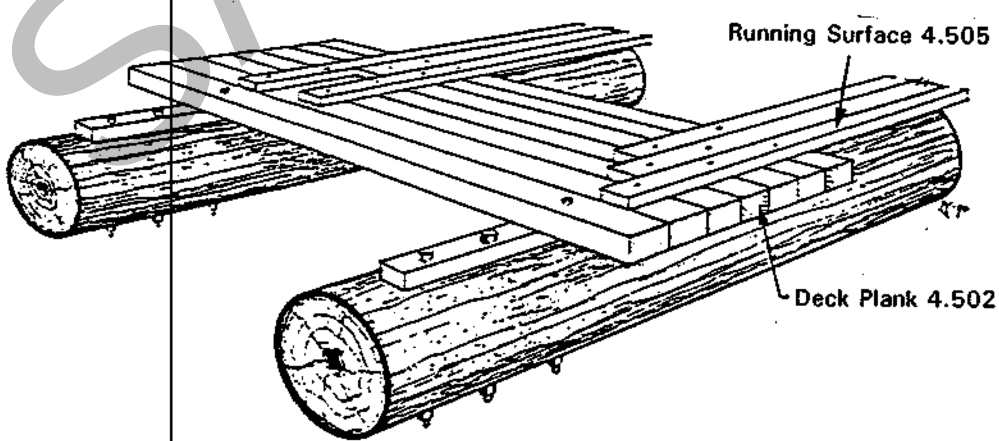


Figure 8.50 - Timber Deck System including Running Planks

4.506 Footway/Kerb

Bridges carry pedestrians as well as vehicular traffic. Bridges have footways and kerbs for this purpose.

Inspectors should check these elements to ensure that pedestrians are not endangered by missing slabs, rough surfaces etc. The footway should be clear so that pedestrians do not have to walk on the roadway.

4.507 Scuppers

Proper drainage of a deck is important. Good deck drainage will ensure that :

- pools of water do not remain on the deck and cause accidents,
- water is not directed to another part of the structure such as approach embankments which may be damaged, or onto girders underneath which may increase the rate of corrosion.

Scuppers are pipes located along the deck to drain surface water from the deck at regular intervals and direct it away from other elements

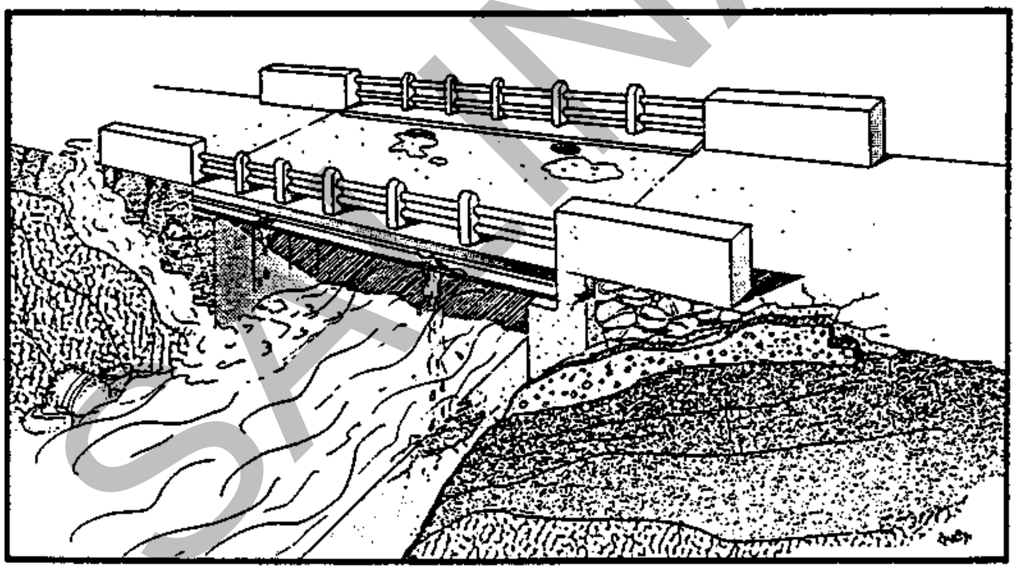


Figure 8.51 - Poor Drainage and Incorrect Scupper Location

3.600 DECK JOINTS (LEVEL 3)

Deck joints are designed to accommodate various rotational, longitudinal and transverse movements of the superstructure under live loading or thermal expansion and contraction.

The functional requirements of deck joints are to:

- accommodate movements of the bridge due to temperature variations, creep, elastic shortening, shrinkage, deformation of bearings, settlement, and traffic loading, without inducing unacceptable stresses in the expansion joint or other parts of the structure
- withstand traffic loads
- prevent the entry of incompressible materials into the expansion joint gap
- be constructed of durable materials which have an economic service life
- be easy to inspect and maintain - parts subject to wear should be easily replaceable
- have good riding qualities and not cause inconvenience to any class of road user (including cyclists, pedestrians or animals where they have access)
- not generate excessive noise or vibration under traffic
- provide for skid resistance at the surface of the joint if it is relatively wide
- be watertight, or have positive provision for carrying away water, silt, grit and other debris (closed joints only)

Inspectors need to check the deck joints to ensure that they are achieving these objectives. Some problems will only be revealed by inspecting the underside of the decks. Loose joints can sometimes be discovered by a rattling noise under traffic.

Open Joints - Open expansion joints are designed to provide for longitudinal movement of the superstructure and partially bridge the joint opening to permit traffic to cross smoothly. Many bridges in Indonesia have open joints.

Closed Joints - Closed expansion joints consist of various materials which close the expansion joint opening. Such devices may incorporate waterproofing in their design.

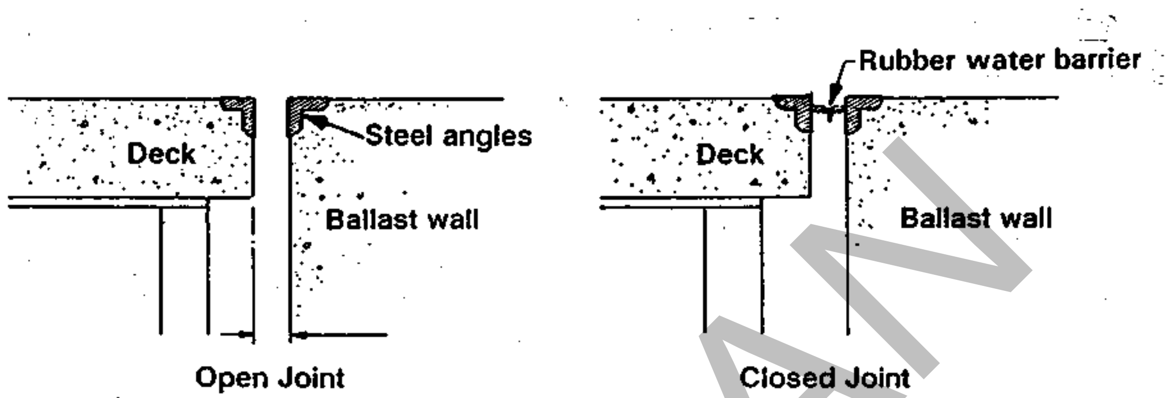


Figure 8.52 - Closed and Open Deck Joints

There are four Level 4/5 elements included under deck joints :

4.601 Steel Deck Joint

4.602 Steel Profile Joint

4.603 Rubber Joint

4.605 Connection (Joint)

Examples of deck joints are shown in Figure 8.53.

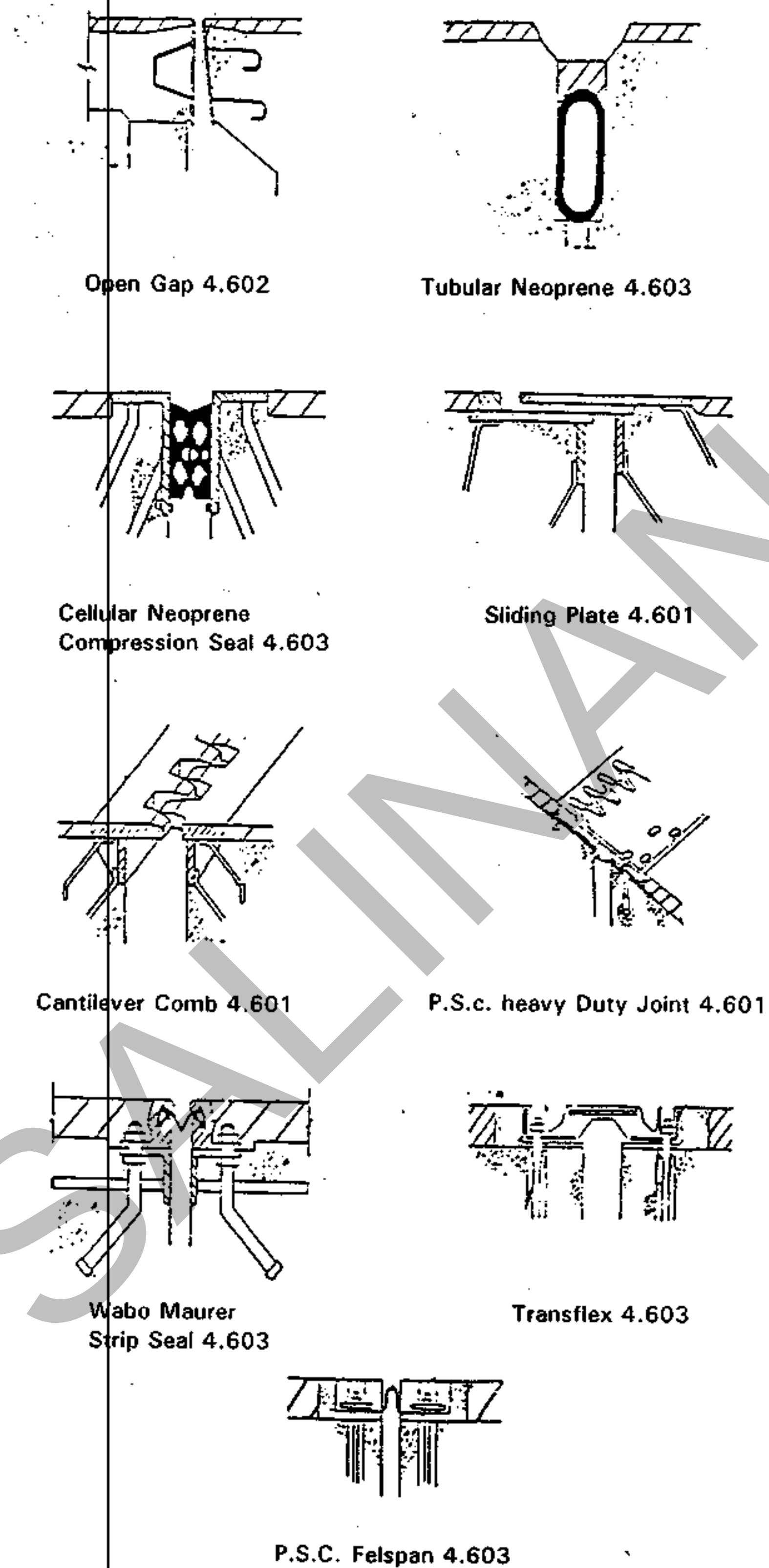


Figure 8.53 - Examples of Typical Deck Joints

3.610 BEARINGS (LEVEL 3)

Bearings are the elements which directly transfer all loads from the superstructure to the substructure.

Bearings must be able to accommodate :

- high bearing pressures
- expansion and contraction due to temperature variation
- minor rotational effects due to girder/truss deflection
- vibration effects due to live load

Normally, one end of a girder or truss will be fixed while the other is free to move longitudinally. However, with neoprene rubber bearings both ends are able to more in any direction to a limited extent.

The simplest fixed bearing is where a girder rests directly on a headstock. Fixed bearings can be made from timber, steel or concrete.

Moving bearings are generally made of steel or neoprene rubber.

There are more sophisticated bearings such as teflon-coated pot bearings.

If bearings do not operate as designed, damage can occur to the bearing and other parts of the structure.

It is essential that bearings :

- are clean and well-drained
- are properly lubricated
- have adequate room to move
- are correctly positioned initially and do not move out of position
- have not deformed excessively or ruptured (elastomeric bearings)
- have sliding surfaces which are not damaged or pitted due to corrosion
- are seated correctly with holding down bolts free enough to allow movement
- are seated on undamaged pedestals
- have metal parts which are not cracked or bent

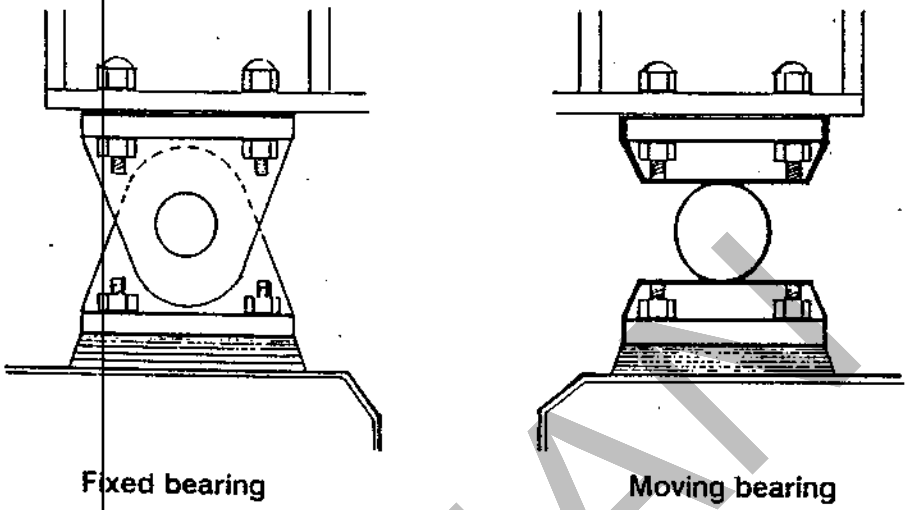


Figure 8.54 - Examples of Fixed and Moving Bearings

4.611 Steel Bearing

The simplest type of steel bearing is the sliding plate. Others include rocker bearings, roller bearings and hinged bearings.

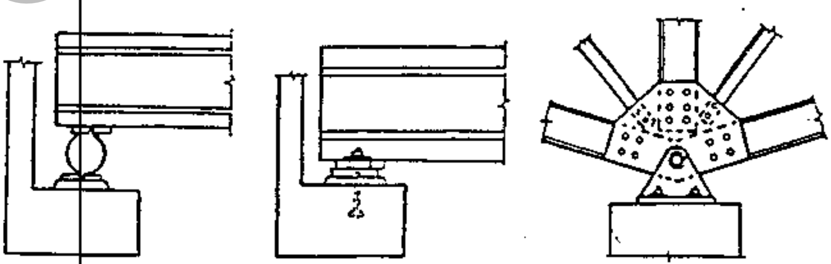


Figure 8.55 - Types of Steel Bearings

4.612 Elastomeric (Rubber) Bearing

Elastomeric (rubber or neoprene) bearings are very common. Where the bearing thickness is more than 30 mm, steel shims are often used to strengthen the bearings.

Elastomeric bearings have an advantage over steel bearings because they can cater for longitudinal and transverse movement as well as some rotation movement, and do not corrode.

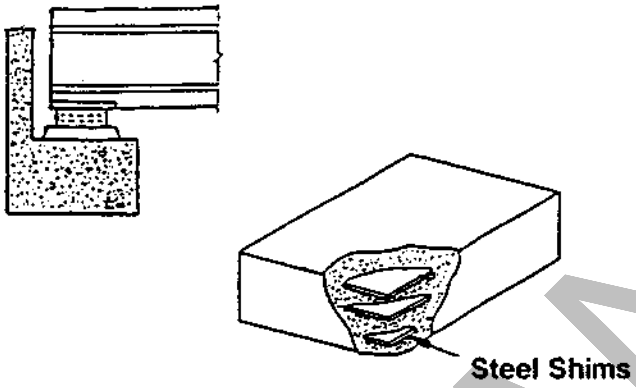


Figure 8.56 - Neoprene Bearing Pad with Steel Shims

Vibration can cause a bearing to move out of place. Restraints are often used to prevent this occurring.

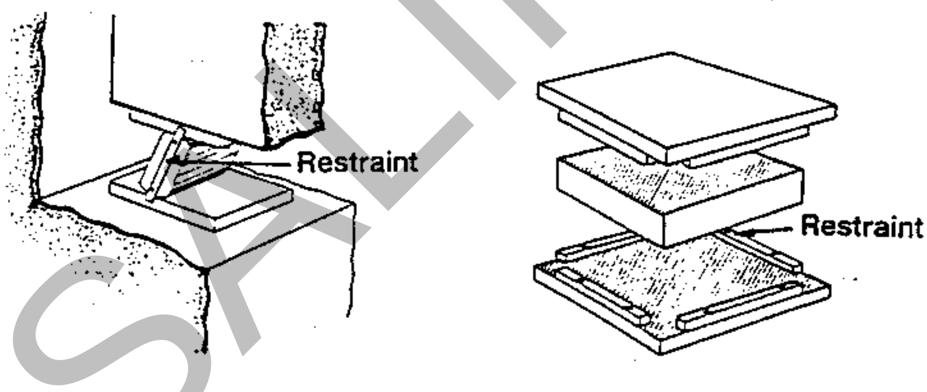


Figure 8.57 - Bearings with Restraints

4.613 Pot Bearing

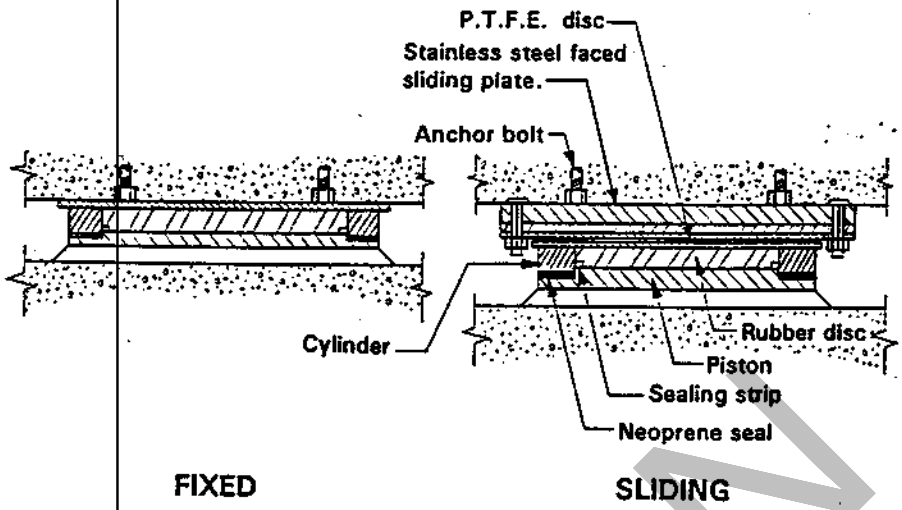


Figure 8.58 - Confined Elastomeric (Pot) Bearing

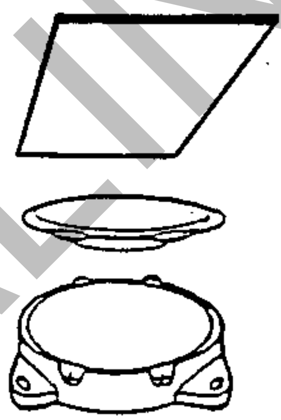


Figure 8.59 - Spherical Pot Bearing (Optional Sliding)

4.614 Mortar Pad/Base Plate

Some bearings are set on special mortar pads whilst others (for example Bailey Bridging) are set on base plates.

4.615 Hold Down Bolts

Many types of bearings are held with hold-down bolts to prevent vertical movement.

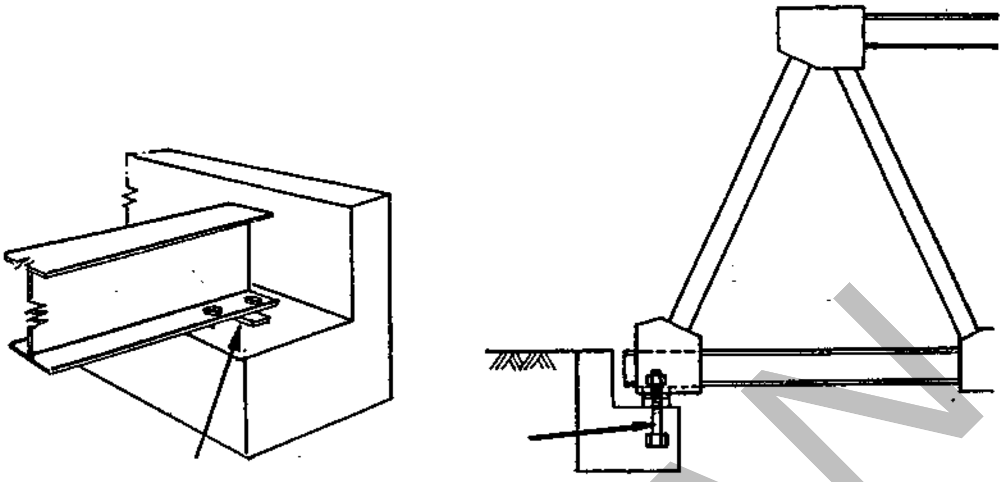


Figure 8.60 - Bearing with Hold-Down Bolts

3.620 RAILING (LEVEL 3)

Railing includes all forms of barriers, railings and parapets, such as the following Level 4/5 elements :

4.621 Post

4.622 Horizontal Railing

4.623 Railing Support

4.624 Parapet

Figures 8.61 and 8.62 show these elements.

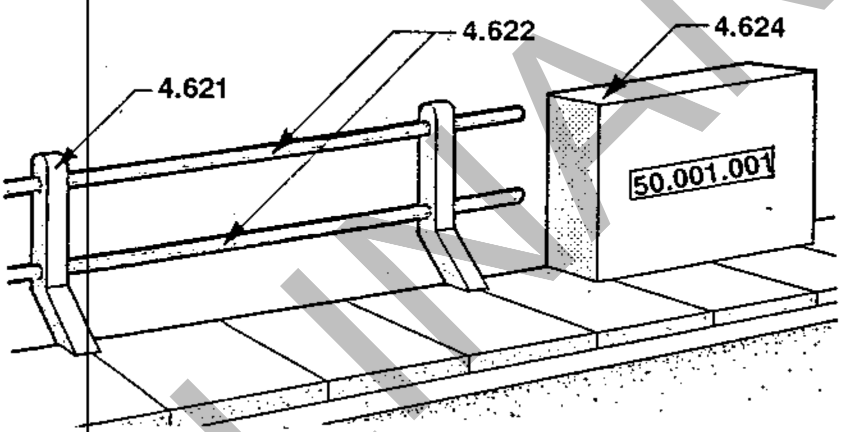


Figure 8.61 - Typical Railing Elements

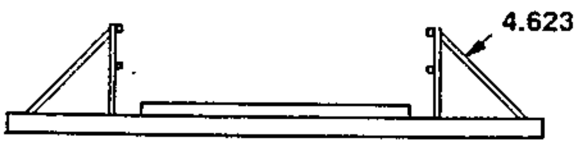


Figure 8.62 - Railing Support

3.700 FURNITURE (LEVEL 3)

Bridge furniture includes Level 4/5 elements which are not essential for the structural integrity of a bridge. However, these elements regulate traffic, enhance the appearance of the bridge and give confidence to those using it.

4.701 Gauges

Many bridges have either height or width gauges. These control the dimensions of vehicles which can use the bridge.

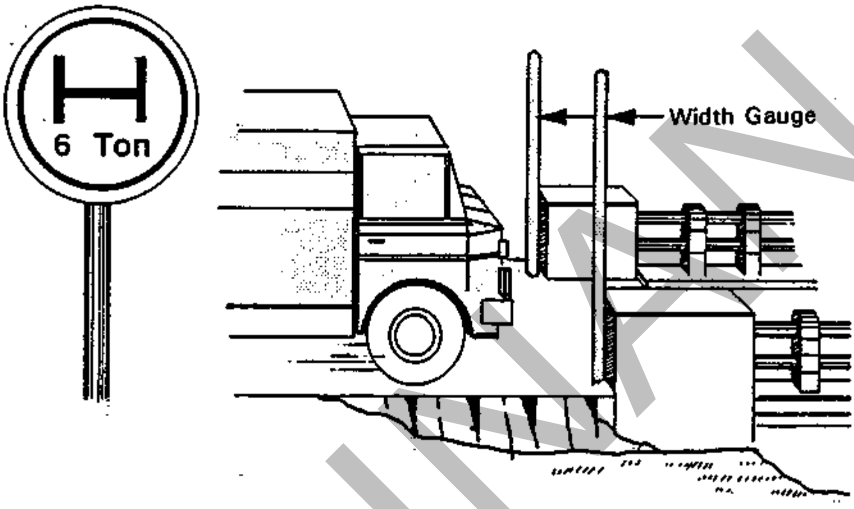


Figure 8.63 - Load Limit Sign and Width Gauge

4.711 Road Sign

Road signs regulate the type of traffic using the bridge and can include signs which advise motorists of speed, weight, or dimension limits.

4.712 Road Marking

Road markings show road lanes, no-overtaking zones and pedestrian lanes.

4.713 Name Plates

Every bridge should have a name plate which should show the name and number of the bridge.

4.714 Statue

4.721 Lighting - light tubes or globes

4.722 Lighting post

4.723 Power Conduit - conduits carrying the power

4.731 Utilities

Many bridges carry utilities or services, including gas, water, electricity, oil, telephone, sewerage services etc.

Damage to utilities can adversely affect the bridge, eg. broken pipes, and such occurrences must be reported and repaired.

2.800 CULVERTS (LEVEL 3)

Culverts are used in locations where :

- there are only minor flows
- there is limited height such as in a causeway
- where foundations are reasonably firm
- where the structure is not designed to take the full flow and over topping of the road is expected

Culverts are classified to type of construction as follows :

4.801 Box Culverts

4.802 Concrete Pipe Culvert

4.803 Corrugated Pipe Arch Culvert

Culverts should be inspected for the type of defect normally associated with the material from which they are made. eg. cracks in concrete, corrosion in steel.

Other aspects of culverts which need careful inspection are alignment, scour prevention etc.

Where culvert sections are butted together, alignment is most important. The culverts must be aligned correctly during the construction phase and the foundation must be strong enough to hold it in place. If either of these is not achieved, misalignment will result.

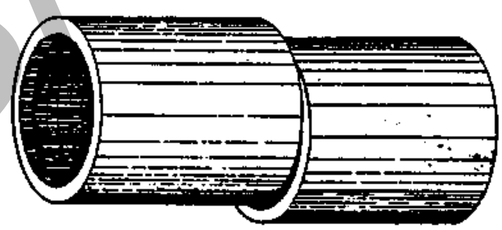


Figure 8.64 - Misalignment of Culverts

Bad misalignment will snag debris and may ultimately cause the culvert to block. If the alignment is very bad then scour pockets may develop. These can progress until the culvert is undermined. Settlement can occur with failure of the road above.

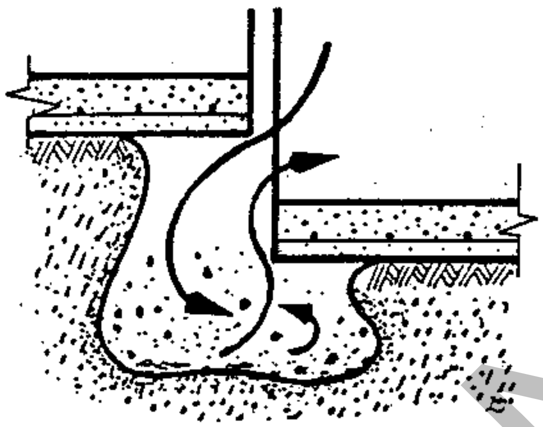


Figure 8.65 - Scour Pocket at Badly Misalignment Culvert

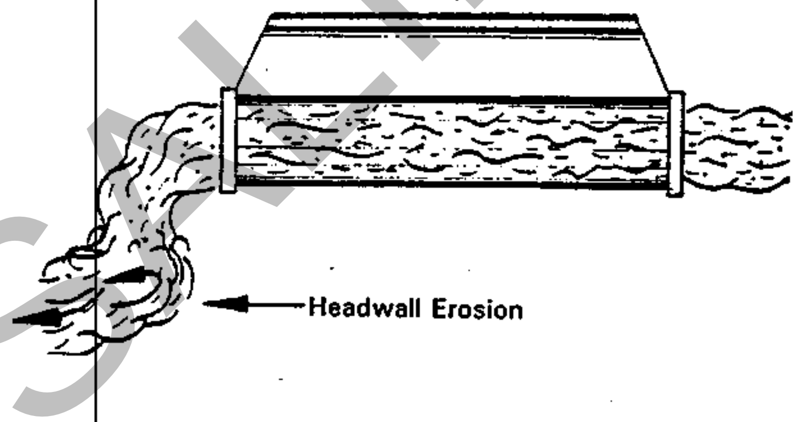


Figure 8.66 - Headwall Erosion

Inspectors should observe the stream conditions. Headwall erosion should be noted so that it can be repaired. Failure to treat headwall erosion can result in the end section of the culvert collapsing into the scour hole. This is turn can result in blocking of the culverts or a road collapse.

3.801 BOX CULVERT

Box culverts are normally made of reinforced concrete. They can be either prefabricated or cast-on-site.

Figure 8.67 shows the usual location of cracks in reinforced concrete box culverts.

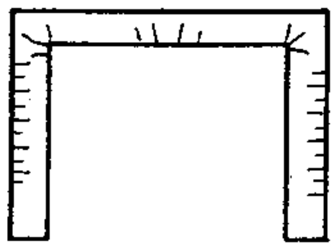


Figure 8.67 - Cracking Points in Box Culverts

3.802 PIPE CULVERT

Pipe culverts can be made from steel or concrete.

Concrete pipes are normally precast and reinforced, and inspectors should check concrete pipes for the usual defects associated with concrete.

Pipes are made in various load categories depending on the depth of fill to be placed over them.

Where excessive load is applied to a pipe, it will crack in the manner shown in Figure 8.68.

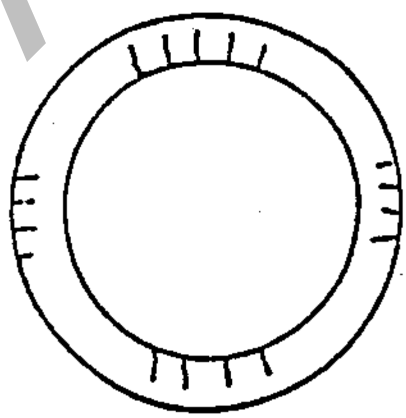


Figure 8.68 - Cracking Pattern in Pipe Culvert

Steel pipes much be checked for corrosion, loose connections, distortion and wear.

3.803 PIPE ARCH CULVERT

Pipe arch culverts are made from corrugated steel and are normally galvanized. They can suffer from corrosion, loose connections, surface abrasion and distortion.

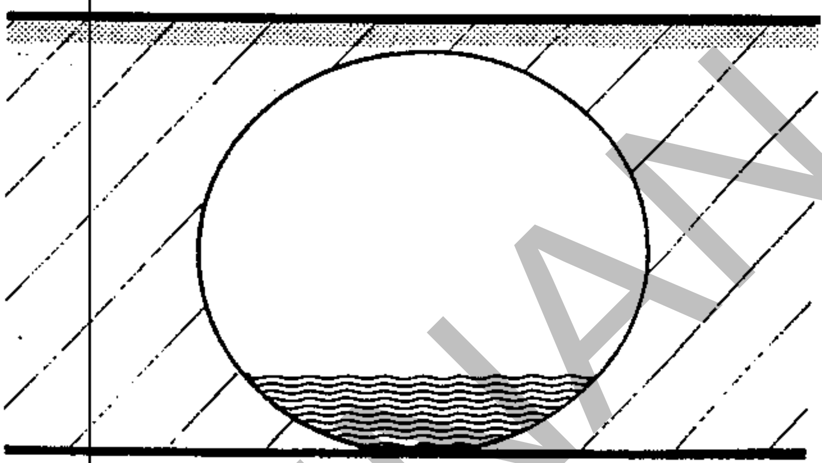


Figure 8.69 - Pipe Arch Culvert

2.900 WET CROSSINGS (LEVEL 3)

Wet crossings are crossings where no structure exists and vehicles travel through water.

3.901 PAVED FERRY CROSSING

A paved crossing is a wet crossing where the running surface is paved. This is generally a concrete slab or a mortared stone paved area. Sometimes there is a bank of culverts (with or without endwalls) to allow low flows under the road.

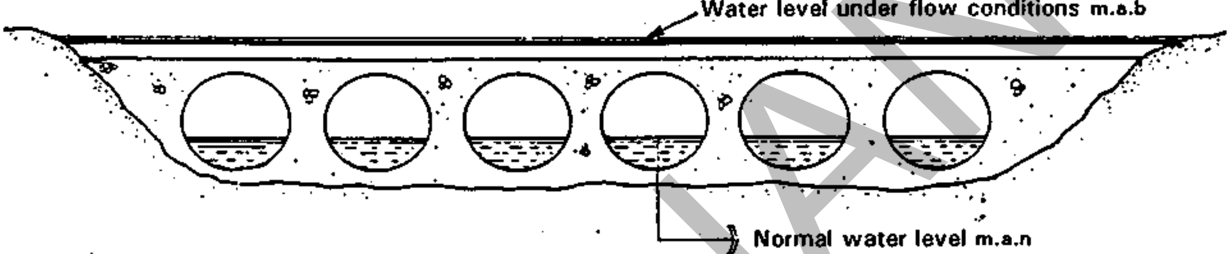


Figure 8.70 - Paved Ferry Crossing

3.902 - UNPAVED RIVER CROSSING

An unpaved crossing or river crossing is a natural crossing where vehicles normally have to ford the stream.

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

BRIDGE INSPECTION MANUAL

SECTION 9

DEFECTS IN BRIDGE MATERIALS

BRIDGE MANAGEMENT SYSTEM
BMS
A PROJECT JOINTLY FUNDED BY INDONESIA AND AUSTRALIA

FEBRUARY 1993

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TABLE OF CONTENTS

9. DEFECTS IN BRIDGE MATERIALS

9.1 GENERAL

Bridge elements are subject to two different types of defects :

- materials-related
- element-related

Materials-Related Defects

There are many defects which are directly related to the materials from which an element is made.

Examples of these are :

- *rot* and *splitting* in timber
- *rust* in steel
- *spalling* in concrete
- *deterioration of mortar* in masonry

Element-Related Defects

Element related defects are not specifically related to the material but to the element itself.

Examples of element-related defects are :

- *scour* at foundations
- *tilting* of a pier
- *missing* height gauges
- *changes* of stream alignment

Table 9.1 lists the common defects associated with various materials. Wherever possible, a defect should be related to a material. However, if the material defect results from a particular problem associated with an element, this should be noted.

eg. A concrete abutment headstock is cracked due to settlement. The inspector must note the defect as cracking but should also note that settlement is the cause. Maintenance personnel can then remedy both the defect and the cause.

Table 9.1 - Defects In Materials

Defect Code	Material and Defect
	MASONRY
101	Deterioration and cracking
102	Bulging or change of shape
103	Broken or missing material
	CONCRETE
201	Defective concrete including spalling, honeycombing, drumminess, porous and poor quality concrete
202	Cracking
203	Corrosion of steel reinforcement
204	Worn, weathered, aged or deteriorated concrete
205	Broken or missing material
206	Deflection
	STEEL
301	Deterioration of corrosion protection
302	Corrosion
303	Deformation
304	Cracking
305	Broken or missing element
306	Incorrect element
307	Frayed cables
308	Loose connection
	TIMBER
401	Defective timber due to rot, insect attack, splitting, crookedness, knots or sloping grain
402	Broken or missing element
403	Shrinkage
404	Deterioration of surface protection
405	Loose element

9.2 DEFECTS IN MASONRY

Masonry can be either natural material such as stone or manufactured material such as clay brick or concrete precast products. Masonry was used extensively prior to 1940 for the construction of arch bridges. Masonry is still often used for abutments, retaining walls and stream bank protection works.

Masonry work can involve regular shaped blocks or irregular stones. Blocks are normally bonded with a sand and cement mortar.

This Section describes the types of defect in masonry and the usual areas where these defects occur.

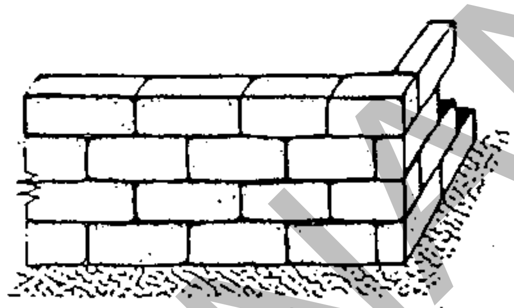


Figure 9.1 - Regular Blocks Set in Mortar

Stones can either be set in concrete or bonded with mortar.

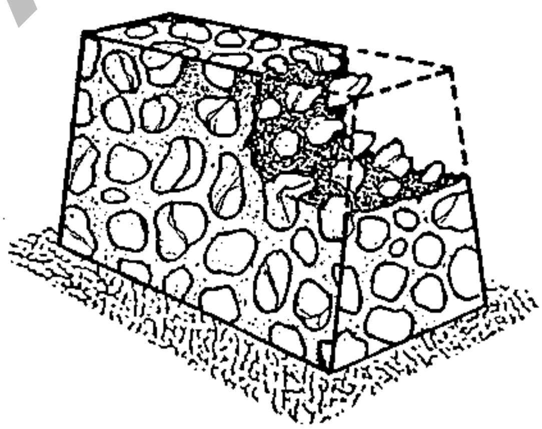


Figure 9.2 - Irregular Stones Set in Concrete

DEFECT 101 - Deterioration and Cracking

Bricks or stones can deteriorate because of the following :

- variation in quality of materials
- accidental damage
- erosion by the river or rain

Deterioration can be inspected by observation, or tapping to check soundness.

Deterioration of masonry in the vicinity of bearings or the point of loading is serious.

The *pointing* (bonding mortar) normally deteriorates before the bricks or stones. This can occur :

- through erosion, generally by water
- as a result of cracking which can dislodge the mortar
- crumbling of the mortar.

Deterioration of pointing is serious if it enables the bricks or stones to move.

Cracking is a serious problem in masonry work which can be caused by :

- settlement of foundations
- vibration in the structure
- excessive loading or impact

Cracking is serious if the masonry will no longer act as a total unit. Cracking can progress and result in collapse of the masonry or damage to other parts of the bridge

Cracking often occurs in the mortar but can also occur through the stones or bricks. Cracking is particularly serious in the vicinity of supports or bearings.

Vegetation can grow in the cracks and force the cracks to open wider.

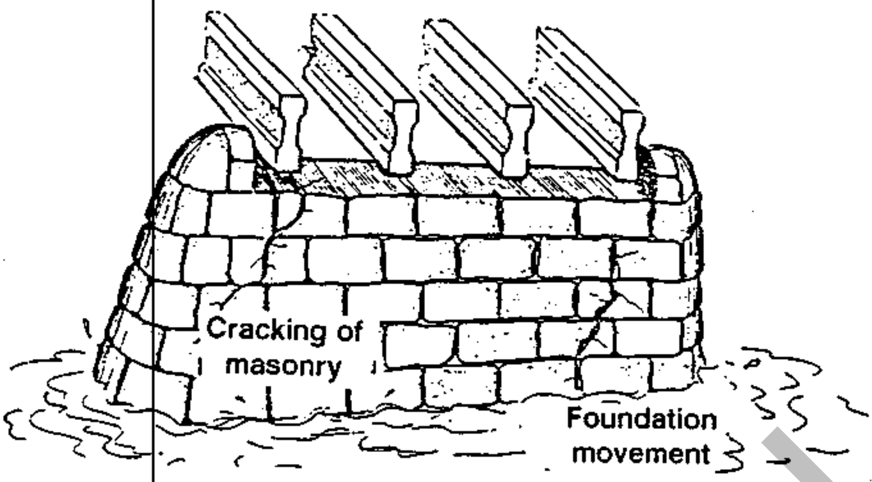


Figure 9.3 - Cracking in Masonry

DEFECT 102 - Bulging or Change of Shape

The face of a masonry structure can bulge or move outwards. This can occur where there is pressure behind the wall. The defect is serious if the bulging is causing mortar to crack or dislodge.

Inspectors should check masonry for straightness and correct shape.

Where bulges are present, a check on the foundations must be made to determine if undermining or settlement is causing movement.

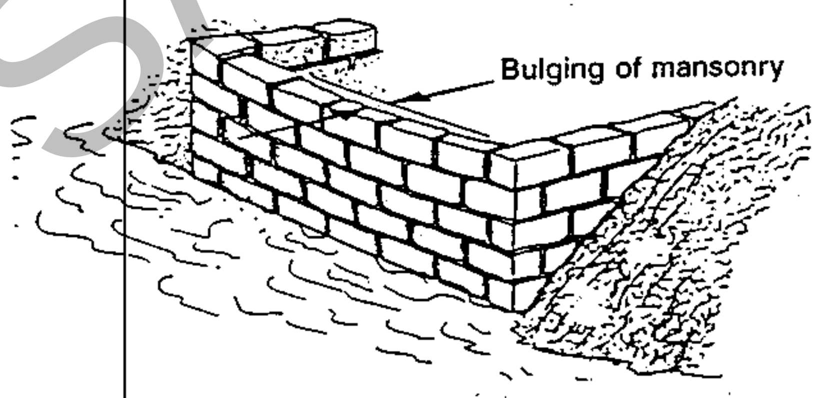


Figure 9.4 - Bulging of Masonry Faces

Bulging and change of shape are particularly serious in arches. There are three particular effects :

- changing shape of arch barrel
- separation of spandrel wall from arch
- foundation movement

Changing Shape of Arch Barrel

The shape of the arch barrel can change and weaken the arch. Cracking will normally occur. If the loss of shape and cracking progresses, the arch will ultimately collapse.

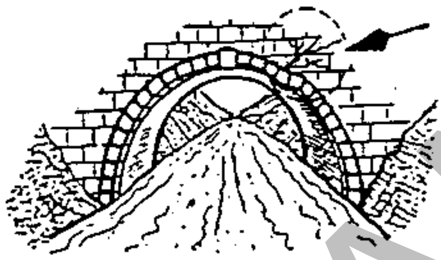


Figure 9.5 - Loss of Shape and Cracking of the Arch Barrel

Separation of the Spandrel Wall from the Arch

This occurs when excessive pressure behind the wall causes it to break or bulge away from the arch barrel and move. If the separation exceeds 30 mm, the defect is serious.

The defect is distinguishable by a step between the spandrel wall and the arch, as shown in Figure 9.6.

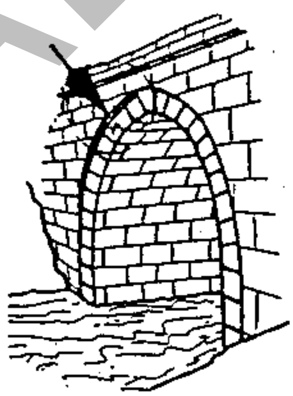


Figure 9.6 - Separation of the Spandrel Wall from the Arch

DEFECT 103 - Broken or Missing Material

Masonry structures often have stones or bricks missing or broken. This often happens with parapets. This results in reduced strength of the masonry work and/or loss of safety.

9.3 DEFECTS IN CONCRETE

9.3.1 General

Concrete is made by mixing cement with stone and sand, and adding water.

The water starts the cementing action and makes the material workable. However, the quantity of water used must not be excessive. The materials have to be mixed in the correct proportions and for sufficient time to ensure uniformity

With structural concrete it is important that the specified water - cement ratio is not exceeded, otherwise the concrete will be weaker than anticipated.

To produce good strong concrete, the concrete must be placed in stable formwork which will not move, without long delays and vibrated to eliminate air voids

After placing, concrete must be cured to ensure that it does not dry out and crack, and so that it achieves full strength.

If these processes are not carried out correctly during construction, then defects may occur.

Concrete is a hard durable material which is very strong in compression but weak in tension.

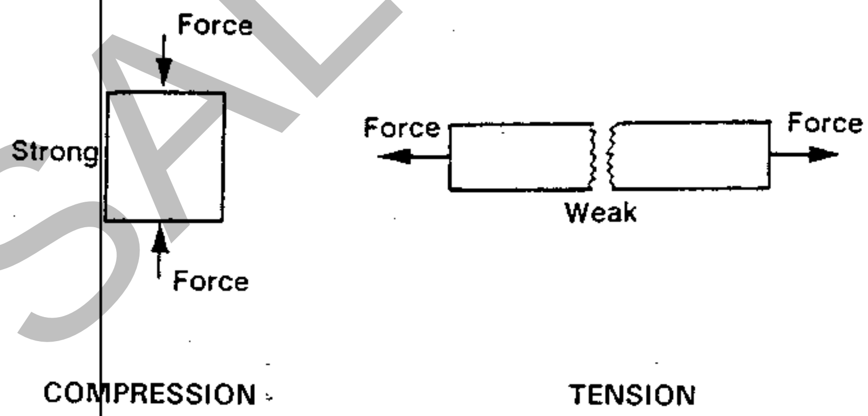


Figure 9.7 - Action of Concrete

When concrete is used in a girder, the top surface is in compression while the lower surface is in tension. Steel reinforcement is used in the bottom of the girder to give the girder strength in tension also. The concrete along the bottom flange holds the steel in place and protects it against corrosion. Lack of cover and resulting corrosion of reinforcement is a very common defect.

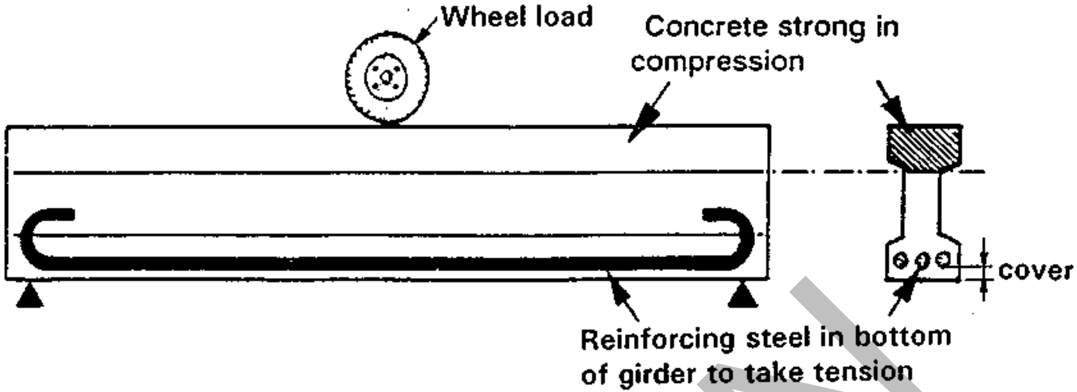


Figure 9.8 - Concrete Girder under Load

More details on concrete construction are given in the Bridge Construction Supervision Manual and Construction Techniques Manual.

9.3.2 Types of Concrete

There are four types of concrete construction :

- Concrete Rubble (Cyclopean Concrete)

  This type of construction uses a mixture of concrete and large stones to make a heavy foundation. This type of construction is often used in footings, retaining walls, beaching and abutment work.

- Unreinforced Concrete

  This is similar to concrete rubble construction except that smaller, graded aggregate is used. This is sometimes used in retaining walls, abutments, kerbs and footways.

- Reinforced Concrete

  Steel bars are embedded in the concrete to carry the tensile forces in the members. Reinforced concrete is used in all parts of bridges.

- Prestressed and Post Tensioned Concrete

  Prestressed concrete is usually used in the superstructure, i.e. in the girders or slabs. However, prestressing is sometimes used in piles and cross heads.

DEFECT 201 - Defective Concrete

This defect includes spalling, honeycombing, drumminess, porous and poor quality concrete.

Spalling

Spalling is the breaking away of a piece of concrete from the main body of the element. It is usually caused by steel reinforcement corroding and expanding, dislodging the concrete.

Spalling due to corrosion can occur anywhere if the cover over the reinforcement is inadequate. The underside of concrete decks, cast-in-situ beams and the corners of columns and headstocks are common areas for this defect.

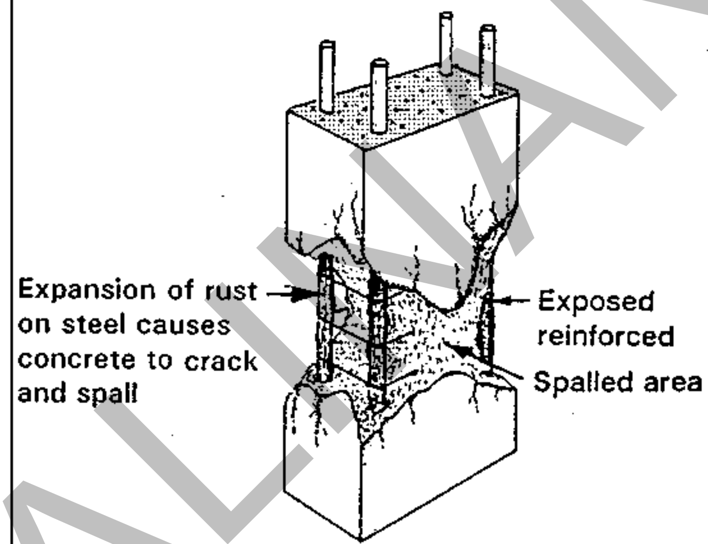


Figure 9.9 - Spalling Concrete

Honeycombing

Honeycombing in concrete occurs when the finer materials do not fill the voids between the larger aggregate and the steel. Consequently the concrete loses durability as air and moisture can easily penetrate into the reinforcing steel and cause rust. Honeycombing is serious if it is extensive.

Honeycombing can occur with a poor mix but more often because of poor construction techniques, such as lack of compaction, loss of mortar through poor quality formwork, and overcrowded reinforcement.

Inspectors should note areas of honeycombing, take photographs and draw sketches if necessary.

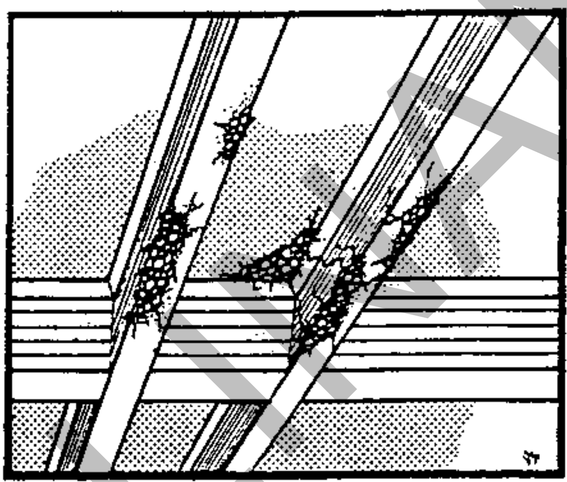


Figure 9.10 - Honeycombing of Concrete

Drumminess

Drumminess is the term given to poor concrete if it makes a hollow or drummey sound when it is hit with a hammer.

Drumminess can be caused by :

- rust in the steel reinforcement lifting a layer of concrete
- a poor repair which has not adhered to the base material and therefore creates a lamination

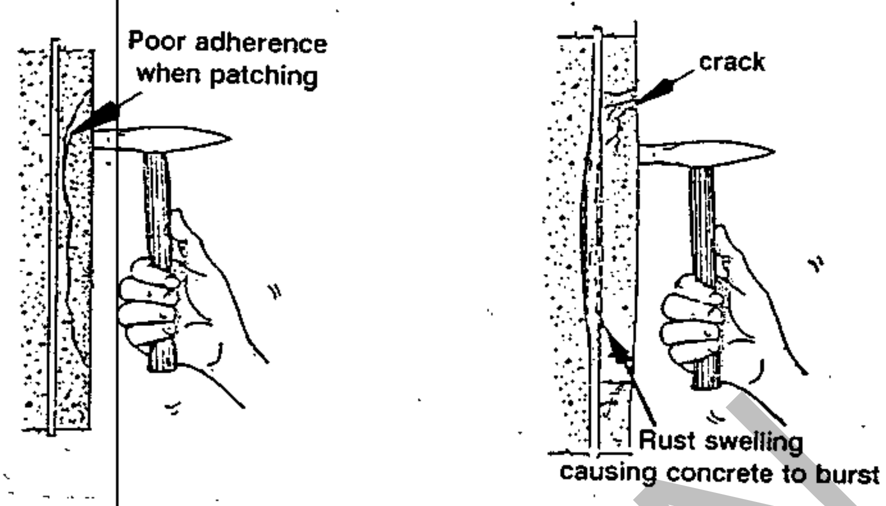


Figure 9.11 - Testing for Drummy Concrete

Porous Concrete

Seepage and leaking occur in concrete when the concrete is porous which allows water to pass through the concrete.

Seepage can be identified by staining of the concrete surface. Sometimes the stain is :

- slimey green where weed growth occurs
- whitish crusty appearance or white stalactites - this indicates that the lime from the cement is leaching out (or washing away).
- a perpetual damp area.

Seepage and transport of moisture through a concrete element can occur anywhere, but more often in deck slabs and at construction joints.

Poor Quality Concrete

This defect is one where the concrete has low strength. This defect is difficult for an inspector to judge as specialised equipment is necessary. If there is a doubt about the strength of the concrete without other defects being present, it should be referred for a Special Inspection.

DEFECT 202 - Cracking

Cracking in concrete is common. There are two types of cracks as follows :

- structural crack
- non-structural crack

To specify a repair treatment it is necessary to know whether the crack is active or is reasonably static.

Structural Crack

Structural cracks are the most serious form of cracking. They result from loads in excess of the load for which the element has been designed.

A structural crack is one which :

- opens and closes when traffic passes over the crack - these are more evident in bridge decks and girder,
- which is still developing due to continuing settlement or movement - these are more evident in the substructure.

Cracks can also occur where corrosion of the reinforcement is taking place under the surface.

Cracking in the girders and major elements can be due to :

- Bending (near mid-span).
- Shear (near the supports).

  These are likely to be on an angle of 40° to 50° to the axis of the element.
- A combination of bending and shear.

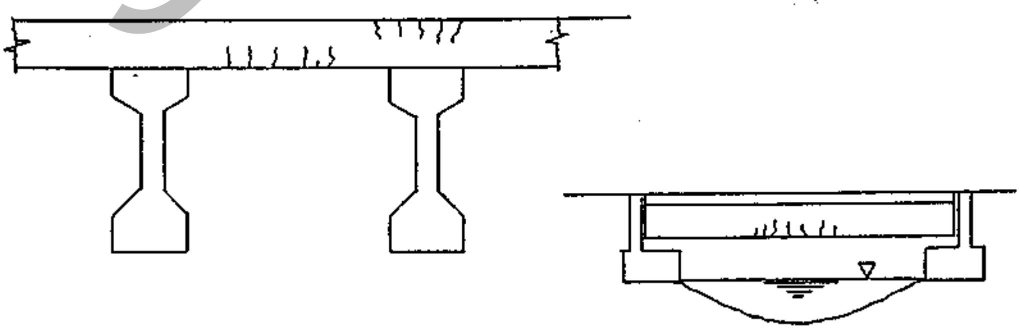


Figure 9.12 - Structural Cracks - Bending

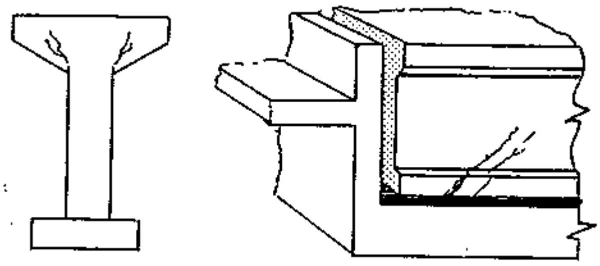


Figure 9.13 - Structural Cracks - Shear

Areas to inspect for structural cracks are :

- Tension Areas

  The critical areas to look for are the areas where concrete can develop tension. Examples are the headstock or the centre of a girder as shown in Figure 9.14.

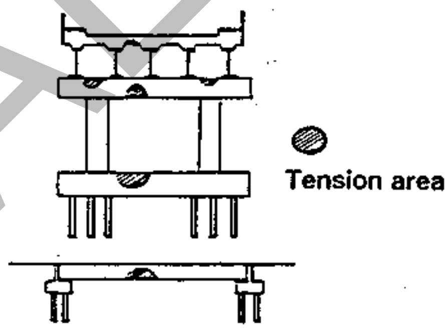


Figure 9.14 - Tension Cracking Due to Bending

- Shear Cracks

  Shear cracks usually occur near supports. This inspector should check for shear cracks near the bearings and near the tops of columns.

Movement in a structural crack can sometimes be felt by placing the palm of the hand over the crack when a heavy vehicle passes over the area. Differential movement will be felt in the hand.

Figure 9.15 - Checking for Structural Cracks

Measuring and Recording of Cracks

When structural cracks are discovered they must be recorded for repair purposes and to monitor the progression of the crack.

Crack widths can be measured using a crack gauge as shown in Figure 9.16 or a graduated magnifying glass.

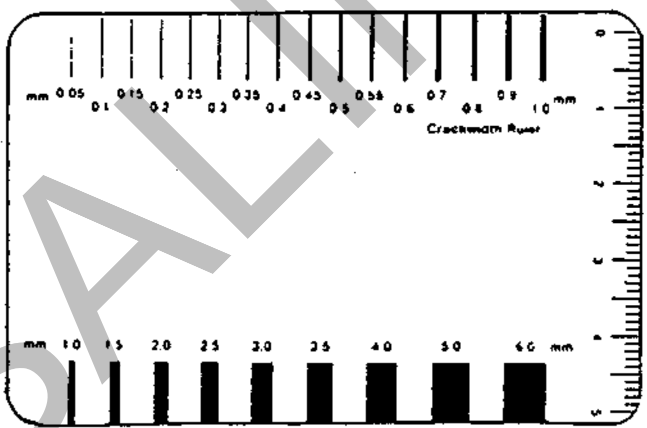
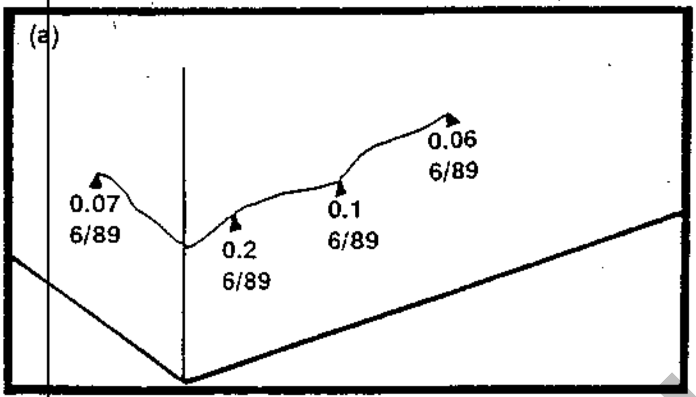


Figure 9.16 - Crack Gauge

Where cracks appear to be developing, the crack details should be marked on the concrete face with a waterproof texta-pen showing :

- the crack location
- the crack width
- the date of the reading

A sketch of the crack should be made showing the crack pattern. Photographs should also be taken of the area.



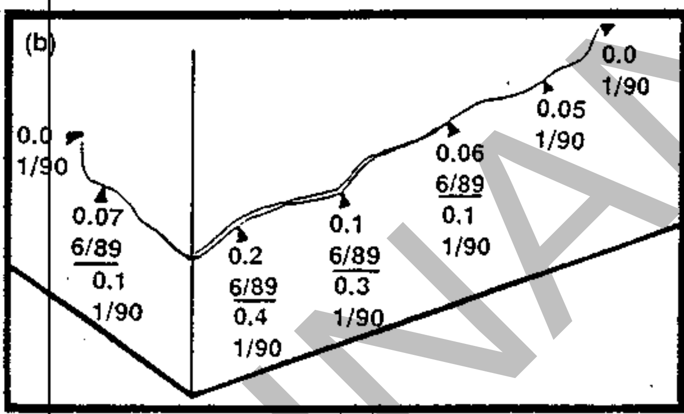


Figure 9.17 - Progressive Recording of Crack Development

Foundation Settlement Cracking

When a foundation settles or moves, many other internal stresses occur in a concrete structure. If settlement is present, then the inspector must check for cracking around the top and base of reinforced columns and the centre of pile caps.

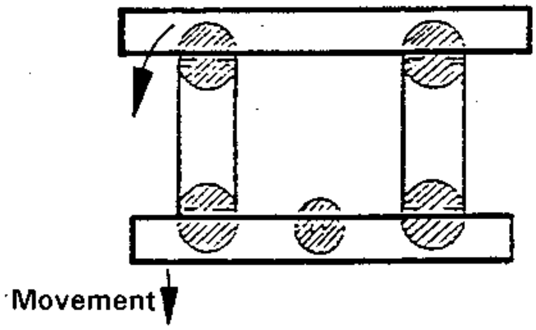


Figure 9.18 - Foundation Settlement Cracking

Cracking Due to Corrosion

Cracks can be caused by corrosion of reinforcing steel under the surface. As the corrosion expands, it heaves the surface causing cracks. Spalling of the concrete may occur as shown previously in Figure 9.9.

The inspector must investigate spalling of concrete which he thinks might be due to corrosion. This is done by hammering out a small piece of the concrete until the reinforcement is exposed. Exposed reinforcement should be noted for future patching work.

Non-Structural Cracks

Non-structural cracks are fissures in the concrete surface which are not active or developing. Some are serious while others are not.

There are several different types of non-structural cracks as follows :

- shrinkage cracks
- surface crazing
- formwork movement crack
- stabilized structural cracks

Shrinkage Cracking

Shrinkage cracking in concrete occurs most commonly on the exposed surfaces of newly-constructed floors and slabs (or other elements with large surface ares) when they are subject to very rapid loss of moisture caused by low humidity, wind, and/or high temperatures.

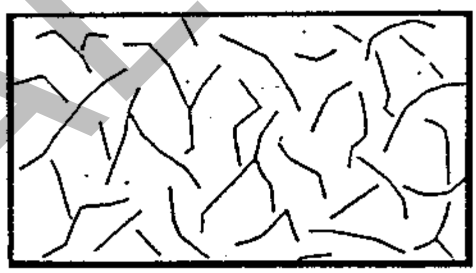
When moisture evaporates from the surface of freshly-placed concrete, the surface concrete shrinks. Shrinkage usually occurs prior to final finishing, before curing is commenced. Due to the restraint provided by the concrete below the surface layer, tensile stresses develop in the weak, stiffening plastic concrete, resulting in shallow cracks which are usually short and which propagate in all directions.

The cracks can vary enormously in length, width and spacing, and the orientation depends on the nature of the concrete element as well as atmospheric conditions, particularly heat and wind.

Figure 9.19 illustrates random plastic cracking.

If the shrinkage is confined by reinforcement just near the surface, the cracks may follow the line of the underlying reinforcement.

Shrinkage cracking is a non-structural crack and is not recorded as a defect if the.width of the crack is less than a millimetre and the length is less than 300 mm.



Random Orientation

Figure 9.19 - Shrinkage Cracking

Surface Crazing

Crazing is the hairline cracking of the surface layer of concrete into small irregularly-shaped areas as shown in Figure 9.20. Crazing is a special case of shrinkage. The cracks do not affect the structural integrity of concrete and should not lead to subsequent deterioration of the concrete.

They are rarely more than a few millimetres deep and are caused by shrinkage of the surface layer. Crazing, which is characterised by irregular, often hexagonal, areas typically between 6 and 75 mm across, is also referred to as map or pattern cracking. Crazing generally occurs in:

- the floated or trowelled surface layers of concrete slabs
- the formed surfaces of concrete

Surface crazing should not be reported as a defect.

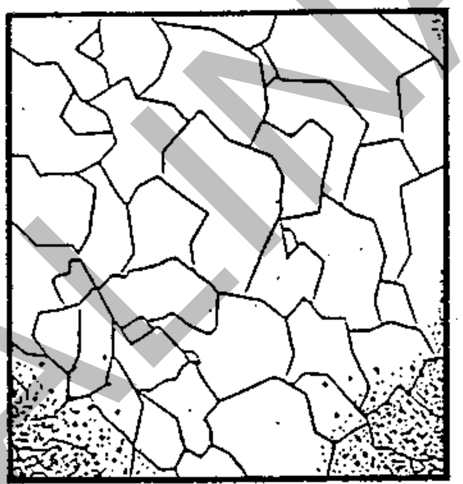


Figure 9.20 - Surface Crazing of Concrete

Formwork Movement Cracking

Cracking due to formwork movement is caused by the movement of the formwork after the concrete starts to stiffen.

Formwork movement cracking is serious if the cracks are deep and reinforcement is exposed.

Stabilized Structural Cracks

Some structural cracks are caused through movement. However, either due to the foundations stabilizing or the cause of the problem being removed further development of the crack ceases.

In these circumstances, the crack becomes a non-working crack. It will often be necessary to monitor the crack structural before being sure that it not still active.

DEFECT 203 - Corrosion of Steel Reinforcement

Corrosion of reinforcing steel is the biggest problem in concrete structures. Steel will corrode if it is not protected from air and water. In reinforced and prestressed concrete, the concrete gives protection to the steel. If there are cracks or holes in the concrete, then the protection is lost.

When the steel starts to corrode it swells and the concrete cracks. This allows more air and water in so the process accelerates.

Corrosion occurs more rapidly :

- in a salt water environment
- when there are defects in the concrete
- when there is insufficient concrete cover over the reinforcement

Corrosion can occur anywhere in a reinforced or prestressed concrete structure. Areas which need particular scrutiny are :

- near the water line
- underside of decks and beams
- underside of headstocks
- under any bulging or drummey concrete faces

Corrosion can be recognised by :

- exposed steel which is rusty
- rust stains on the concrete surface. Care must be taken not to confuse gravel stains with rust.

Where corrosion is encountered, it is important that the inspector assesses how much of the steel has been corroded away.

The normal minimum cover for concrete is about is 30 mm. If insufficient cover is causing a corrosion problem it must be noted by the inspector - a covermeter can be used to determine cover.

DEFECT 204 - Worn, Weathered Aged or Deteriorated Concrete

Concrete can abrade or be weathered. This can be caused by :

- traffic
- abrasion by water or by water-borne material
- chemical attack

Traffic

Traffic will normally only abrade the deck surface. However, abrasion of the deck is unusual unless the concrete is very poor.

Abrasion

Abrasion can occur in columns or piles in the area below water level. This is more common if the river is carrying a heavy load of sand or small rocks. If the abrasion is evident but the extent cannot be measured, a Special Inspection should be recommended.

Chemical Attack

Where chemicals are present in a river, they may attack the concrete. In these cases the concrete may become soft or crumbley, or may lose the fine materials leaving only coarse aggregate.

If chemical attack is evident, then a Special Inspection should be recommended.

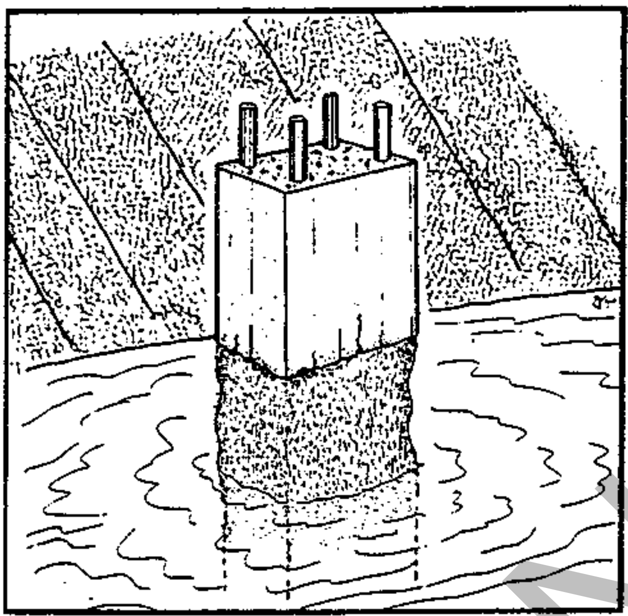


Figure 9.21 - Chemical Attack of Concrete

DEFECT 205 - Broken or Missing Piece

Concrete members can be broken by accident without exposing reinforcement. If a piece is broken off or missing but there is no apparent damage to the reinforcement it should be recorded as Defect 205.

Areas closest to traffic are most likely to suffer accident damage. Examples of this defect are damage caused by a vehicle hitting the railing and damage caused by a floating log hitting a pier.

DEFECT 206 - Deflection

Deflection can be caused by movement under load or movement of forms during construction.

9.4 DEFECTS IN STEEL

This Section describes the types of defect which can affect steel and the most probable areas where these defects occur.

Steel is used in many bridges because it is strong, hard and durable if well- maintained. Most of the bridges constructed in Indonesia since the mid-1970s have been made from steel superstructures in the form of trusses or girders, with concrete decks. Prior to that the steel bridges which were constructed often had inadequate corrosion protection.

There are five main problem areas in steel bridges which require inspection as follows :

- deterioration of paint and galvanising
- corrosion
- damage to steel parts
- loose connections
- cracking.

DEFECT 301 - Deterioration of Corrosion Protection

Steel will corrode if it is not protected from air and water. Steel is protected by painting or galvanising. Galvanising is a thin layer of zinc on the surface of the steel applied by a special process. Galvanised steel appears gray or silver in colour. Galvanising protects steel for a longer period than paint.

Surface protection coatings can break down due to aging or accidental abrasion. Damage to the surface protection by vehicular impact can also occur. Deterioration of the coating system is more common along the sharp edge of the steel work where surface coatings are normally thinner, particularly on painted members.

Early deterioration can be detected by bubbles appearing on the surface. This indicates rust growing beneath the coating system. The inspector should look for small signs of rust on paint surfaces which can rapidly lead to further deterioration. Galvanising deteriorates by corrosion of the zinc. White spots on the surface of the zinc show it is corroding.

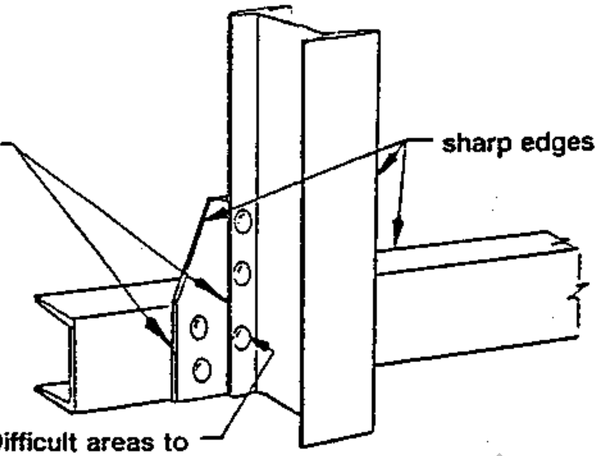


Figure 9.22 - Areas Where Paintwork Shows Initial Deterioration

DEFECT 302 - Corrosion

If the coating system fails and air and moisture come in contact with the steel, corrosion will take place. Corrosion is an irreversible chemical change in the steel. It is first observed when the surface shows brown rust. If not treated, the rust eats into the steel work and creates pitting. Pitting is the eating-away of the steel creating a depression in the surface. If corrosion is not stopped it can become very bad and lamination can occur. This has the appearance of the steel splitting into thin layers which are easy to peel off. This type of corrosion requires urgent attention as the defect is serious.

When steel rusts it expands. If rust occurs between two plates, the swelling action of the rust can force the plates apart. This exerts extra load on the rivets, bolts or welds and may cause failure of the joint.

Locations to be particularly checked for corrosion are :

- corners
- areas where debris, rubbish, soil etc can collect and trap moisture
- greased areas such as sliding plate deck joints, rocker or roller bearings.
- in cables and cable anchorages for suspension and cable stayed bridges.
- connections.

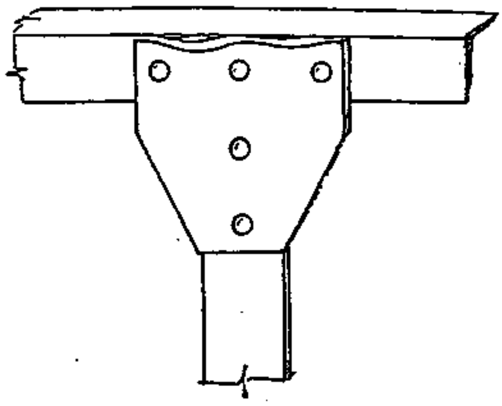


Figure 9.23 - Joint Swollen by Corrosion

Locations to be checked for corrosion on girder and truss bridges are shown in Figures 9.24 and 9.25.

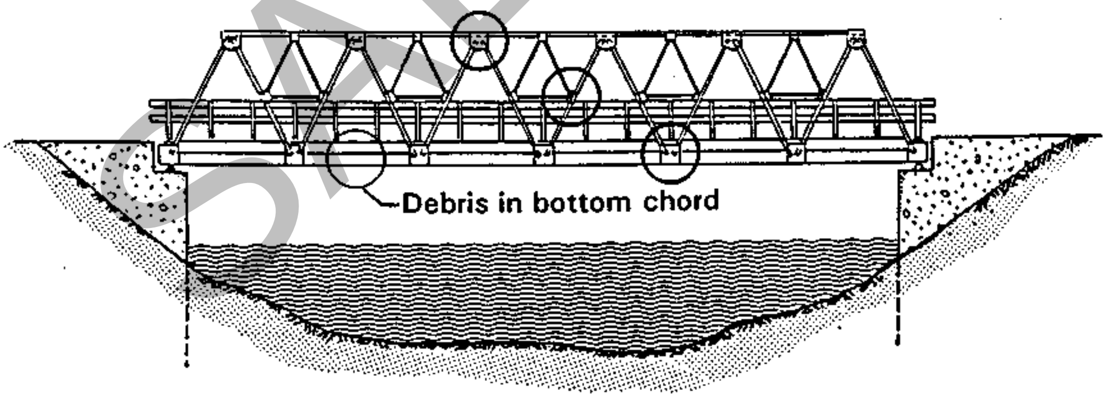


Figure 9.24 - Common Locations of Corrosion in Steel Truss Bridges

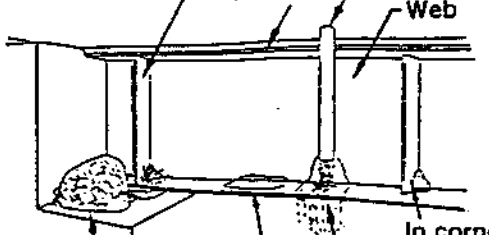


Figure 9.25 - Common Locations of Corrosion in Steel Girder Bridges

DEFECT 303 - Deformation in Members

Collision by vehicles and their loads, or by river debris can damage and bend steel bridge members and cause deformation. Steel bridge members can also be damaged during transport and handling. Defects can be local deformation in an element or total deformation of an element.

The structure can be weakened from deformation caused by impact and such damage may need to be promptly inspected by a specialist.

Some damage may not affect the strength of a structure but may make it vulnerable to corrosion where the coating is damaged or where damage allows water to collect. Such damage is to be reported.

Total deformation of a steel element should always be treated as a matter of urgency unless non-structural elements such as handrails or signs are affected. Local deformation can also be serious if the extent is large.

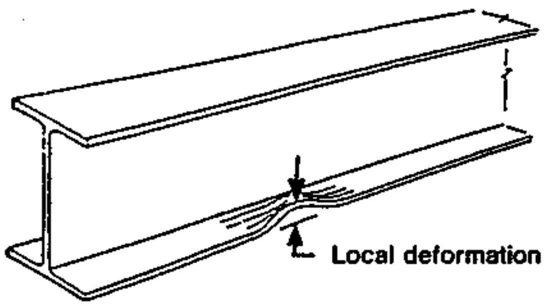


Figure 9.26 - Local deformation of steel

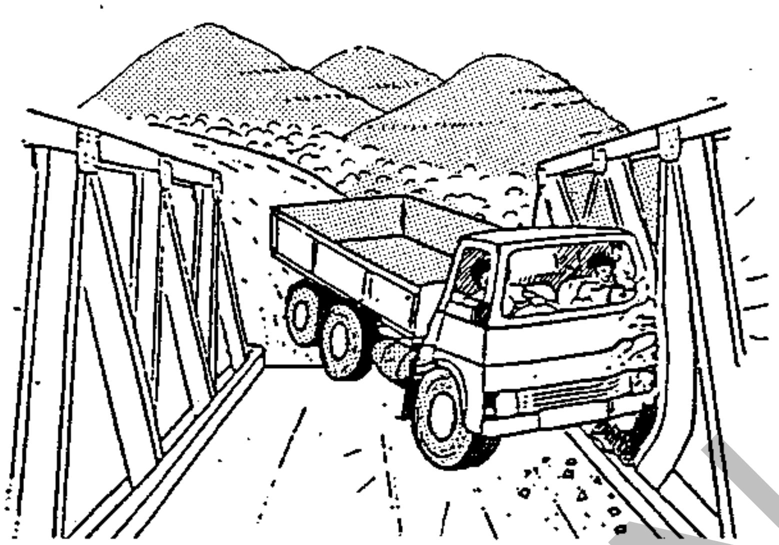


Figure 9.27 - Total Deformation Caused by Impact

The inspector must report the damaged element and the extent of the deformation.

Occassionally, accidents can occur on or under bridges. Sometimes very hot fires result from those accidents. If steel is subjected to intense heat the elements or fixings can be adversely affected. High strength bolts are more easily damaged than other fixings.

Damage can be revealed by sagging of an element and blistering if gusset plates are warped or rippled.

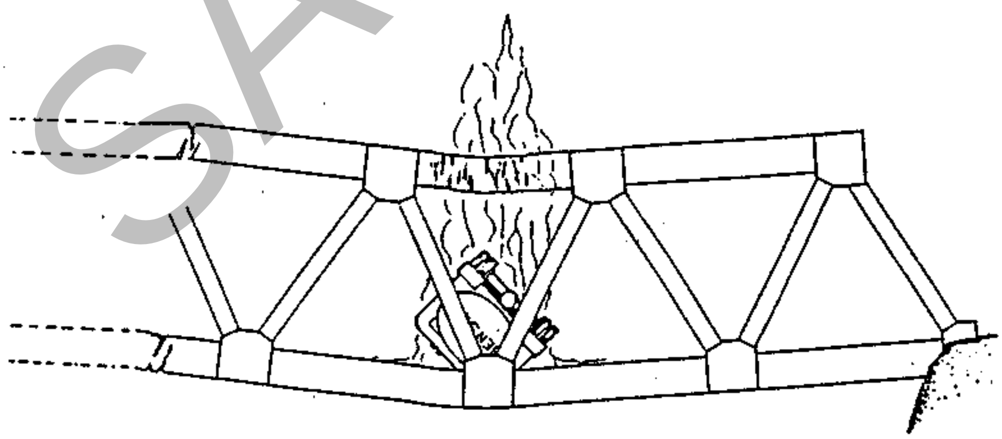


Figure 9.28 - Hot Fire affecting steelwork

DEFECT 304 - Cracking

Cracks in steel members can be caused by accidental damage (collision of vehicles etc) or by repeated loadings. If it caused by repeated loadings it is called metal fatigue.

Cracking can occur in the member itself or in the connections such as a weld.

Cracking in structural steel or welds is usually critical, so if it is discovered, a Special Inspection should be requested. Measurements and photographs should accompany the request for Inspection. Emergency precautions may be necessary. Figures 9,29, 9.30 and 9.31 show some common locations where cracking occurs.

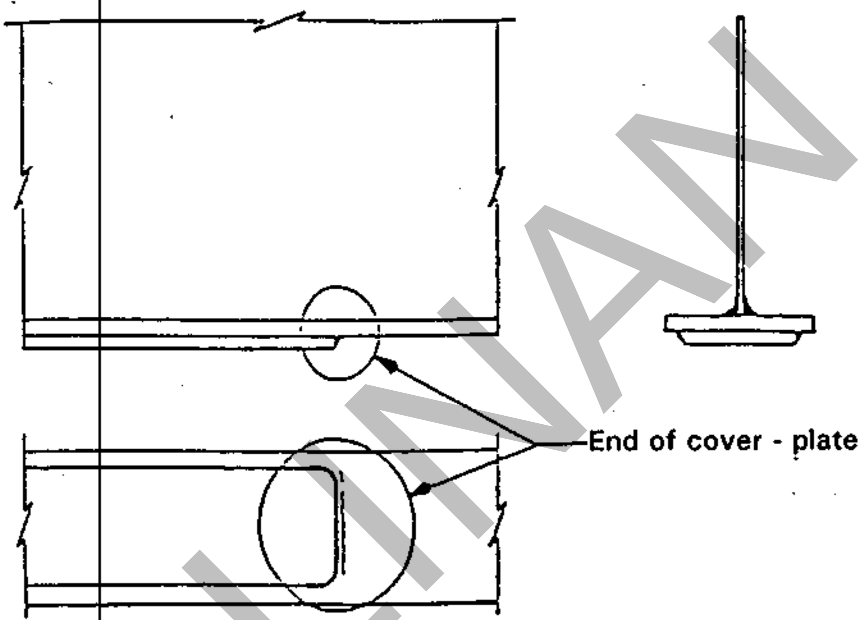


Figure 9.29 - Cover-Plated Beam Showing Common Location of Cracking

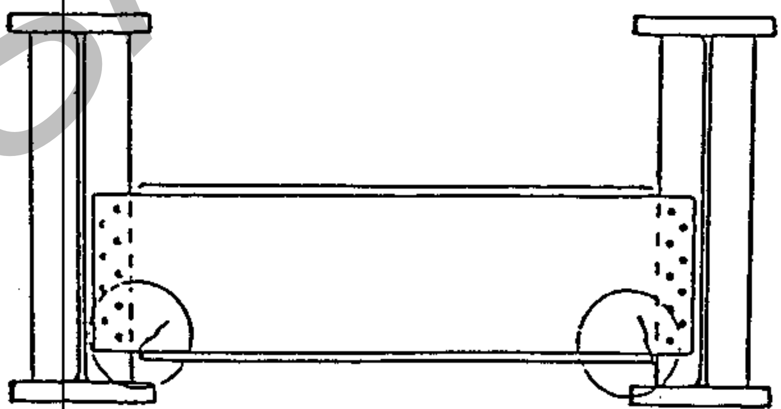


Figure 9.30 - Diaphragm with Coped Flanges Showing Common Location of Cracking

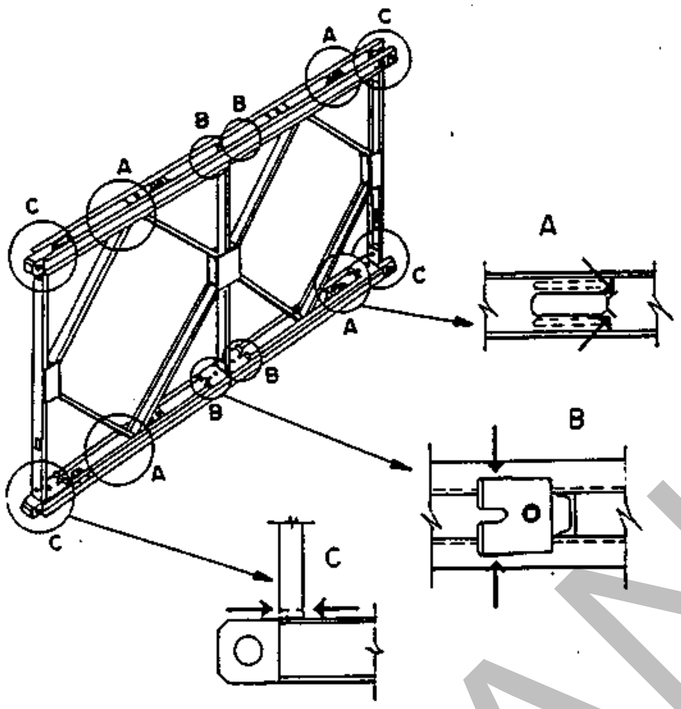


Figure 9.31 - Bailey Bridge Truss Showing Common Locations of Cracking

DEFECT 305 - Broken or Missing Element

Errors in construction, accidents or vandalism can result in elements being broken or missing, including missing connections.

Missing members and connections are usually obvious if there are connection points without adjoining members.

DEFECT 306 - Incorrect Element

Incorrect elements are hard to identify without extensive experience. The Inspector would not normally check for these items. However, incorrect members are serious and should be reported for early action. If in doubt, the Inspector can refer to design drawings and erection manuals.

DEFECT 307 - Frayed Cables

Cables are found in suspension and cable-stayed bridges. The cables are the main supporting element of the bridge so they must be inspected carefully.

Deterioration of cables normally occurs due to corrosion, abrasion or overload. All these can cause fraying of the cables.

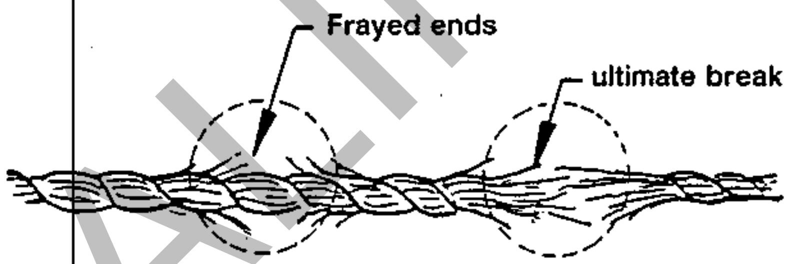


Figure 9.32 - Frayed Cable

The critical areas to look at on cables are at fixing points and at anchorages (refer to Figure 9.33).

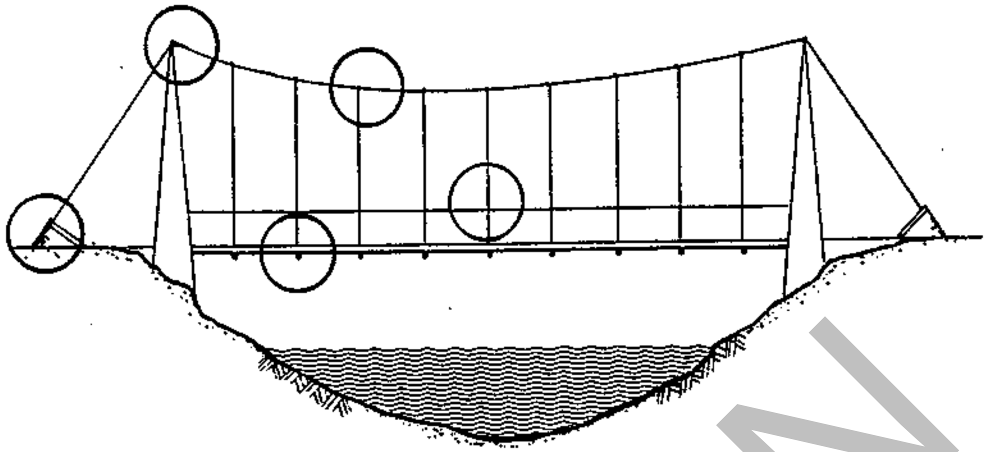


Figure 9.33 - Critical Location of Fraying of Cables in Suspension Bridge

DEFECT 308 - Loose Connection

Steel work connections are normally one of three types; bolted, rivetted or welded.

Bolts can be high strength or normal bolts which are only snug-tightened. High strength bolts can act in bearing or friction, and must be fully tensioned.

High strength bolts can be identified by the markings on the head as shown in Figure 9.34. Rivets and bolts can become loose, and welds can crack.

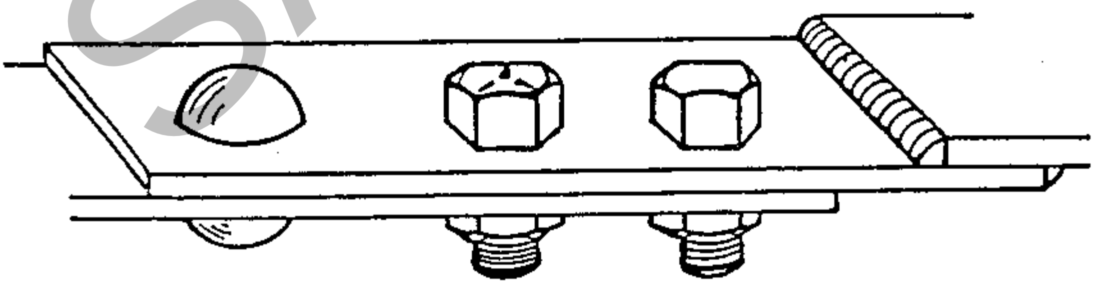


Figure 9.34 - Rivets, Bolts and Welds

Loose or broken rivets and high strength bolts can be easily identified by placing a finger on one side of the head so that the finger touches both the steel plate and the bolt or rivet head, and hitting the other side of the head lightly with a hammer. If the rivet or bolt is loose it can be felt. The defective connection should be marked with a waterproof marker, for later repair.

It is more common for loose or damaged connections to be found on elements near the points of loading.

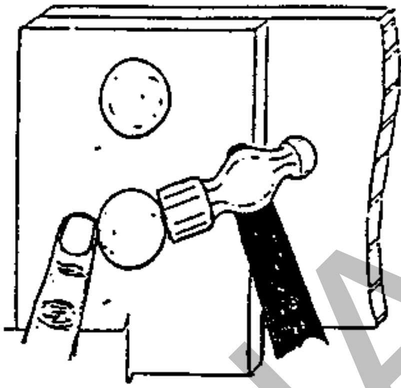


Figure 9.35 - Inspection of Rivet Tightness

Temporary Bridges

Temporary bridges such as Bailey bridges must be checked to ensure that :

- clamps are tight
- all pins and circlips are in their correct locations
- all braces are pulled tight with the turnbuckles
- all bolts are tight

9.5 DEFECTS IN TIMBER

This Section explains defects in timber and ways to recognise them. The main problems in timber bridges are :

- timber decay
- insect attack
- timber joint degeneration
- timber imperfection
- poor construction/design procedures
- special damage

Timber is a natural fibre which is relatively economic, but is less durable than steel or concrete so it needs much closer monitoring. Natural defects exist even when the material is new.

A timber log consists of four main components.

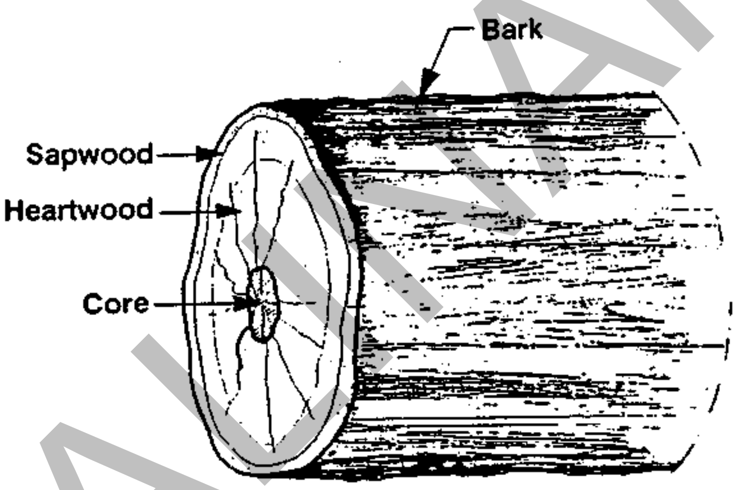


Figure 9.36 - Components of a Timber Log

Bark

The bark is the outer covering of the log and has no structural value. Bark should be removed during an inspection, to observe the timber underneath.

Sapwood

The sapwood is the outer layer of wood which was still growing at the time the tree was felled. The sapwood is softer, damper and normally lighter in color than the rest of the log. It is more susceptible to insect attack and has little structural value.

Heart wood

This is the section of the log from which the best timber is obtained.

Core

The core is the centre of the log which was the beginning of the tree growth and often contains defects. Rot often commences in the core where water can collect and this also encourages insect attack.

Timber Defects

The most important factor influencing the strength of timber is the presence of defects. A serious defect such as a very large knot can reduce the strength considerably, irrespective of the species, moisture content etc. Defects can often be detected visually and their effect can be assessed by the Bridge Inspector.

DEFECT 401 - Defective Timber

These defects include rot, insect attack, splitting, crookedness, knots and sloping grain. Defective timber should be replaced.

Rot and Decay

Timber decay is caused by fungal attack associated with dampness in the wood. As decay progresses, the strength of the timber is reduced. Inspectors should identify those areas which are subject to dampness and examine them thoroughly for rot and decay. Such areas are :

- where dirt accumulates - for example, on top of headstocks, in the cracks between deck planks
- where timber is in contact with the ground - for example, bed logs, abutment or wingwall sheeting, timber piles at and below ground level.
- areas that are constantly subject to wetting and drying - for example, piers or piles at the normal water level or in the tidal zone
- at timber fixing points (particularly if the fixing is loose) - for example, bolt holes, spike holes, timber interfaces
- exposed ends of timbers subject to all weather - for example, ends of piles, headstocks etc.
- around splits or knot holes or other timber imperfections.
- at the core.

Common locations for timber rot and decay are shown in Figure 9.37.

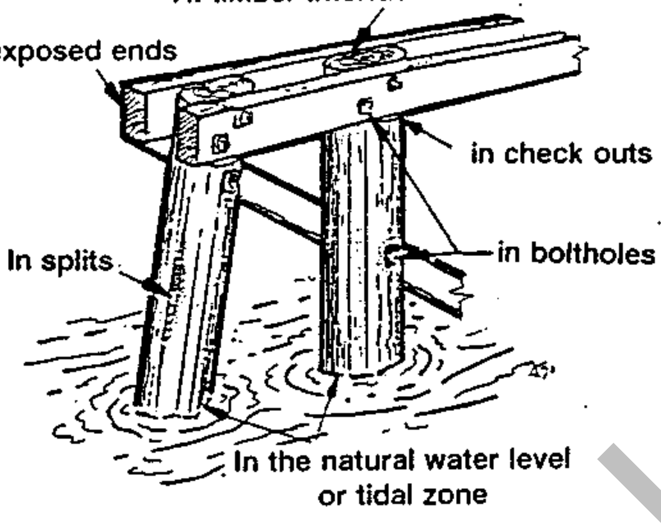


Figure 9.37 - Common Locations for Decay in Timber Substructures

Insect Attack

The effect of insect damage on timber may vary from negligible to complete destruction.

Termites (white ants) are a serious menace, and some beetles also attack timber.

Insect damage can often be detected during the inspection by observing holes on the surface of the timber. These often have dust around them. A few small holes (less than 5 mm diameter) are not usually serious; however, if they are larger or more numerous, it can indicate serious insect damage.

Where timber piles are in contact with the ground and termite attack is suspected, the inspector should dig around the pile to a depth of about 800 mm below the ground surface and test the timber to that depth. This check should be carried out at least every five years.

Termite nests near the bridge indicate that a thorough bridge inspection is required. The location of the nest should also be noted for immediate destruction. Nests are identified by termite mounds.

Testing for insect attack includes sounding (hammering), picking and boring, as well as visual observation.

Timber at or below water level in a marine environment should be checked for attack by marine organisms. If present, marine organisms seriously reduce the strength of timber piles and other timber in contact with salt water or even water of low salinity. Toredo worms are the greatest menace.

Toredo worms eat away the timber leaving holes about 10 to 15 mm diameter. Eventually, when sufficient holes exist, the pile (or other affected timber) will collapse. Testing (sounding) just above the water line is the best method to test for toredo worm.

Splitting of Timber

Splitting of timber can be caused by natural defects in the timber. These include sap veins and sap pockets which are natural cavities between the grains of the timber which are filled with the tree sap. These are unsightly and reduce the shear strength but for ordinary structural work are not detrimental, provided the gum veins are tight and the gum pockets are not extensive. They are undesirable in locations where shear stresses are high, for example, ends of timber girders.

Splits in timber near a joint can be serious particularly if the split occurs near the end of member and will allow the bolt to shear out of the end.

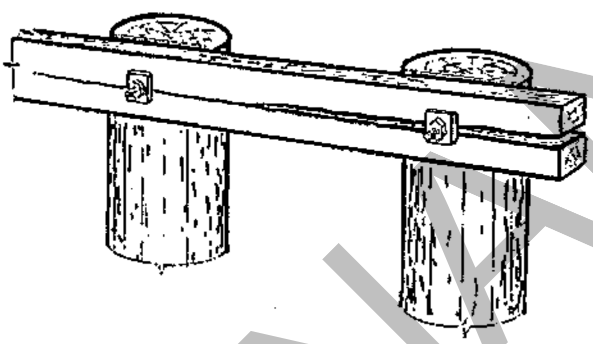


Figure 9.38 - Split near Timber Joint

Splintering of Deck Planks

Splintering is normally only a problem in deck planks. Splintering often occurs if the deck plank supports are far apart or if fixings are loose .

Constant traffic can produce splintering of the top of the deck planks and timber disintegration along the growth rings.

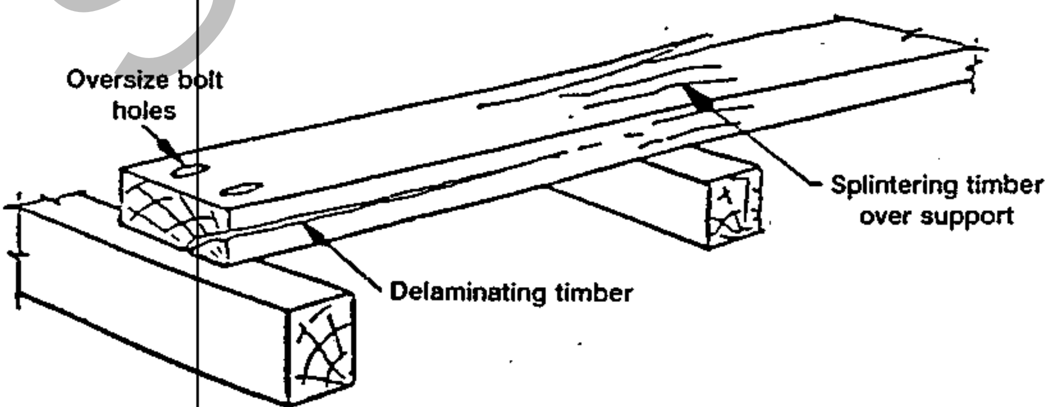


Figure 9.39 - Typical Worn Deck Plank

Crookedness

The strength of crooked round timbers used as columns is considerably reduced because of the resulting eccentrically of the load.

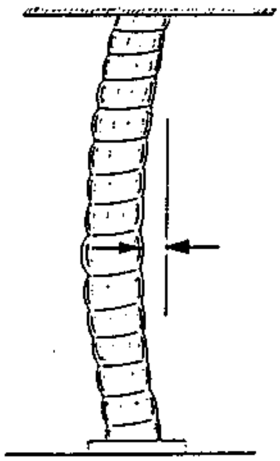


Figure 9.40 - Crookedness

Knots are probably the most common defect in timber, particularly in timber stringers. However, even when large and frequent, knots do not appreciably affect the stiffness of timber, and therefore knotty timber can be retained where stiffness rather than strength is the requirement.

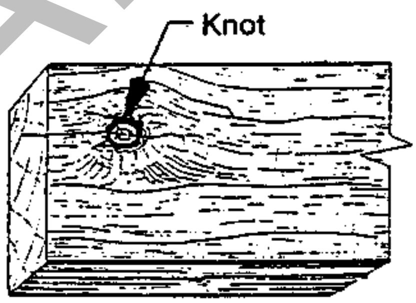


Figure 9.41 - Knots

Sloping Grain

Sloping grain is a serious defect in sawn timber, but is often difficult to detect. The approximate effect on the strength of beams is set out in Table 9.2.

Table 9.2 - Effect of Sloping Grain on Strength of Beams

Slope of grain	1 in 20	1 in 16	1 in 12	1 in 10	1 in 8
Reduction in strength of beams (%)	0	20	30	40	50

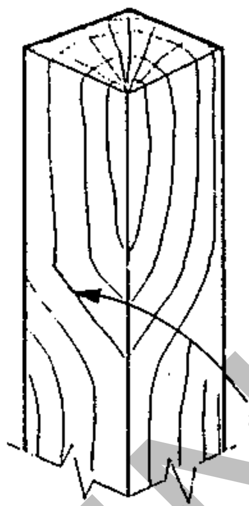


Figure 9.42 - Sloping Grain

DEFECT 402 - Broken or Missing Element

Broken or missing elements can result from :

- accident
- poor construction
- elements deteriorating and falling out
- fire damage
- cuts
- vandalism or theft.

If the missing elements or connections are structural then the defect is serious.

DEFECT 403 - Timber Shrinkage

The cross-sectional dimensions can change if newly cut timber is used in construction.

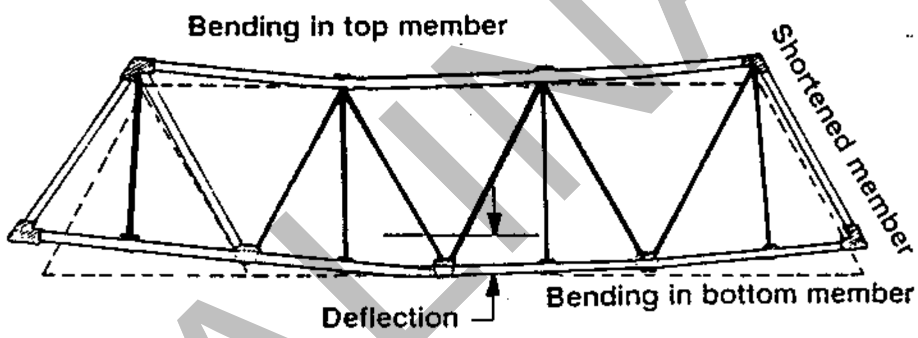


Figure 9.43 - Effect of Shortened Members in Timber Truss

DEFECT 404 - Deterioration of Surface Protection

It is desirable to protect the timber surface with paint, bituments, anti-fungal or insect deterrent coating. This may age and deteriorate.

DEFECT 405 - Loose Element

If joints are not kept tight, then shaking or rattling of a bridge can occur. This will ultimately cause deterioration and damage to the structure.

All bolts should be checked for tightness. If gang-nail fixings are used they should be checked to ensure they are still secure. Any nail or spike which is loose should be repaired.

INSPECTION METHOD FOR TIMBER STRUCTURES

Visual

All timber must be visually checked where possible. The visual check will cover the timber defects described in this Section. External plant growth is the most obvious sign of fungal problems. Abnormal surface shrinkage and crazing may indicate the presence of subsurface fungal attack also. Localised colour changes in the timber can indicate decay. Watermarks or rust staining of timber can also show that fungal attack is occurring, particularly if the staining is white.

Probing

Probing into the ends or faces of timber can reveal decaying timber, the presence of fungi and termite attack. Resistance to the probe will indicate how solid the timber is. Probing should be carried out with a screw driver or square spike. This will avoid confusion for inspectors who may subsequently mistake round probe holes for insect holes.

Sounding (Hammering)

Sounding is the basic method of inspecting timber. Sounding is carried out by striking the member with a hammer, the back of an axe or similar implement. The sound gives an indication of how solid the timber is or how hollow if core rot exists. A dull thud indicates the presence of poor surface timber (may be due to saturated timber, fungal attack or a termite colony).

When deteriorated timber is located by sounding, then additional testing is required to determine the significance of the problem.

Listening

Listening to the noises made by a bridge as traffic passes over it may reveal the presence of some defects. This will be in the form of squeaking with cracks or clattering if there are loose joints.

Boring

Timber members can be tested to determine the extent of decay by drilling a small hole. Care must be taken regarding the number and locations of bore holes. Every bore hole further weakens the structure.

The hole is normally about 10 mm diameter. The resistance to the drill reveals the presence of rot and the structural value of the timber. A probe can be inserted into the hole to further determine the soundness of the timber. Experience is required before reliable diagnosis is achieved.

Bore holes should be self-draining. If this is not possible, then they should be plugged with timber pegs.

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

BRIDGE INSPECTION MANUAL

SECTION 10

DEFECTS IN BRIDGE ELEMENTS

BRIDGE MANAGEMENT SYSTEM
BMS
A PROJECT JOINTLY FUNDED BY INDONESIA AND AUSTRALIA

FEBRUARY 1993

DOCUMENT No. BMS2-M.E

TABLE OF CONTENTS

10. DEFECTS IN BRIDGE ELEMENTS

10.1 GENERAL

There are some defects which are not related to the materials from which the bridge is made. These defects are specific to particular elements, and are listed in Table 10.1.

Table 10.1 - Defects in Elements

Defect Code	Element and Defect
	WATERWAY
501	Siltation
502	Debris accumulation and obstruction of the waterway
503	Scour
504	Excess afflux
	SCOUR PROTECTION
511	Missing material
	EMBANKMENTS
521	Scour
522	Cracking/settlement/bulging of fill
	REINFORCED EARTH
531	Bulging of facing panels
532	Cracking/spalling/breaking of panels
	ANCHORS
541	Instability
	ABUTMENTS/PIERS
551	Movement
	EARTHQUAKE RESTRAINT BLOCK
561	Loose or missing element
	BEARING
601	Loss of movement ability
602	Improper seating
603	Cracked or spalled mortar pad
604	Excessive movement or deformation
605	Defective material including aged, split torn, cracked or broken bearings
606	Loose parts
607	Dry metal bearing

Table 10.1 - Defects in Elements (continued)

Defect Code	Element and Defect
	SLAB AND DECKING
701	Excess movement in longitudinal deck joint
702	Excessive deflection
	WEEP HOLES/SCUPPERS/DECK DRAINAGE
711	Blocked scuppers and weep holes
712	Missing material
	RUNNING SURFACE
721	Slippery surface
722	Potholed/rough/cracked surface
723	Heaving/rutting of pavement
724	Excessive overlay
	FOOTWAY AND KERBS
731	Slippery footway
732	Potholed/rough/cracked footway
733	Missing material
	DECK JOINTS
801	Rough/uneven joints
802	Loss of movement ability
803	Loose parts/loss of adhesion
805	Broken/missing parts
806	Cracked asphalt due to joint movement
	GAUGES
901	Damaged/missing gauges
	ROAD SIGNS AND MARKINGS
911	Aged or worn material
912	Missing element
	LIGHTING, POLES AND CONDUITS
921	Aged or deteriorated materials
922	Missing materials
	UTILITIES
931	Malfunction

10.2 DEFECTS IN WATERWAYS

501 - Siltation

Siltation occurs where the flow in a river or stream is not fast enough to carry materials and silt which settle to the bottom of the riverbed.

In some instances, the deposition of silt may constrict the waterway in the vicinity of the foundations. This can cause overtopping of the bridge or approaches during large river flows.

502 - Debris Accumulation and Obstruction

Debris is carried in many rivers and can be deposited against the foundations of a bridge. The debris can build up against the pier or abutment and cause extra lateral loading on the structure and constriction of the waterway.

Obstruction can also occur as a result of leaving falsework piers or old structures in the riverbed after bridge construction.

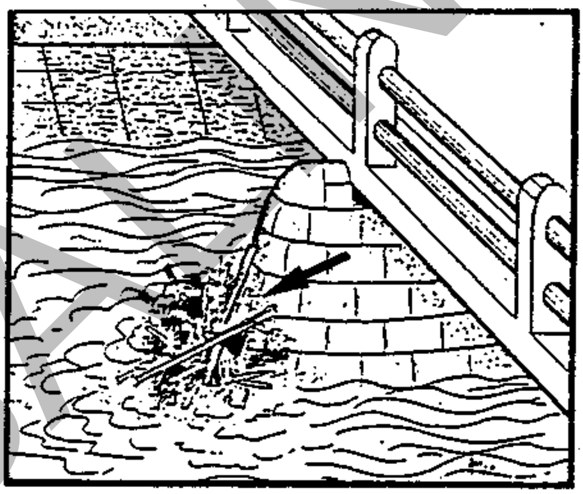


Figure 10.1 - Debris Accumulation

503 - Scour

Collapse of bridges caused by scour are common, so this aspect of the bridge must be checked at every location.

If it is suspected that there is a problem under the surface of the water, then a Special Inspection should be recommended.

504 - Excess Afflux

There are many bridges which have inadequate length and waterway area. Consequently, water can back up behind the structure causing afflux in the flood plain upstream.

The backing-up may cause excessive stream velocities and scour. Flooding of villages or other developments may also be caused upstream of the bridge.

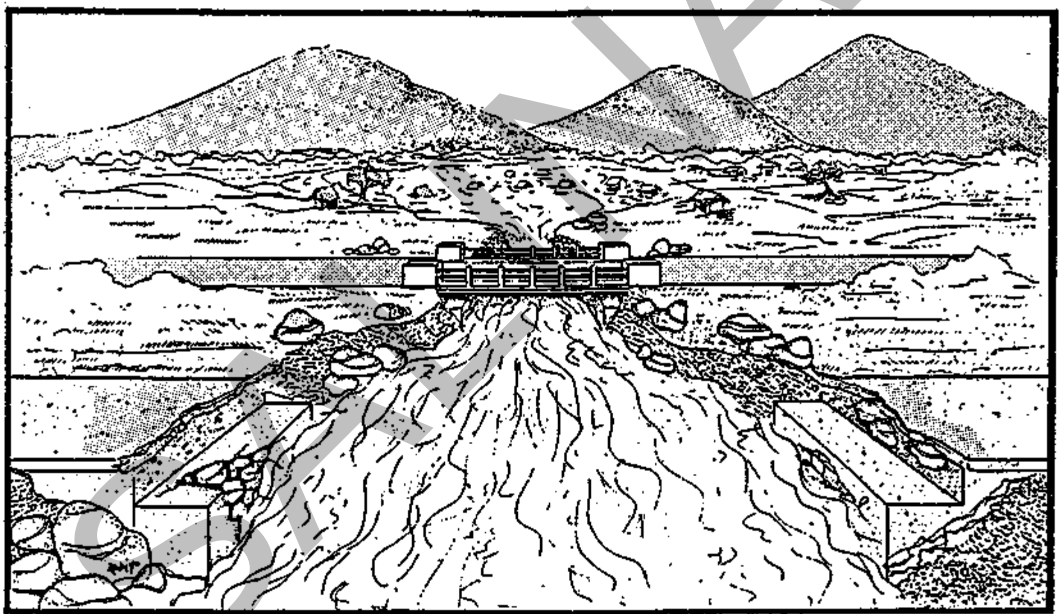


Figure 10.2 - Flooding Upstream Due to Inadequate Waterway

10.3 DEFECTS IN SCOUR PROTECTION

511 - Missing Material

This defect includes the following :

- scour protection which has been lost due to erosion, floods or deterioration

- scour protection which is needed to control a serious scour problem.

The elements affected by this defect include:

- fender piles
- groynes
- gabions and mattresses
- sheet piling
- stone pitching

10.4 DEFECTS IN EMBANKMENTS

Embankments refer to the road embankment at each end of the bridge. Defects affecting the embankment include :

521 - Scour

This can restrict the roadway or cause its collapse, and is often the result of poor deck drainage.

522 - Crack/Settlement/Bulging

Large cracks can indicate an unstable embankment. Cracks allows ingress of water and lead to scour or weakening of the road pavement.

522 - Settlement

Settlement of the bridge approaches in the immediate vicinity of the abutment can cause similar problems to a bumpy or pot-holed surface. ie. increase in impact loads on the bridge.

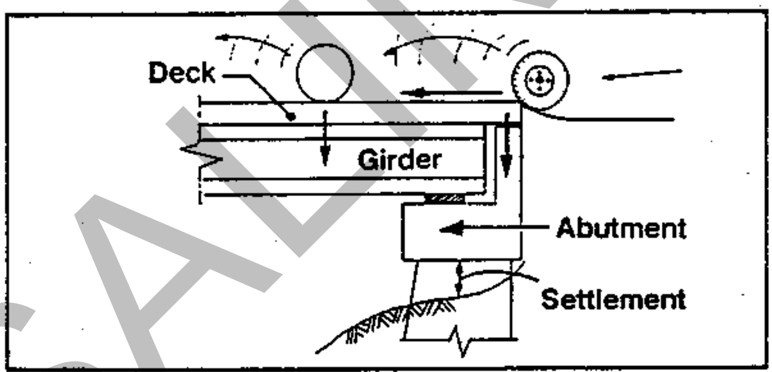


Figure 10.3 - Effects of Abutment Subsidence

Where the road has subsided at the abutments, there may be settlement under the abutment headstock (crosshead) also, if spill-through abutments have been used. This requires checking of the approach embankment to avoid potential collapse.

522 - Bulging

Bulging of the side batters of an approach embankment may indicate an unstable batter.

10.5 DEFECTS IN REINFORCED EARTH

531 - Bulging of Facing Panels

Failure of the Reinforced Earth anchors can occur due to :

- breakage of the steel anchor straps
- loss of friction between the anchor strap and the soil.

These defects will cause bulging of the Reinforced Earth facing panels.

532 - Cracking, Spalling or Breaking of Reinforced Earth Panels

The Reinforced Earth facing panels can be damaged by :

- accidents or vandalism
- settlement of the fill

Accident or vandalism damage is quite obvious. Damage due to settlement will normally be in the form of cracking. As the facing panels are interlocking, any movement of the wall may spall or break off edges of the panels.

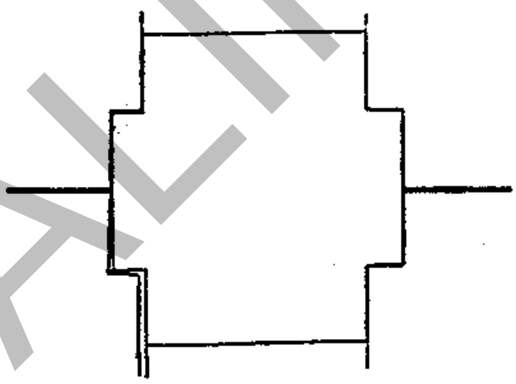


Figure 10.4 - Reinforced Earth Panel- Corner Damage Due to Settlement

10.6 DEFECTS IN ANCHORS

541 - Instability

Suspension and cable stayed bridges rely on the stability of the anchorages for safety. If a cable anchor moves, then the bridge will sag. If the movement is excessive or if the anchorages "pull-out", then the bridge will collapse.

Where anchors are unstable, the ground around the anchorage may show signs of folding or cracking.

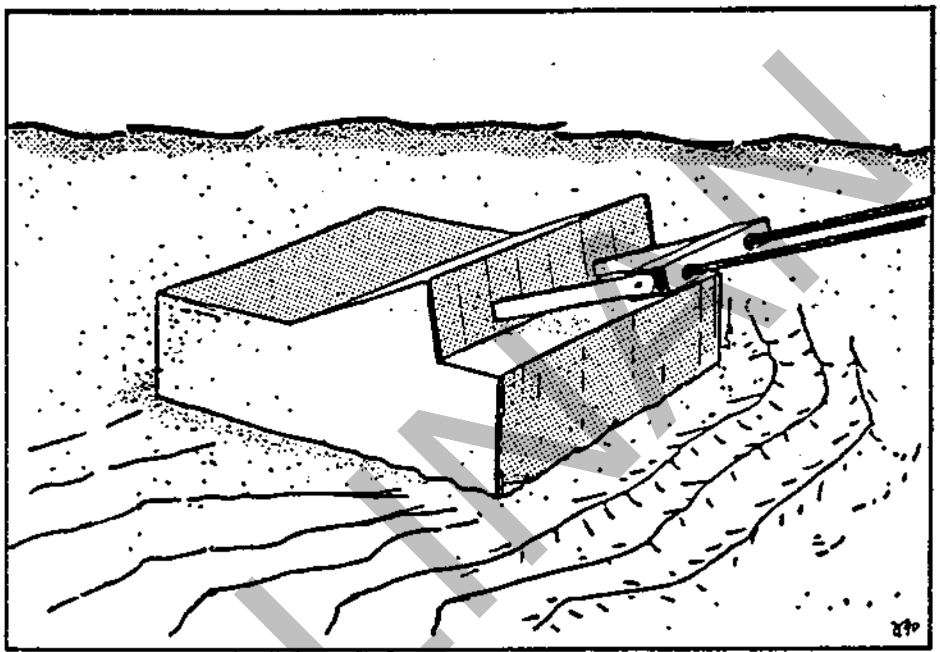


Figure 10.5 - Anchorage Movement

10.7 DEFECTS IN ABUTMENTS AND PIERS

551 - Movement of Abutment/Pier

The most common types of movement are :

- tilting
- rotating
- overturning

Movement can be caused by excessive forces, scour and settlement

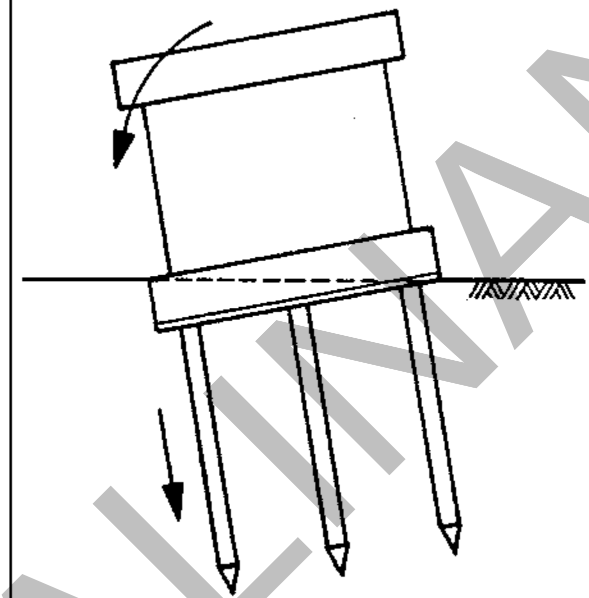


Figure 10.6 - Tilting Due to Settlement

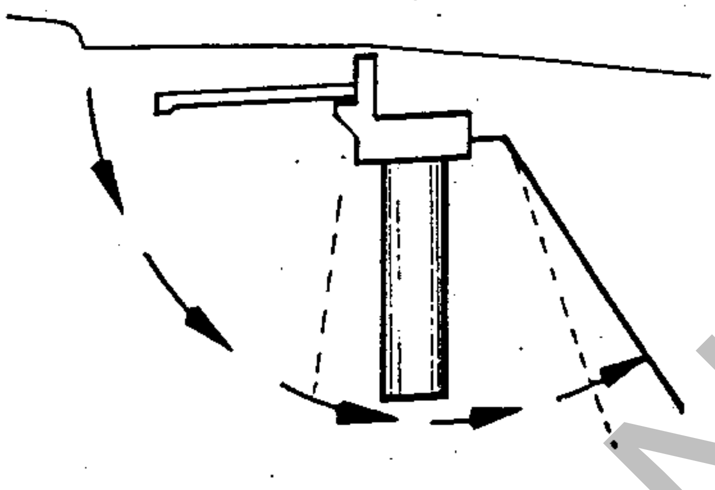


Figure 10.7 - Rotation Due to Slip Failure of Embankment

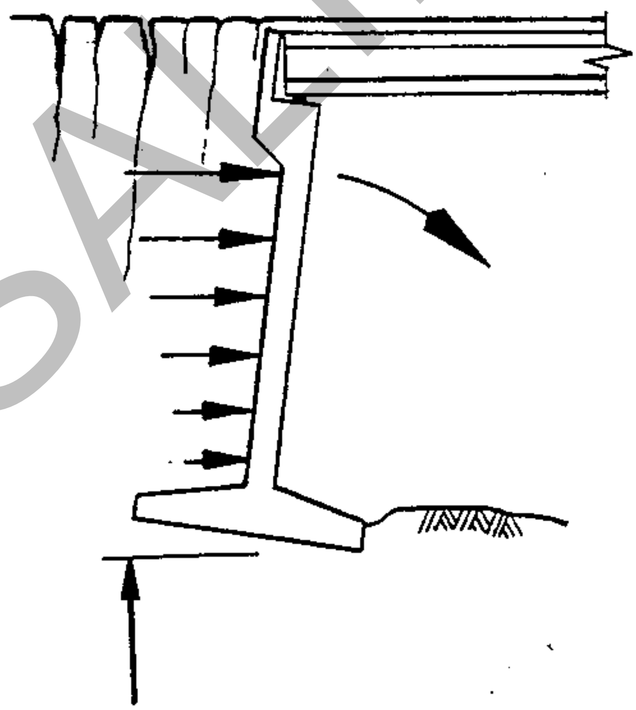


Figure 10.8 - Overturning Due to Excessive Earth Pressure

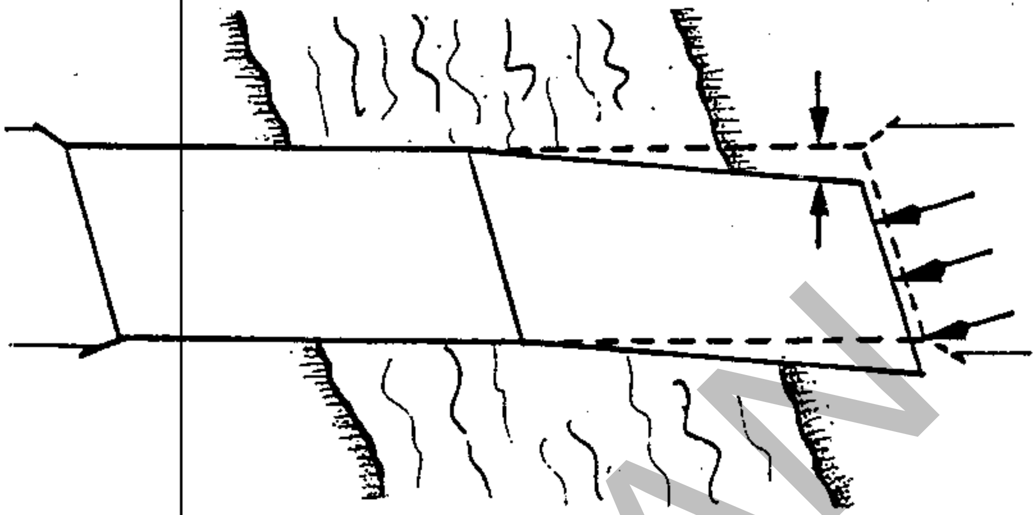


Figure 10.9 - Movement of Skew Bridge Caused by Excessive Horizontal and Lateral Forces

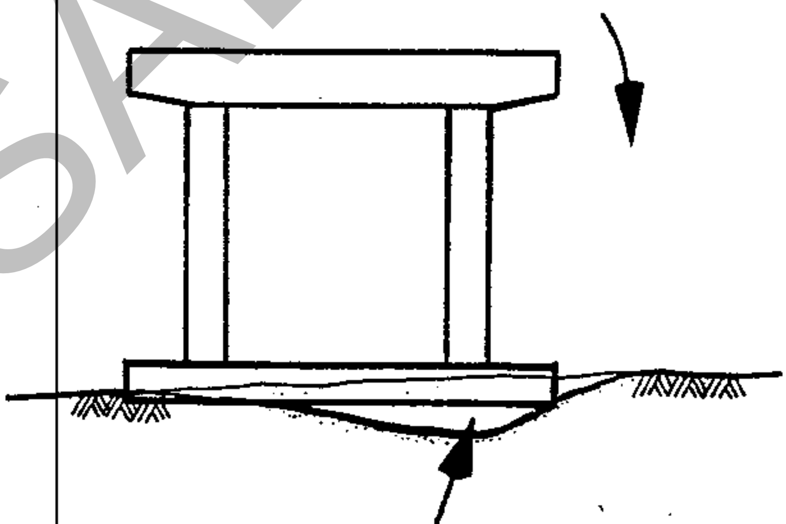


Figure 10.10 - Tilting Due to Scour

Retaining walls can move the same as abutments and piers. Movements can result in overturning, rotation, or settlement.

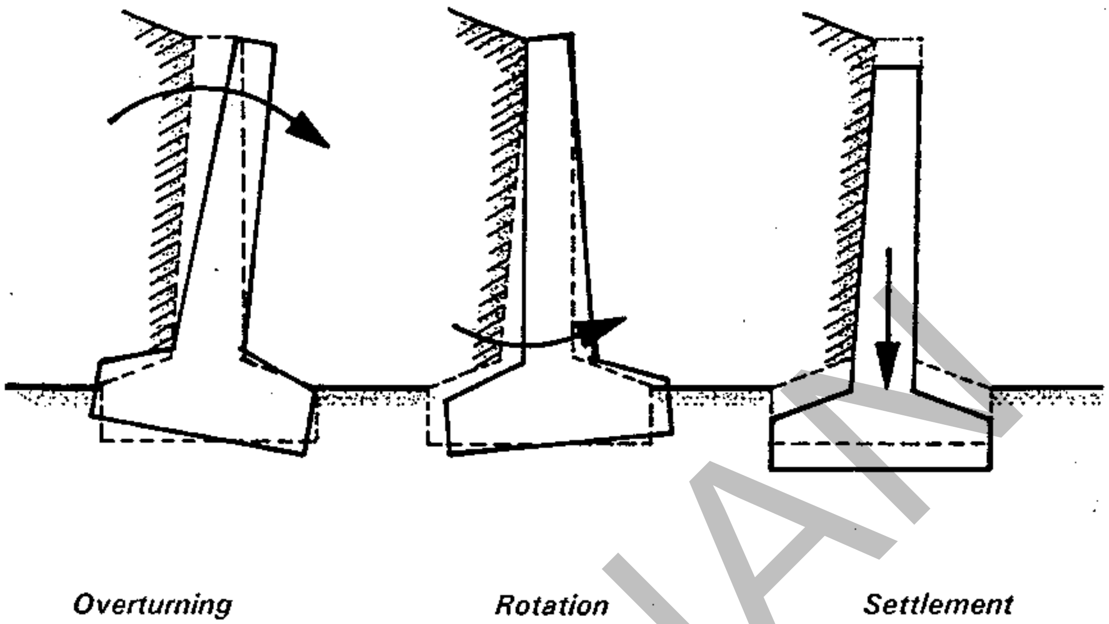


Figure 10.11 - Retaining Wall Movements

10.8 DEFECTS IN EARTHQUAKE RESTRAINT BLOCKS

Earthquake restraint blocks are only used on certain types of bridges. eg.: Australian truss and girder bridges.

561 - Loose or Missing Element

10.9 DEFECTS IN BEARINGS

601 - Loss of Movement Ability

Moving bearings lose their value if they are confined. If the bearing is rigid instead of mobile as intended, it can sometimes lead to damage to other parts of the structure.

If the bearing is constrained by rocks or other debris between the abutment and the superstructure and cannot move, then damage to either of these can occur.

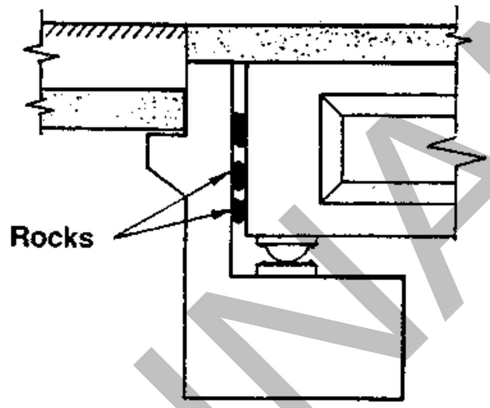


Figure 10.12 - Bearing unable to move

If the problem is due to hold-down bolts being over-tightened so that the bearing cannot move, then the bolts may become bent, the concrete pedestal may crack or the end of girder may be damaged.

In the case of the rocker bearings used in Indonesia, hold-down bolts must not be too long or they will foul the upper plate, thereby preventing the rocking movement.

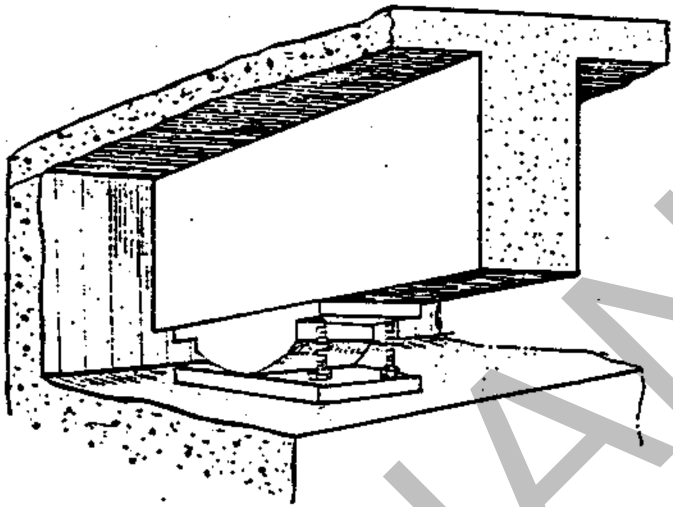


Figure 10.13 - Jammed Rocker Bearing

602 - Improper Bearing Seating

Sometimes a bearing may not have been seated correctly. This results in uneven or concentrated transfer of load from the superstructure to the substructure. This can result in failure either of the bearing or of the other elements associated with it.

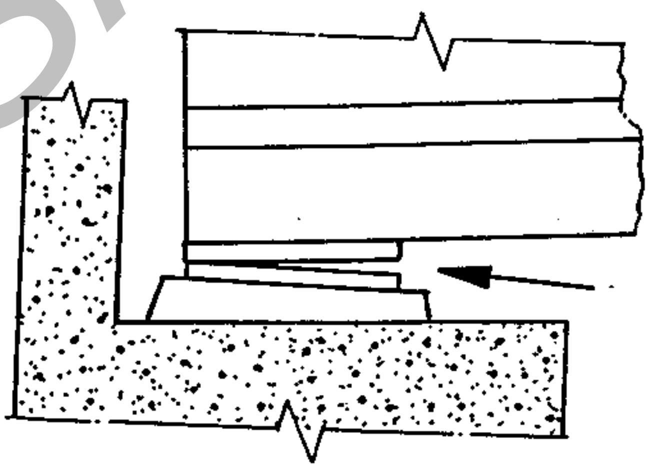


Figure 10.14 - Uneven Bearing Seating

In some cases, the bridge may have been set out incorrectly. In other cases, a pier may have moved. The result can be insufficient bearing area as shown in Figure 10.15. If not corrected, the girder may fall off the headstock.

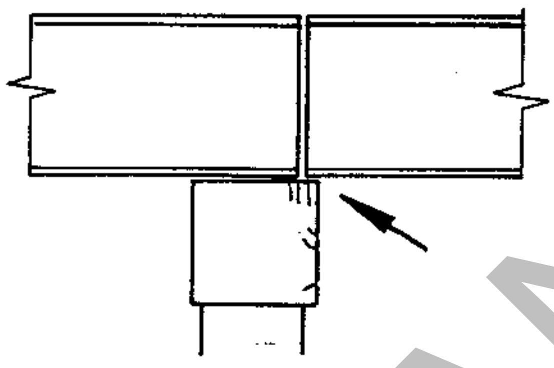


Figure 10.15 - Insufficient Bearing Seating Area

603 - Crack or Spalling in Mortar Pad

Where bearings are uneven or binding of the moving surfaces has occurred, the mortar bearing may become damaged or broken.

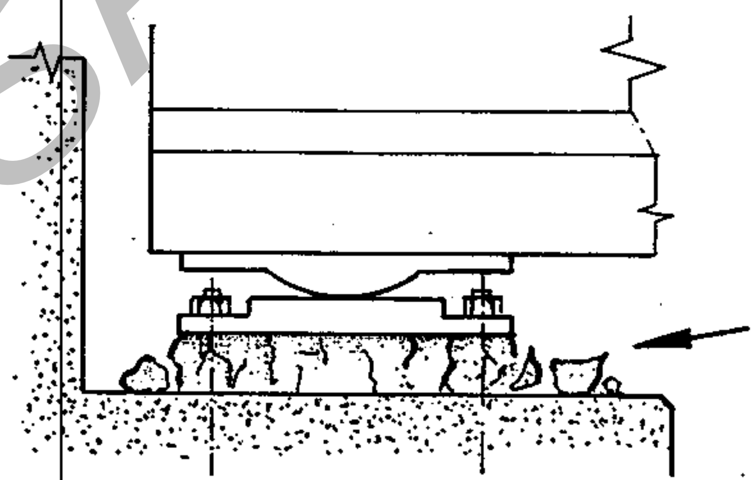


Figure 10.16 - Damaged Pedestal or Mortar Bedding

604 - Excessive Movement or Deformation

Bearings may collapse if their movement is beyond the design range. This can occur if the bearings were not positioned correctly during construction or excessive movement has occurred since. This defect is also an indication that other ground movements may be occurring.

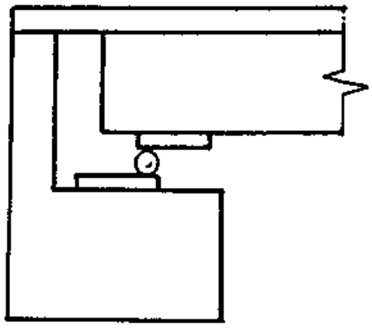


Figure 10.17 - Excessive Movement in Bearings

Occasionally rubber or neoprene bearings are deformed excessively. This deformation occurs during construction if improper placement of bearings or girders occurs.

Deformation can also occur if movement of the bridge occurs after construction. Such movement, if excessive, often results from movement of the substructure. Inspectors must check the substructure when excessive deformation is observed.

Longitudinal deformation is the most common problem but transverse deformation can occur also. Rotational deformation is less common but should also be checked.

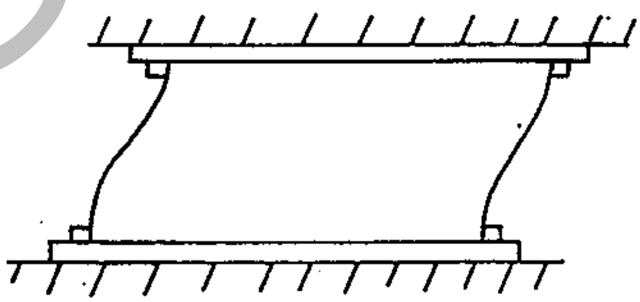


Figure 10.18 - Deformation of Neoprene Bearing

605 - Defective Material

There are some defects in bearings which are unique to specific materials. This applies to rubber or neoprene bearings because they depend upon flexibility of the material.

This defect includes :

- aged material
- poor quality material
- split, torn or cracked material
- broken or missing material

Torn, split or cracked bearings can be caused by uneven bedding, poor materials or poor handling.

The sides of the bearing must be examined for tears, splits or cracks.

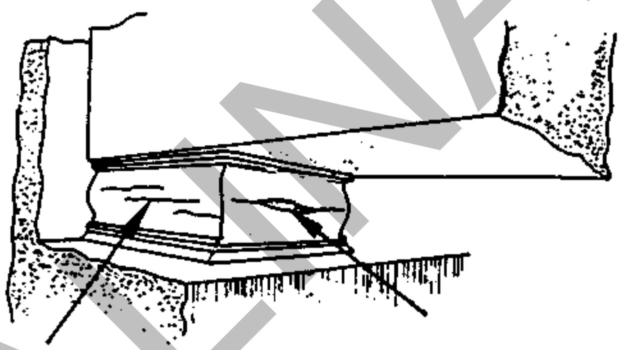


Figure 10.19 - Cracked and Split Neoprene/Rubber Bearing

606 - Loose Parts

Bolts, pins and bearings must be checked to ensure that they are not loose.

607 - Dry Metal Beraing

Metal bearings require oiling or greasing. This should be carried out annually. If a metal bearing is not lubricated, then it may seize. Lack of lubrication may also cause corrosion.

10.10 DEFECTS IN SLAB AND DECKING

701 - Excess Movement in Longitudinal Deck Joint

Longitudinal deck joint defects are most commonly found where a bridge deck has been widened. The joint between the two deck sections sometimes deteriorates particularly if there is differential movement.

702 - Excessive Deflection

Excessive deflection can occur in both the lateral and vertical direction.

Vertical deflection is serious when the deck, girder or truss deflects excessively - particularly under load.

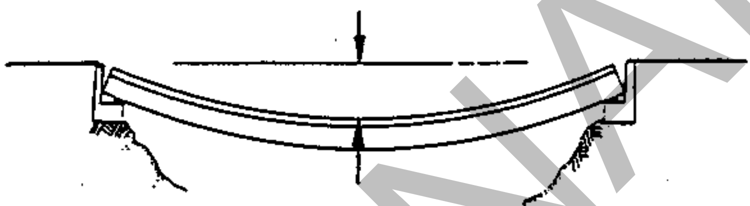


Figure 10.20 - Vertical Deflection

Some bridges have excessive lateral movement when a vehicle passes over them. This is common where the bridge approaches are curved and the bridge is high.

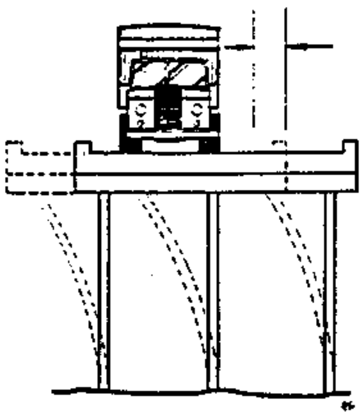


Figure 10.21 - Lateral Deflection

10.11 DEFECTS IN WEEP HOLES, SCUPPERS, DECK DRAINAGE

711 - Blocked Scuppers and Weep Holes

Blocked scuppers and poor drainage can result in:

- ponding - this can cause aqua-planing of vehicles.
- flow of water - this can cause erosion around abutment areas.

Excess pore pressure can build up when water is trapped behind a retaining wall. Weep holes are placed through the walls to relieve this pressure. When weep holes become blocked, the pressure can cause failure of the wall.

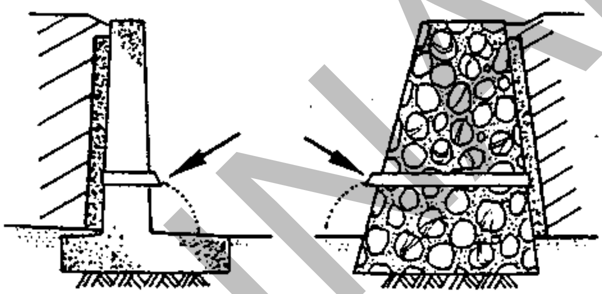


Figure 10.22 - Weep Holes

712 - Missing Material

Missing weep holes can cause excessive pressure behind wall.

Missing scuppers - it is common to find scuppers with the lower portion missing. This often results in water flowing onto the girders, and rapid corrosion may result.

10.12 DEFECTS IN RUNNING SURFACE

If the running surface is not in good condition, then the impact loads on the bridge will be increased.

721 - Slippery Surface

Where a deck surface has become highly polished or the seal coat is very slick, there is a possibility of vehicles skidding in wet weather. This is particularly dangerous if the approaches are not straight or the bridge is in a braking zone. Slippery deck conditions should be reported so that a non-skid treatment can be applied.

722 - Potholed/Rough Surface

Potholed surfaces on the bridge or just before the bridge magnify impact loadings on bridges significantly. They cause a vehicle to bounce rather than ride smoothly.

A rough surface can have the same effect as a potholed surface and can cause impact loading.

722 - Cracked Running Surface

Cracking is usually associated with :

- differential movement between bridge parts - this often occurs around expansion joints
- poor running surface material or poor construction

Cracking in the pavement is the first sign that potholing of the running surface may develop.

All significantly cracked or badly crazed surfaces should be reported.

Loose Timber Decks and Running Shrinkage of Planks

Loose deck timbers are very dangerous as they can cause damage to a vehicle if they fail and may even impale a car. If longitudinal running planks are cracked or dislodged, then wheel loads will not be correctly distributed.

Loose planks can also cause a driver to lose control of his vehicle.
Excessive shrinkage in running planks may also cause problems for narrow-tyred vehicles.

723 - Heaving Rutting of Pavement

Heaving of the pavement occurs when one area is compressed and another area is squeezed up.

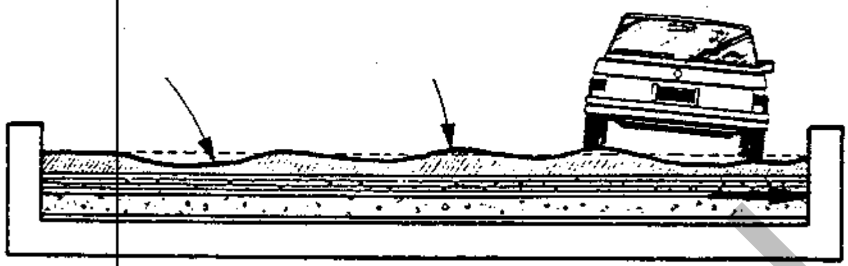


Figure 10.23 - Heaving Pavement

Fill is sometimes placed on a bridge, particularly on arch structures. As fill is permeable, it is essential that adequate drainage be provided. Drainage can be surface drains, weep holes, or subsurface perforated pipes. If drainage is not effective, heaving of the running surface can occur making driving dangerous and introducing undesirable loading on the structure.

When heaving occurs, lateral pressures are generated. This pressure can cause cracking of the kerb or spandrel walls.

If heaving of asphalt or macadam pavements is observed on timber or steel decks, water may be lying on the timber or steel. This should be checked to see whether rot or corrosion is occurring.

724 - Excessive Overlay

Excessive overlay occurs when a new overlay of asphalt is constructed and if the existing layer is not removed or reduced. If the total thickness is excessive and heavy, then the bridge load-carrying capacity is reduced.

Normal designs allow for a 50 mm bituminous overlay thickness. There is an allowable margin of 10 mm. If the total overlay thickness exceeds 60 mm, then it should be reported.

10.13 DEFECTS IN FOOTWAY AND KERBS

Footways and kerbs can have similar defects to the bridge running surface. These defects all cause danger to pedestrians.

731 - Slippery Footway

732 - Potholed, Rough or Cracked Footway

733 - Missing Element

Figure 10.24 - Missing Footway Element

10.14 DEFECTS IN DECK JOINTS

801 - Rough/Uneven Joint

Rough or uneven joints give the motorist a rough ride. They also cause additional impact loading on the bridge deck and superstructure.

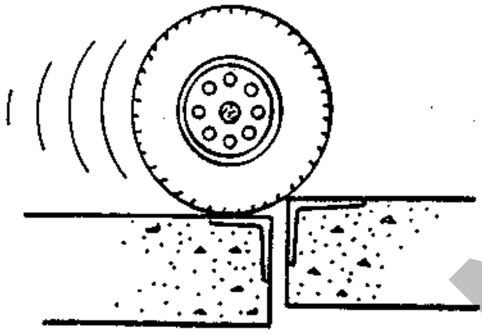


Figure 10.25 - Rough Joint

802 - Loss of Movement Ability

It is common for deck expansion joints to become jammed. Fortunately, there are no extreme temperature variations in Indonesia or there would be a very serious problem. Many joints have asphalt placed over the joint. Others have stones lodged in them so that they cannot expand. In bad cases, damage to adjacent members can occur.

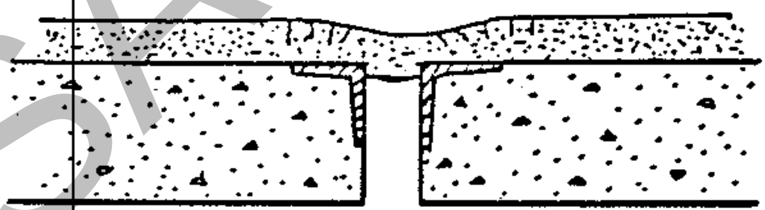


Figure 10.26 - Jammed Joint

803 - Loose Parts/ Loss of Adhesion

Part of the deck joint can become loose and suffer additional damage. Cover plates are particularly dangerous to passing traffic if they become dislodged.

If there is the likelihood of vehicular damage, then it should be brought to the attention of the maintenance organization immediately.

Rubber or neoprene water stops can lose adhesion to the sides of the joint.

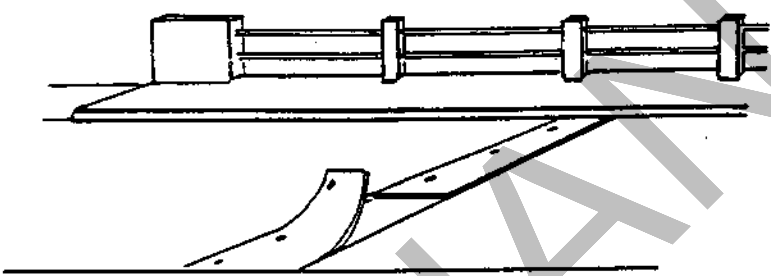


Figure 10.27 - Loose and Damaged Deck Joint

805 - Broken or Missing Parts

806 - Cracked Asphalt due to Joint Movement

Sometimes in joints with a sliding steel plate, cracking of the asphaltic running surface occurs. This is not serious unless the asphalt starts to crumble leaving wide cracks (> 10 mm) or potholes, which can lead to impact loads and ingress of water.

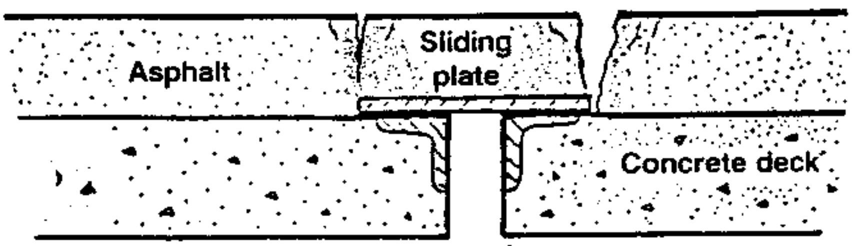


Figure 10.28 - Cracked Asphalt at Deck Joint

10.15 DEFECTS IN GAUGES

901 - Damaged or Missing Gauges

Some bridges have gauges to test vehicle dimensions. In the case of width gauges, they are sometimes used to restrict certain types of vehicles from that particular route. They should be checked for appropriateness to the particular bridge.

Height gauges are used to avoid damage to overpass bridges, electrified railways and truss bridges. The height gauge can take the form of a solid rail above the road at a fixed height or "chime" type weights suspended in advance of the structure site. The vertical clearance of these should be checked against the members being protected to ensure a safety margin of at least 60 mm. Care must be taken if overhead electric wires are involved.

Where damage has occurred through collision by a vehicle with part of the structure (particularly a stringer, girder or part of a truss), it should be reported as it may have affected the structural capacity of the bridge.

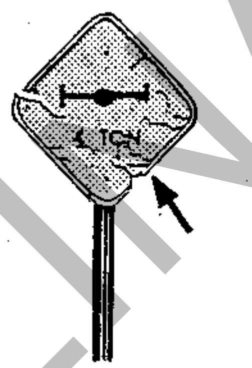


Figure 10.28 - Damaged Load Sign

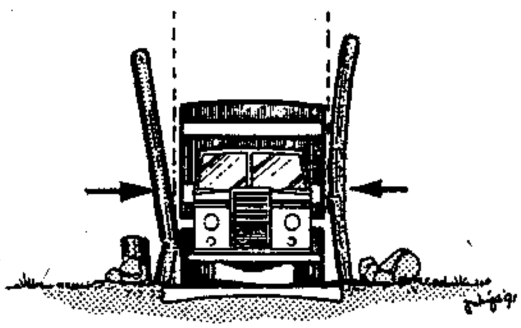


Figure 10.29 - Damaged Width Gauge

10.16 DEFECTS IN ROAD SIGNS AND ROAD MARKINGS

Where permanent signs relating to the bridge have been erected, they should have been recorded in the Inventory data. Signs may relate to :

- load restriction
- speed restriction
- height restriction
- width restriction or lane closure
- bridge name/number plate

Road markings are used to help regulate traffic and in some situations are important.

911 - Aged or Worn Material

Many signs lose effectiveness because the legend becomes unreadable after several years exposure to the sun, wind and rain. If a sign cannot be easily read by the vehicle driver, then it should be reported as defective.

Signs can also be damaged by accident or vandalism and permanent road markings can wear due to the traffic.

912 - Missing Element

A sign which is often missing is the bridge name/number plate.

10.17 DEFECTS IN LIGHTING POLES AND CONDUITS

921 - Aged or Deteriorating Materials

922 - Missing Material

10.18 DEFECTS IN UTILITIES

931 - Malfunction

Utilities such as water pipes, sewerage, electricity, oil etc are not the responsibility of the Bridge authority. However, if a defect in a utility has an adverse affect on the bridge or bridge user, then it should be recorded. Some examples of this are as follows :

- explosed electrical wiring which may injure or kill a pedestrian
- leaking pipes causing scour to the embankments or ponding on the bridge
- heavy or loose utilities which are causing damage to the main structure

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

BRIDGE INSPECTION MANUAL

APPENDIX 1

BRIDGE INSPECTION REPORTS - IBMS REPORTS

FEBRUARY 1993

DOCUMENT No. BMS2-M.E

INVENTORY INSPECTION REPORT

Bridge No.										LINK SUFFIX	

Bridge Name		*Cabang*
Bridge Location	*from* name of Base Town	*km* distance from Base Town
Date of Inspection	*Inspector's Name*	*NIP*

EMERGENCY ACTION

Is Emergency Action recommended? *(please circle correct answer)*	Yes	No
Reason for Emergency Action		

REMARKS

For Office Use Only

Data entry date	*by Operator*

INVENTORY INSPECTION CODES

Crossing Type	JN road overpass	KA railway crossing	S over water	L other

A. Superstructure Type		B. Material		C. Superstructure Source		D. Foundation Type		E. Abutments and Piers	
B	box culvert	K	timber	W	Acrow/Bailey	CA	cakar ayam		
Y	pipe culvert	S	masonry - brick						
A	pipe arch culvert	M	masonry - stone	A	Australia (permanent)	LS	spread footing		Abutments
		G	gabions, etc.	P	Australia (semi permanent)			A	cap
T	suspension	H	stone pitching	T	Australia (temporary)	TP	driven pile	B	retaining wall
C	cable stayed	D	concrete - unreinforced			PB	bored pile	K	special abutment
		T	concrete - reinforced	B	Holland (new type)	TU	screw pile		
G	girder	P	concrete - prestressed	D	Holland (old type)				
M	composite	B	steel			SU	caisson		
P	plate	U	steel trough deck	I	Indonesia				Piers
		Y	steel tube - concrete fill	U	Callendar Hamilton (UK)	LL	other	C	pile cap
L	beam arch	J	aluminium	J	Japan			P	solid wall
E	arch	E	neoprene / rubber					S	single column
		F	teflon	R	Austria (permanent)			D	two column
R	truss	V	PVC	S	Austria (semi permanent)			T	three or more columns
S	temporary	N	geotextile					L	other
		O	common soil / clay or fill	X	no structure				
F	ferry	A	asphalt						
K	railway level crossing	R	gravel / sand	L	other				
W	wet crossing	W	macadam						
U	other	X	natural material						
		L	other						

F. INVENTORY CONDITION MARK		Note
0	as new with no defects	Inventory Condition Mark in this table to be used only if Detailed Inspection is not being carried out at the same time as the Inventory Inspection
1	very minor defects	
2	defects which require monitoring or maintenance in the future	
3	defects which require attention soon	
4	critical condition	
5	component broken or no longer functioning	

INVENTORY INSPECTION REPORT

Bridge No.									LINK SUFFIX	

BRIDGE REGISTRATION

Bridge Name		Cabang
Bridge Location	from name of Base Town	km distance from Base Town
Date of Inspection	Inspector's Name	NIP

Crossing Type (enter JN, KA, S, LI)	Number of Spans
	Total Length (m)
Year Built	Skew Angle (degrees °)

Superstructure														
Span No.	Span Length (m)	Width between Kerbs (m)	Footway Width (m)	Vertical Traffic Clearance (m)	Support Structure				Deck/Running Surface			Railing		
					Type	Material	Source	Condition	Material	Material	Condition	Material	Material	Condition
					A	B	C	F	B	B	F	B	B	F
B1														
B2														
B3														
B4														
B5														
B6														
B7														
B8														
B9														
B10														

Substructure						
Abutment or Pier No.	Foundation			Abutment or Pier		
	Type	Material	Condition	Type	Material	Condition
	D	B	F	E	B	F
Abutment A1						
Pier P1						
P2						
P3						
P4						
P5						
P6						
P7						
P8						
Pier P9						
Abutment A2						

Comments

INVENTORY INSPECTION REPORT

Bridge No.											LINK SUFFIX	

ANCILLARY INFORMATION

1. Existing Functional Restrictions

Posted axle or vehicle load limit (tonnes)	
Other restrictions (please specify)	

2. Traffic Flow

Is existing bridge width with regards to present traffic flow :	*Enter 1,2 or 3*
1 Adequate - vehicles travel freely over bridge *2 Just wide enough - vehicles slow due to congestion on bridge* *3 Too narrow - vehicles have to stop and queue*	

3. Detour and Diversion

If bridge is closed to traffic at any time, can traffic be diverted to an alternative route or side track? (please circle correct answer)	Yes	No
If Yes, what is extra travel distance (km)		

4. Highest Flood Data

Highest known flood level: enter + if above deck or - if below deck (m)	
Date of highest flood (month, year)	
Source of information	

DETAILED INSPECTION REPORT

Bridge No.										LINK SUFFIX	

Bridge Name		Cabang	
Bridge Location	from name of Base Town	km distance from Base Town	
Date of Inspection	Inspector's Name	NIP	

INVENTORY DATA

Is Inventory Data correct? (circle answer)	Yes	No
If any data is incorrect, please show corrections on Inventory Data Report with red pen		

SPECIAL INSPECTION

Is Special Inspection recommended? (circle answer)	Yes	No

Elements for Special Inspection

Element Code	Location	Reason for Special Inspection

EMERGENCY ACTION

Is Emergency Action recommended? (circle answer)	Yes	No

Elements for Emergency Action

Element	Location	Reason for Emergency Action

For Office Use Only

Data entry date	by Operator

DETAILED INSPECTION REPORT

DEFECT LIST FOR LEVEL 3-5 ELEMENTS

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)					Condition Mark						Condition Mark					
				A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK

ROUTINE MAINTENANCE

1	*Is there accumulation of debris in the waterway?* (circle answer)	Yes	No
2	*Is there accummulation of dirt and debris on the bridge?*	Yes	No
3	*Is there excessive vegetation?*	Yes	No
4	*Is deck drainage inadequate?*	Yes	No
5	*Is drainage of approaches inadequate?*	Yes	No
6	*Are there potholes and rough surfaces?*	Yes	No
7	*Do handrails need painting?*	Yes	No
8	*Is the number plate on bridge wrong or missing?*	Yes	No
9	*Is the name plate on bridge wrong or missing?*	Yes	No

Bridge No.										

ELEMENT EVALUATION

Sketch Y/T	Photo Y/T	Quantity	Unit	Emergency Action	Special Inspection

LEVEL 3		Condition Mark (Must complete)					
Code	Element	S	R	K	F	P	NK
3.210	Waterway						
3.220	Scour Protection						
3.230	Embankments						
3.310	Foundations						
3.320	Abutments/Piers						
3.410	Girder System						
3.420	Flat Slab						
3.430	Arch						
3.440	Beam Arch						
3.450	Trusses						
3.480	Suspension System						
3.500	Deck System						
3.600	Deck Joints						
3.610	Bearings						
3.620	Railing						
3.700	Furniture						
3.80_	Culvert						
3.90_	Wet Crossing						

LEVEL 2		Condition Mark (Optional)					
Code	Element	S	R	K	F	P	NK
2.200	Waterway/Embankmen						
2.300	Substructure						
2.400	Superstructure						
2.700	Miscellaneous						
2.800	Culvert						
2.900	Wet Crossing						

LEVEL 1		Condition Mark (Optional)					
Code	Element	S	R	K	F	P	NK
1.000	Bridge						

DETAILED INSPECTION REPORT

LINK SUFFIX

Bridge No.

NOTES AND SKETCHES

ROUTINE INSPECTION REPORT

LINK SUFFIX

Bridge No.												

Bridge Name			Cabang
Bridge Location		from name of Base Town	km distance from Base Town
Date of Inspection		Inspector's Name	NIP

ROUTINE MAINTENANCE

1	Is there accumulation of debris in the waterway? (circle answer)	Yes	No
2	Is there accumulation of dirt and debris on the bridge?	Yes	No
3	Is there excessive vegetation?	Yes	No
4	Is deck drainage indequate?	Yes	No
5	Is drainage of approaches inadequate?	Yes	No
6	Are there potholes and rough surfaces?	Yes	No
7	Do handrails need painting?	Yes	No
8	Is the number plate on bridge wrong or missing?	Yes	No
9	Is the name plate on bridge wrong or missing?	Yes	No

EMERGENCY ACTION

Is Emergency Action required? (circle answer)	Yes	No

Elements for Emergency Action

Component/Element	Location	Reason for Emergency Action

For Office Use Only

Data entry date	by operator

ROUTINE INSPECTION REPORT

Bridge No.											LINK SUFFIX	

NOTES AND SKETCHES

IBMS-BD1 - Bridge Inventory Data Report

Sistem Manajemen Jembatan
Direktorat Bina Program Jalan
Direktorat Jenderal Bina Marga

IBMSv1.73 - BD1
TANGGAL: 29/01/93
WAKTU : 13:59:55

LAPORAN DATA INVENTARISASI JEMBATAN

PROPINSI : 17. LAMPUNG Halaman : 1

TANGGAL INSPEKSI	NOMOR JEMBATAN	LNK SFX	CA-DIN	NAMA JEMBATAN	<- LOKASI-> DARI	KM	PANJANG	TIPE LINTASAN	SELESAI DIBANGUN	SKEW ANGLE	JUM BENT	STATUS JALAN
24/06/92	17.001.001.0	2K	BDL	W.KANDIS	TLB	13.20	8.5	S	1969	0	1	N A

						Lantai	Pelengkap	<---- ABUTMENT 1 ---->				< PILAR / ABUTMENT 2 >			
								<Pondasi >		<Bng Bawah>		<Pondasi >		<Bng Bawah>	
Nobent	Panjang	Lebar	Trotoar	Clearance	Batipe	Tipe	Tipe	Tipe	Bahan	Tipe	Bahan	Tipe	Bahan	Tipe	Bahan
1	8.5	7.5	0.0	0.0	GTI	A			M		M		M		M

KETERANGAN TAMBAHAN

1. BATASAN FUNGSIONAL: Muatan Gandar (ton): [15] Lain-Lain: [ ]
2. ARUS LALU-LINTAS: [1] 1. Longgar 2. Cukup Lebar 3. Sempit
3. JALAN ALTERNATIF dan JALAN MEMUTAR: [Ya] (Ya/Tidak) [15] km
4. DATA BANJIR TERBESAR: [0.0] m di atas lantai [,] Tanggal banjir (bulan, tahun) Sumber Informasi [ ]
5. ADA GAMBAR KONSTRUKSI: [Tidak] Bangunan Atas tipe standar? [Tidak] Sebutkan tipe standar [ ]

IBMS-BD2 - General Bridge Data Report

Sistem Manajemen Jembatan
Direktorat Bina Program Jalan
Direktorat Jenderal Bina Marga

IBMSv1.72 - BD2
TANGGAL: 16/10/92

LAPORAN DATA JEMBATAN UMUM

PROPINSI: 32. KALTENG

Halaman: 1

NOMOR JEMBATAN	LNK SFX	NAMA JEMBATAN	STATUS	LOKASI DARI	KM	CADIN	PANJANG	JUM BENT	LEBAR JBT	BANG ATAS	TAHUN	KONDISI UMUM B.A	LNT	B.B	DAS	JBT	NILAI TRAFC	IRMS AADT	LEB JLN	INSPEKSI DETAIL
32.001.001.0		S.DAPUR	N A	PRY	20.02	PKY	45.0	4	7.0	GTI	1965	1	1	1	0	1	0	7188	6.0	
32.001.001.A	K	BATU	N A	PRY	0.00	PKY	25.0	1	7.0	GTI	1990	1	1	1	0	1	0	6857	6.0	
32.001.002.0		S.SOEKARNO	N A	PRY	21.70	PLR	22.0	2	7.0	GTI	1965	0	0	0	2	0	0	7188	6.0	18/01/91
32.001.003.0		S.TAHAI	N A	PRY	28.33	PLR	45.0	4	7.0	GTI	1965	0	0	0	1	0	0	7186	6.0	13/01/91
32.002.001.0		LUNGGARU	N A	BJM	224.68	BEL	10.0	1	4.4	GBI	1940	3	3	3	2	3	*5	3615	4.5	
32.002.002.0		MAMPUHING	N A	BJM	227.75	BEL	5.0	2	7.0	BTI	1984	1	1	1	0	1	0	3615	4.5	
32.002.003.0		SANGGAR WASI	N A	BJM	230.40	BEL	7.6	2	8.5	PTI	1984	1	1	1	0	1	0	3615	4.5	
32.002.004.0		S.LAYUNG	N A	BJM	231.40	BEL	7.0	1	4.3	GKI	1940	3	4	3	2	3	5	3615	4.5	
32.002.005.0		JAAR	N A	BJM	232.20	BEL	30.0	2	4.5	GTI	1981	1	1	1	0	1	0	3615	4.5	
32.002.006.0		TAULUH	N A	BJM	234.30	BEL	12.0	2	4.6	GKI	1940	3	3	3	0	3	0	3615	4.5	
32.002.007.0		BARUH PINANG	N A	BJM	235.10	BEL	8.0	1	4.8	GBI	1940	1	3	1	0	1	0	3615	4.5	
32.003.001.0		SIRAU	N A	BJM	237.30	BEL	30.0	2	6.2	GBI	1989	0	0	0	0	0	0	3547	4.5	
32.003.002.0		DAYU 1	N A	BJM	256.30	BEL	50.0	2	5.0	GTI	1988	0	0	0	0	0	0	3547	4.5	17/01/91
32.003.003.0		DAYU II	N A	BJM	257.20	BEL	25.0	1	4.5	GBA	1984	0	0	0	0	0	0	3547	4.5	16/01/91
32.003.004.0		PUTUT WILAS	N A	BJM	262.20	BEL	13.0	3	4.4	GKI	1953	2	2	1	0	2	0	3547	4.5	
32.003.006.0		TAMPA	N A	BJM	264.50	BEL	20.0	2	4.5	GTI	1961	1	1	1	0	1	0	3547	4.5	
32.003.007.0		PAKU	N A	BJM	264.90	BEL	30.0	1	4.5	RBA	1983	0	0	0	0	0	0	3547	4.5	16/01/91
32.003.008.0		TETEMUNTE I	N A	BJM	265.40	BEL	20.0	1	7.0	GBI	1982	0	0	0	0	0	0	3547	4.5	18/01/91
32.003.009.0		TETEMUNTE II	N A	BJM	265.50	BEL	21.5	2	4.5	GTI	1982	0	0	0	3	1	0	3547	4.5	18/01/91
32.003.010.0		PAREI	N A	BJM	266.30	BEL	10.0	1	4.5	GTI	1982	0	0	0	0	0	0	3547	4.5	17/01/91
32.003.011.0		MANSIBAK	N A	BJM	272.60	BEL	20.0	1	7.0	GBA	1988	0	0	0	0	0	0	3547	4.5	17/01/91
32.003.012.0		SANTUEN	N A	BJM	272.70	BEL	20.0	1	7.0	GBA	1988	0	0	0	0	0	0	3547	4.5	17/01/91
32.003.013.0		SERAU	N A	BJM	273.10	BEL	20.0	1	6.0	GKI	1978	0	0	0	0	0	0	3547	4.5	18/01/91
32.003.014.0		NINUNG	N A	BJM	276.10	BEL	12.0	1	4.5	GTI	1982	1	0	1	0	1	0	3547	4.5	
32.003.015.0		MANGATU ANAK	N A	BJM	277.80	BEL	3.0	1	4.5	GKI	1978	0	0	0	0	0	0	3547	4.5	
32.003.018.0		TUYAU	N A	BJM	281.50	BEL	10.5	1	4.5	GTI	1982	0	0	0	1	0	0	3547	4.5	17/01/90
32.003.019.0		MATALIAU I	N A	BJM	282.50	BEL	15.0	1	4.5	GTI	1982	1	0	0	0	1	0	3547	4.5	
32.003.020.0		MATALIAU II	N A	BJM	282.60	BEL	15.0	1	4.5	GTI	1982	1	1	1	0	1	0	3547	4.5	
32.003.021.0		KARAU	N A	BJM	283.50	BEL	32.0	2	6.2	GBI	1981	0	0	0	3	2	0	3547	4.5	17/01/91
32.004.001.0		SERAPAT I	P K	TLY	0.10	BEL	3.5	1	4.3	GKI	1980	3	2	2	0	3	0	1655	4.0	
32.004.002.0		SERAPAT II	P K	TLY	4.10	BEL	15.0	3	4.3	GKI	1980	3	3	3	2	3	0	1655	4.0	
32.004.003.0		MARUTUWU	P K	TLY	13.10	BEL	14.0	2	3.5	GBI	1934	3	2	2	2	3	*5	1655	4.0	
32.004.004.0		LUKSADUR	P K	TLY	20.00	BEL	8.5	1	3.8	GBI	1960	1	1	1	2	1	*5	1655	6.0	
32.004.005.0		TETEPUPUNG	P K	TLY	23.10	BEL	5.5	1	3.6	GKI	1980	1	1	1	0	1	0	1655	6.0	

TOTAL : 630 METER
34 JEMBATAN

*CATATAN: Nilai Trafic *5 (jembatan terlalu sempit), *0 (jembatan cukup lebar) pendapat inspektur*

IBMS-BD3 - Detailed Inspection Report

Sistem Manajemen Jembatan
Direktorat Bina Program Jalan
Direktorat Jenderal Bina Marga

IBMSv1.73 - BD3
TANGGAL: 29/01/93
WAKTU : 14:01:03

LAPORAN INSPEKSI MENDETAIL

PROPINSI : 17. LAMPUNG

DATA JEMBATAN

Halaman : 1

TANGGAL INSPEKSI	NOMOR JEMBATAN	LNK SFX	CA-DIN	NAMA JEMBATAN	<- LOKASI-> KOTA	KM	PANJANG	TIPE LINTASAN	SELESAI DIBANGUN	SKEW ANGLE	JUM BENT	STATUS JALAN
24/06/92	17.001.001.0	2K	BDL	W.KANDIS	TLB	13.20	8.5	S	1968	0	1	N P

Nobent	Panjang	Lebar	Trotoar	Clearance	Batipe	Lantai Tipe	Sandaran Tipe	ABUTMENT 1 Pondasi Tipe	ABUTMENT 1 Pondasi Bahan	ABUTMENT 1 Bng Bawah Tipe	ABUTMENT 1 Bng Bawah Bahan	PILAR / ABUTMENT 2 Pondasi Tipe	PILAR / ABUTMENT 2 Pondasi Bahan	PILAR / ABUTMENT 2 Bng Bawah Tipe	PILAR / ABUTMENT 2 Bng Bawah Bahan
1	8.5	7.5	0.0	0.0	GTI	A			M		M		M		K

KETERANGAN TAMBAHAN

1. BATASAN FUNGSIONAL: Muatan Gandar (ton): [15] Lain-Lain: [ ]
2. ARUS LALU-LINTAS: [1] 1. Longgar 2. Cukup Lebar 3. Sempit
3. JALAN ALTERNATIF dan JALAN MEMUTAR: [Ya] (Ya/Tidak) [15] km
4. DATA BANJIR TERBESAR: [0.0] m di atas lantai [,] Tanggal banjir (bulan, tahun) Sumber Informasi [ ]
5. ADA GAMBAR KONSTRUKSI: [Tidak] Bangunan Atas tipe standar? [Tidak] Sebutkan tipe standar [ ]

DATA INSPEKSI MENDETAIL YANG SEBELUMNYA

Belum ada inspeksi mendetail

IBMS-AR1 - Emergency Action Report

Sistem Manajemen Jembatan
Direktorat Bina Program Jalan
Direktorat Jenderal Bina Marga

IBMSv1.72 - AR1
TANGGAL: 16/10/92

LAPORAN TINDAKAN DARURAT

PROPINSI: 32.KALTENG

Halaman : 1

NOMOR/NAMA JEMBATAN	LNK SFX	STA TUS	LOKASI DARI KM	PANJ (M)	BANG ATAS	TGL. INSP SEBELUMNYA	ELEMEN	LOKASI XxYyZz	ALASAN / URAIAN
PLR - (CABANG)									
32.001.003.0 S.TAHAI		N A	PRY 28.3	45.0	GTI	D 13/01/91	3.620 RAILING		SANDARAN HILANG
TOTAL CABANG DINAS				45.0 METER 1 JEMBATAN					
TOTAL				45.0 METER 1 JEMBATAN					

STATUS : NASIONAL & PROPINSI

IBMS-AR2 - Special Inspection Report

Sistem Manajemen Jembatan
Direktorat Bina Program Jalan
Direktorat Jenderal Bina Marga

IBMSv1.72 - AR2
TANGGAL: 16/10/92

LAPORAN PEMERIKSAAN KHUSUS

PROPINSI: 30.KALBAR

Halaman : 1

NOMOR/NAMA JEMBATAN	LNK SFX	STA TUS	LOKASI DARI KM	PANJ (M)	BANG ATAS	TGL. INSP SEBELUMNYA	ELEMEN	LOKASI XxYyZz	ALASAN / URAIAN
PTK - PONTIANAK			(CABANG)						
30.001.026.0 H.HUSIN		N	A PTK 18.6	26.0	RBU	D 12/12/91	4.232 DRAINAGE - EMBANKMENT	A1	515
							4.232 DRAINAGE - EMBANKMENT	A2	515
							4.621 POST RAILING	B1 2 1	305
							4.621 POST RAILING	B1 4 2	305
TOTAL CABANG DINAS				26.0 METER 1 JEMBATAN					
TOTAL				26.0 METER 1 JEMBATAN					

STATUS : NASIONAL & PROPINSI

IBMS-AR3 - Routine Maintenance Report

Sistem Manajemen Jembatan
Direktorat Bina Program Jalan
Direktorat Jenderal Bina Marga

IBMSv1.72 - AR3
TANGGAL: 16/10/92

LAPORAN PEMELIHARAAN RUTIN

PROPINSI: 32.KALTENG

Halaman : 1

CABANG DINAS	NOMOR JEMBATAN	LNK SFX	NAMA JEMBATAN	STATUS JALAN	LOKASI DARI	KM	PANJANG (M)	BANG ATAS	TGL. INSP SEBELUMNYA	P/R Sungai	X/S Jbt	Tumb liar	Pipa Sumbat	Drain Jalan	Lubang Lantai	Sand Dicat	Plat-Nomor	Hilang Nama
BEL	BEL - BARITO SELATAN																	
	32.003.002.0		DAYU I	N A	BJM	256.30	50.0	GTI	R 15/06/92		*	*	*					
	32.003.003.0		DAYU II	N A	BJM	257.20	25.0	GBA	R 15/06/92			*						
	32.003.008.0		TETEMUNTE I	N A	BJM	265.40	20.0	GBI	R 15/06/92		*	*	*					
	32.003.009.0		TETEMUNTE II	N A	BJM	265.50	21.5	GTI	R 15/06/92		*	*	*					
	32.003.010.0		PAREI	N A	BJM	266.30	10.0	GTI	R 15/06/92		*	*	*					
	32.003.011.0		MARSIBAK	N A	BJM	272.60	20.0	GBA	R 15/06/92		*	*						
	32.003.012.0		SANTUEN	N A	BJM	272.70	20.0	GBA	R 15/06/92		*	*	*		*			
	32.003.013.0		SERAU	N A	BJM	273.10	20.0	GKI	R 15/06/92		*							
	32.003.018.0		TUYAU	N A	BJM	281.50	10.5	GTI	R 15/06/92		*	*						
	32.003.021.0		KARAU	N A	BJM	283.50	32.0	GBI	R 15/06/92		*	*						
	32.005.001.0		ASAK	P K	APH	1.85	15.7	GTI	R 16/06/92		*	*				*		
	32.005.002.0		PUTAI	P K	APH	3.70	10.0	GTI	R 16/06/92			*				*	*	*
	32.005.003.0		DANAU KAJANG	P K	APH	4.00	14.7	GTI	R 16/06/92		*	*			*			
	32.005.004.0		MARIMBAI	P K	APH	4.40	20.5	GBA	R 16/06/92			*				*	*	*
	32.005.005.0		TUMPUNG ULUNG	P K	APH	5.40	8.0	GTI	R 16/06/92			*				*	*	*
	32.005.009.0		JIHI	P K	APH	15.40	40.0	RBA	R 16/06/92		*	*						
	32.005.024.0		RIKUT JAU I	P K	APH	35.65	6.0	GKI	D 11/11/91		*	*			*	*	*	*
	32.005.027.0		MALAWEN	P K	APH	40.87	50.0	RBA	D 11/11/91						*			
	32.005.029.0		PAMAIT	P K	APH	42.37	25.0	GBA	D 14/01/91		*	*						
			TOTAL CABANG DINAS				418.9	METER		0	305	349	122	0	91	60	45	45
							19	JEMBATAN		0	14	17	5	0	4	5	4	4
SUT	BUT - BARITO UTARA																	
	32.007.007.0	1	TAKILI	P K	APH	6.40	12.0	GTI	D 18/01/91		*	*	*		*			
	32.007.032.0	1	TULANG	P K	APH	23.80	25.0	GBA	D 18/01/91		*	*	*		*			
	32.007.033.0	1	BIANG I	P K	APH	24.70	20.0	GBA	D 18/01/91		*	*	*		*			
	32.007.048.0	1	SINGAN III	P K	APH	32.50	20.0	RBA	D 16/01/91		*	*	*		*			
	32.007.049.0	1	AYUH	P K	APH	35.00	60.0	RBA	D 16/01/91			*			*			
	32.007.050.0	2	MEA	P K	APH	40.50	25.0	GBI	D 16/01/91		*	*	*		*			
	32.007.054.0	2	TAMPARAK LAYUNG	P K	APH	44.60	20.0	GBA	D 18/01/91		*	*			*			
	32.007.062.0	2	RAMPANEA	P K	APH	55.30	30.0	GBA	D 18/01/91		*	*						
	32.007.066.0	2	TAPIN I	P K	APH	61.70	20.0	GBI	D 15/11/91		*	*			*	*		
	32.007.070.0	2	JAPUS	P K	APH	75.50	25.0	GBA	D 15/11/91		*	*				*		
	32.007.072.0	3	KAKUNYUT II	P K	APH	94.30	25.0	GBA	D 15/11/91		*	*			*	*		
			TOTAL CABANG DINAS				282.0	METER		0	222	282	102	0	227	70	0	0
							11	JEMBATAN		0	10	11	5	0	9	3	0	0
PLR	PLR -																	
	32.001.002.0		S.SOEKARNO	N A	PRY	21.70	22.0	GTI	D 18/01/91		*	*	*		*			
	32.001.003.0		S.TAHAI	N A	PRY	28.33	45.0	GTI	D 13/01/91		*		*					
			TOTAL CABANG DINAS				67.0	METER		0	67	22	67	0	22	0	0	0
							2	JEMBATAN		0	2	1	2	0	1	0	0	0
			TOTAL				767.9	METER		0	594	653	291	0	340	130	45	45
							32	JEMBATAN		0	26	29	12	0	14	8	4	4

STATUS : NASIONAL & PROPINSI

IBMS-IR1 - Link and Traffic Data Report

Sistem Manajemen Jembatan
Direktorat Bina Program Jalan
Direktorat Jenderal Bina Marga

IBMSv1.72 - IR1
TANGGAL: 16/10/92

LAPORAN DATA LALU-LINTAS & RUAS

PROPINSI: 06. SUMBAR HALAMAN : 1

NOMOR RUAS	NAMA	AADT	LOKASI DARI	KM	KE KM	STATUS JLN	FNC	PROGRAM JALAN
001	Padang-Lb.Alung	1075	PDG	18.2	33.3	N	A	
001 1K	Jln.Diponegoro	0	PDG	1.2	2.3	N	A	
001 2K	Jln.Arau	0	PDG	2.3	4.2	N	A	
001 3K	Psr.Hilir + Mudik	0	PDG	4.2	5.7	N	A	
001 4K	Jln.Ganting-Pr.Gdng	0	PDG	5.8	7.9	N	A	B
001 K	Padang-Lb.Alung	0	PDG	0.0	18.2	N	A	
002	Lb.Alung-Sicincin	860	PDG	33.3	47.9	N	A	
003	Sicincin-Pd.Panjang	26875	PDG	47.9	67.2	N	A	
003 K	Sicincin-Pd.Panjang	0	PDG	67.2	73.5	N	A	
004	Pd.Panjang-Kb.Keramb	108	PDG	76.8	81.5	P	K	
004 K	P.Panjang-K.Kerambil	0	PDG	72.2	76.8	P	K	
005	Kb.Kerambil-Solok	0	PDG	81.5	122.0	P	K	
005 K	Kb.Kerambil-Solok	0	PDG	122.0	125.7	P	K	B
006	Solok-Ma.Kalaban	0	PDG	63.3	88.1	N	A	
006 K	Solok-Ma.Kalaban	0	PDG	61.5	63.3	N	A	
007	Simancung-Tj.Ampelu	0	PDG	95.3	106.0	P	K	
008	Tj.Ampelu-Sijunjung	0	PDG	106.0	127.0	P	K	
009	Tn.Bdtng-Kiliran Jao	0	PDG	114.0	165.0	N	A	B
010	Sp.Sikabau-Sp.K.Baru	0	PDG	193.0	222.2	P	L	
011	S.K.Baru-Tj.Simalidu	0	PDG	222.2	234.0	P	K	B
012	Sp.K.Baru-Junction	3225	PDG	222.2	227.6	P	K	
013	Klr.Jao-Bts Riau	0	PDG	165.0	188.3	P	K	
014 1	Lb.Selasih-Surian	0	PDG	35.4	95.4	P	K	
014 2	Surian-Sp.Pd.Aro	0	PDG	95.4	163.1	P	K	
014 3	Sp.Pd.Aro-Bts.Jambi	0	PDG	163.1	198.6	P	K	
015 K	Lb.Begalung-B.Putus	0	PDG	4.5	8.8	N	A	B
016	Bkt.Putus-Painan	0	PDG	28.3	77.0	N	A	
016 K	Bkt.Putus-Painan	0	PDG	5.8	28.3	N	A	P
017 1	Painan-Kambang	0	PDG	77.0	131.0	P	K	
017 2	Kambang-Inderapura	0	PDG	131.0	188.0	P	K	
018	indrapura-ma.sakai	0	PDG	188.0	195.7	P	L	
019	Inderapura-Tapan	0	PDG	188.0	212.2	P	K	
020	Tapan-Bts.Jambi	300	PDG	212.2	237.7	P	K	B

CATATAN: Program Jalan - B Betterment
P Betterment atau Periodic baru selesai

IBMS-DI1 - Routine Inspection Paket

Sistem Manajemen Jembatan
Direktorat Bina Program Jalan
Direktorat Jenderal Bina Marga

IBMSv1.72 - DI1
TANGGAL: 16/10/92

PAKET INSPEKSI RUTIN 92/93
Menurut Link

PROPINSI: 30.KALBAR

Halaman : 1

CABANG DINAS	NOMOR JEMBATAN	LNK SFX	NAMA JEMBATAN	STATUS JALAN	LOKASI DARI	LOKASI KM	JUMLAH BENTANG	PANJANG (M)	BANG ATAS	LEBAR	TROTOAR	TINGGI BEBAS	NIL. KOND	CATATAN
	30.001.001.0	K	PRT.WAK SALIM	N	PTK	0.20	3	10.5	GKI	8.3	0.0	0.0	1	DETAIL
	30.001.002.0	K	PRT.GUDANG GARAM	N	PTK	0.30	2	5.9	GKI	7.8	0.0	0.0	1	
	30.001.003.0	K	PRT.KUNYIT	N	PTK	0.50	3	11.8	GKI	8.8	0.0	0.0	0	
	30.001.004.0	K	PRT.BANSENG	N	PTK	0.70	2	8.4	GKI	8.8	0.0	0.0	1	
	30.001.005.0	K	PUTAT	N	PTK	1.10	3	12.6	GKI	6.9	0.0	0.0	0	DETAIL
	30.001.006.0	K	SELAMAT	N	PTK	1.70	2	7.7	GKI	7.7	0.0	0.0	1	DETAIL
	30.001.007.0	K	JUNGSENG	N	PTK	2.20	2	8.2	GKI	7.6	0.0	0.0	1	
	30.001.008.0	K	SAMANG KECIL	N	PTK	2.60	2	8.8	GKI	7.8	0.0	0.0	1	
	30.001.009.0	K	SAMANG BSE	N	PTK	3.40	2	10.9	GKI	9.0	0.0	0.0	1	DETAIL
	30.001.010.0	K	PRT BELANGA	N	PTK	4.70	2	6.3	GKI	6.7	0.0	0.0	1	DETAIL
	30.001.011.0	K	BATU LAYANG II	N	PTK	5.40	2	6.5	GKI	6.1	0.0	0.0	0	DETAIL
	30.001.012.0	K	BATU LAYANG III	N	PTK	5.95	2	8.4	GKI	6.0	0.0	0.0	1	
	30.001.013.0	K	KUNYIT BATU	N	PTK	6.51	2	7.2	GKI	6.3	0.0	0.0	2	DETAIL
	30.001.014.0	K	PANDAN	N	PTK	7.40	2	8.2	GKI	6.4	0.0	0.0	2	
	30.001.015.0		PRT.BARU	N	PTK	8.20	2	8.4	GKI	6.4	0.0	0.0	1	
	30.001.016.0		TLK DALAM MATI	N	PTK	8.75	3	12.6	GKI	6.0	0.0	0.0	2	
	30.001.017.0		SEI.DURIAN	N	PTK	9.95	2	7.6	GKI	7.1	0.0	0.0	1	DETAIL
	30.001.018.0		PRT.BRAHMA	N	PTK	11.40	2	7.0	GKI	7.0	0.0	0.0	1	DETAIL
	30.001.019.0		SP.EMPAT	N	PTK	11.45	2	8.0	GKI	6.0	0.0	0.0	1	
	30.001.020.0		WAK.DONGKAK	N	PTK	13.37	3	10.6	GKI	7.0	0.0	0.0	1	
	30.001.021.0		PRT.WAJOK	N	PTK	14.70	3	13.0	GKI	6.0	0.0	0.0	1	
	30.001.022.0		PRT.ADAM	N	PTK	15.42	2	7.6	GKI	6.0	0.0	0.0	3	DETAIL
	30.001.023.0		PRT.GADUH	N	PTK	16.60	2	7.5	GKI	6.0	0.0	0.0	1	DETAIL
	30.001.024.0		PRT.KEBAYAN	N	PTK	17.05	4	13.4	GKI	7.0	0.0	0.0	3	
	30.001.025.0		AJUSMAN	N	PTK	17.77	2	8.1	GKI	6.9	0.0	0.0	1	
	30.001.026.0		H.HUSIN	N	PTK	18.60	1	26.0	RBU	6.0	1.2	0.0	0	
	30.001.027.0		JUNGKAT	N	PTK	19.90	2	9.7	GKI	8.0	0.0	0.0	2	
	30.001.028.0		H.HASAN	N	PTK	21.57	2	8.0	GKI	6.9	0.0	0.0	1	
	30.001.029.0		PRT.NIPAH I	N	PTK	22.25	3	15.5	GKI	6.2	0.0	0.0	2	
	30.001.030.0		AIR HITAM	N	PTK	24.80	1	26.0	RBU	6.0	0.0	0.0	3	
	30.001.031.0		PENITI KECIL	N	PTK	27.45	2	11.0	GKI	6.0	0.0	0.0	3	DETAIL
	30.001.032.0		PENITI BESAR	N	PTK	30.40	3	50.0	GTI	6.0	2.0	0.0	2	
	30.001.033.0		PENITI II	N	PTK	30.67	3	16.5	GKI	6.0	0.0	0.0	2	
	30.001.034.0		PURUN BESAR	N	PTK	36.05	1	25.6	GBA	1.3	1.0	1.0	0	
	30.001.035.0		PURUN KECIL	N	PTK	37.85	2	6.8	GKI	7.4	0.0	0.0	1	DETAIL
	30.001.036.0		DAYAK	N	PTK	39.90	2	8.0	GKI	6.2	0.0	0.0	3	
	30.001.037.0		PENIRAMAN	N	PTK	42.45	3	12.0	GKI	6.0	0.0	0.0	2	
	30.001.038.0		NUSAPATI I	N	PTK	46.15	2	5.8	GKI	6.8	0.0	0.0	1	DETAIL
	30.001.039.0		NUSAPATI II	N	PTK	46.10	2	10.0	GKI	7.0	0.0	0.0	1	
	30.002.001.0	1	KEPAYANG	N	PTK	58.10	1	25.3	RBU	6.0	1.0	0.0	3	
	30.002.002.0	1	PAKBULU	N	PTK	71.70	1	25.6	GPI	4.0	0.0	0.0	0	
	30.002.003.0	1	NGARAK I	N	PTK	74.90	2	6.4	GKI	6.7	0.0	0.0	0	DETAIL
	30.002.003.1	1	NGARAK	N	PTK	74.90	2	3.2	GKI	6.7	0.0	0.0	0	DETAIL
	30.002.005.0	1	SALATIGA	N	PTK	82.70	1	31.7	GPI	6.0	0.0	0.0	1	
	30.002.006.0	1	MANDOR	N	PTK	87.90	1	32.8	RBU	6.0	1.0	0.0	0	
	30.002.007.0	1	TAITUKONG	N	PTK	92.90	4	12.4	GKI	6.0	0.0	0.0	1	
	30.002.008.0	2	SETABAR	N	PTK	102.80	2	12.0	GBI	5.0	0.0	0.0	0	
	30.002.009.0	2	SEBADU	N	PTK	106.40	2	9.5	GKI	6.0	0.0	0.0	0	
	30.002.011.0	2	AIR GAMBUR	N	PTK	115.00	2	11.0	GBI	4.3	0.0	0.0	2	
	30.002.011.1	2	SEI. BAGA	N	PTK	116.00	2	3.2	GKI	6.0	0.0	0.0	0	DETAIL

INSPEKSI RUTIN jika kolum CATATAN kosong

IBMS-DI2 - Detailed Inspection Paket

Sistem Manajemen Jembatan
Direktorat Bina Program Jalan
Direktorat Jenderal Bina Marga

IBMSv1.72 - DI2
TANGGAL: 16/10/92

PAKET INSPEKSI MENDETAIL 92/93
Menurut Link

PROPINSI: 30.KALBAR　　Halaman : 1

CABANG DINAS	NOMOR JEMBATAN	LNK SFX	NAMA JEMBATAN	STATUS JALAN	LOKASI DARI	KM	JUMLAH BENTANG	PANJANG (M)	BANG ATAS	LEBAR	TROTOAR	TINGGI BEBAS	NIL. KOND	TGL. INSP SEBELUMNYA
	30.001.001.0	K	PRT.WAN SALIM	N	PTK	0.20	3	10.5	GKI	8.3	0.0	0.0	1	/ /
	30.001.005.0	K	PUTAT	N	PTK	1.10	3	12.6	GKI	6.9	0.0	0.0	0	/ /
	30.001.006.0	K	SELAMAT	N	PTK	1.70	2	7.7	GKI	7.7	0.0	0.0	1	/ /
	30.001.009.0	K	SAHANG BSR	N	PTK	3.40	2	10.9	GKI	9.0	0.0	0.0	1	/ /
	30.001.010.0	K	PRT BELANGA	N	PTK	4.70	2	6.3	GKI	6.7	0.0	0.0	1	/ /
	30.001.011.0	K	BATU LAYANG II	N	PTK	5.40	2	6.5	GKI	6.1	0.0	0.0	0	/ /
	30.001.013.0	K	KUNYIT BATU	N	PTK	6.51	2	7.2	GKI	6.3	0.0	0.0	2	/ /
	30.001.017.0		SEI DURIAN	N	PTK	9.95	2	7.6	GKI	7.1	0.0	0.0	1	/ /
	30.001.018.0		PRT BRAHMA	N	PTK	11.40	2	7.0	GKI	7.0	0.0	0.0	1	/ /
	30.001.022.0		PRT ADAM	N	PTK	15.42	2	7.6	GKI	6.0	0.0	0.0	3	/ /
	30.001.023.0		PRT GADUH	N	PTK	16.60	2	7.5	GKI	6.0	0.0	0.0	1	/ /
	30.001.031.0		PENITI KECIL	N	PTK	27.45	2	11.0	GKI	6.0	0.0	0.0	3	/ /
	30.001.035.0		PURUN KECIL	N	PTK	37.85	2	6.8	GKI	7.4	0.0	0.0	1	/ /
	30.001.038.0		NUSAPATI I	N	PTK	46.15	2	5.8	GKI	6.8	0.0	0.0	1	/ /
	30.002.003.0	1	NGARAK I	N	PTK	74.90	2	6.4	GKI	6.7	0.0	0.0	0	/ /
	30.002.003.1	1	NGARAK	N	PTK	74.90	2	3.2	GKI	6.7	0.0	0.0	0	/ /
	30.002.011.1	2	SEI BAGA	N	PTK	116.00	2	3.2	GKI	6.0	0.0	0.0	0	/ /
	30.002.016.0	2	BAGA	N	PTK	122.79	1	7.4	GBI	6.5	0.0	0.0	1	/ /
	30.002.018.0	2	RANSIK	N	PTK	125.62	3	12.6	GKI	6.0	0.0	0.0	0	/ /
	30.002.027.0	2	BATIKAN	N	PTK	146.52	2	7.5	GKI	5.0	0.0	0.0	1	/ /
	30.003.001.0	1	KELAWIT	N	PTK	154.50	2	6.0	GKI	5.6	0.0	0.0	1	/ /
	30.003.005.0	1	TANGGOK I	N	PTK	166.70	1	6.0	GBI	6.4	0.0	0.0	1	/ /
	30.003.006.0	1	TANGGOK II	N	PTK	166.85	2	7.4	GBI	6.5	0.0	0.0	1	/ /
	30.003.008.0	1	UKAH	N	PTK	176.20	1	7.0	GBI	6.3	0.0	0.0	1	/ /
	30.004.024.0	1	SEKADAU	N	PTK	311.63	1	86.6	TBD	2.8	1.0	3.6	1	/ /
	30.004.027.0	2	TERENTANG	N	PTK	319.50	1	9.0	PTI	4.5	0.0	0.0	1	/ /
	30.004.049.0	2	KRANGKING	N	PTK	370.42	1	9.0	PTI	4.5	0.0	0.0	1	/ /
	30.006.001.0		PUNTI	P	PTK	388.10	2	8.0	GKI	5.0	0.0	0.0	1	/ /
	30.006.004.0		BELANTIK	P	PTK	402.75	1	6.2	GKI	4.3	0.0	0.0	1	/ /
	30.006.005.0		DAKAN I	P	PTK	404.54	2	10.4	GKI	4.6	0.0	0.0	1	/ /
	30.006.006.0		DAKAN II	P	PTK	407.80	2	8.9	GKI	3.9	0.0	0.0	1	/ /
	30.006.008.0		REMBANG I	P	PTK	411.49	2	10.0	GKI	4.7	0.0	0.0	1	/ /
	30.006.009.0		REMBANG II	P	PTK	412.90	1	20.4	GBA	6.0	0.0	0.0	1	/ /
	30.006.010.0		SAYONG III	P	PTK	413.50	2	12.3	GKI	4.0	0.0	0.0	1	/ /
	30.006.011.0		PINTAS BATU	P	PTK	414.60	1	20.5	GBA	6.2	0.0	0.0	1	/ /
	30.006.012.0		LEBAK ARANG	P	PTK	414.70	1	20.4	GBA	6.0	0.0	0.0	1	/ /
	30.006.013.0		PUTIH AIR	P	PTK	415.41	3	12.2	GKI	3.0	0.0	0.0	1	/ /
	30.006.015.0		EMANG	P	PTK	416.11	2	11.0	GKI	4.0	0.0	0.0	1	/ /
	30.006.016.0		KETITIK EMANG	P	PTK	416.49	2	10.3	GKI	4.0	0.0	0.0	1	/ /
	30.006.017.0		KANINJAL	P	PTK	418.90	1	41.3	RBA	6.0	0.5	0.0	1	/ /
	30.006.018.0		MATUK	P	PTK	421.61	2	9.2	GKI	4.0	0.0	0.0	1	/ /
	30.006.020.0		KENYIKAP	P	PTK	433.05	3	14.3	GKI	4.8	0.0	0.0	4	/ /
	30.007.002.0	1	SAWAK	P	PTK	453.70	3	15.6	GKI	4.5	0.0	0.0	1	/ /
	30.007.003.0	1	MANGAT	P	PTK	455.25	2	46.5	RBW	3.7	0.0	0.0	1	/ /
	30.007.004.0	1	MELABAN	P	PTK	457.00	2	8.1	GKI	4.0	0.0	0.0	1	/ /
	30.007.005.0	1	BEMBAN	P	PTK	461.65	2	11.8	GKI	4.0	0.0	0.0	1	/ /
	30.007.006.0	1	BEMBAN II	P	PTK	467.96	2	12.3	GKI	4.0	0.0	0.0	1	/ /
	30.007.007.0	1	NONAME	P	PTK	473.36	2	10.4	GKI	4.3	0.0	0.0	1	/ /
	30.007.008.0	1	NONAME	P	PTK	479.36	3	15.3	GKI	4.3	0.0	0.0	1	/ /
	30.007.009.0	1	KELAWAI	P	PTK	483.05	2	80.8	RBA	4.7	0.5	0.0	1	/ /

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

BRIDGE INSPECTION MANUAL

APPENDIX 2

GUIDELINES FOR ASSESSMENT OF NATURE AND DEGREE OF DEFECTS

BRIDGE MANAGEMENT SYSTEM
BMS
A PROJECT JOINTLY FUNDED BY INDONESIA AND AUSTRALIA

FEBRUARY 1993

DOCUMENT No. **BMS2-M.E**

GUIDELINES FOR ASSESSMENT OF NATURE AND DEGREE OF DEFECTS IN MATERIALS

DEFECTS IN MASONRY ELEMENTS

Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	Unit of Measurement
101	Deterioration	Aging Impact Erosion Poor material quality	Harmful	Stone/bricks Mortar ≤ 20 mm deep > 20 mm deep	Heavy Light Heavy	m²
	Cracking	Foundation failure Movement Overload Vegetation Vibration	Harmful Harmful Harmful Harmful Harmful	Mortar ≤ 5 mm wide > 5 mm wide	 Light Heavy	
102	Bulging and changing shape	Foundation failure Overloading	Harmful Harmful	> 40 mm outward movement of face and/or < 750 mm long > 750 mm long	Heavy Light Heavy	m²
103	Broken or missing material	Any	Harmful	Non-structural element Structural element	Light Heavy	m³

DEFECTS IN CONCRETE ELEMENTS (INCLUDING REINFORCEMENT)

Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	Unit of Measurement
201	Spalling Honeycombing Drumminess Poor quality	Carbonation Impact Insufficient cover Overloading Poor workmanship Prestressing force Volumetric expansion Chemical attack	Harmless Harmless Harmful Harmful Harmless Harmful Harmful Harmful	 Reinforcement not visible Reinforcement visible Visible leaching	 Light Heavy Heavy	m² or m³
202	Cracking	Overloading	Harmful	≤ 0.2 mm wide > 0.2 mm wide Visible leaching or seepage	Light Heavy Heavy	m or m²
		Carbonation Impact Foundation failure Prestressing force Shrinkage Vegetation Volumetric expansion	Harmless Harmful Harmful Harmful Harmless Harmful Harmful	Visible leaching or seepage ≤ 0.4 mm wide > 0.4 mm wide	Heavy Light Heavy	
203	Corrosion of steel reinforcement	Any	Harmful	≤ 10% of cross section > 10% of cross section	Light Heavy	m or m²
204	Worn, weathered or aged (Deterioration)	Abrasion Aging Chemical attack Impact Poor workmanship Volumetric expansion	Harmful	≤ Cover layer > Cover layer	Light Heavy	m² or m³
205	Broken or missing material	Any	Harmful	Structural element Non-structural element	Heavy Light	m² or m³
206	Deflection	Impact Foundation failure Overloading	Harmful	Slabs ≤ 1 in 600 > 1 in 600 Other Elements ≤ 20 mm > 20 mm	 Light Heavy Light Heavy	m³

GUIDELINES FOR ASSESSMENT OF NATURE AND DEGREE OF DEFECTS IN MATERIALS

DEFECTS IN STEEL ELEMENTS						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
301	Deterioration of Corrosion Protection	Aging Cracks Dampness Vandalism Wearing	Harmful Harmless Harmful Harmless Harmful	No visible steel surface Visible steel surface	Light Heavy	m^2
302	Corrosion	Any	Harmful	≤ 10% of dimension > 10% of dimension	Light Heavy	m^2
303	Deformation	Impact Foundation failure Heat Overloading	Harmful	For structural elements ≤ 20 mm > 20 mm For non-structural elements	Light Heavy Light	m of member
304	Cracking	Any	Harmful	Any	Heavy	m
305	Broken or Missing element	Any	Harmful	Non-structural element Structural element	Light Heavy	m of member
306	Incorrect element	Any	Harmful	Not undersized Undersized	Light Heavy	m of member
307	Frayed cables	Any	Harmful	≤ 5% of strands > 5% of strands	Light Heavy	m of member
308	Loose connection	Any	Harmful	Any	Heavy	no. of fixings

DEFECTS IN TIMBER ELEMENTS						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
401	Rot	Dampness	Harmful	≤ 15% of section affected > 15% of section affected	Light Heavy	m or m^2 or m^3
	Insect attack	Infestation	Harmful			
	Splitting/ Splintering	Aging Drying out Imperfect material Overloading	Harmful Harmless Harmful Harmful	Splits < 10 mm wide and/or < 1 m long Otherwise	Light Light Heavy	
	Crookedness	(For compression) Imperfect material Overloading (For tension)	Harmful Harmless	Deviation ≤ 50 mm in 3m Deviation > 50 mm in 3m	Light Heavy	
	Knots, sloping grain	Imperfect material	Harmful	Knot dimension ≤ 15% of section Knot dimension > 15% of section Sloping grain ≤ 1 in 16 Sloping grain > 1 in 16	Light Heavy Light Heavy	
402	Broken or missing element	Any	Harmful	Non-structural elements Structural elements	Light Heavy	m or m^3
403	Shrinkage	Poor quality	Harmless	≤ 50 mm deflection in a truss > 50 mm deflection in a truss Any in other structure	Light Heavy Light	member or m^3
404	Deterioration of surface protection	Aging Vandalism Wearing	Harmful	Non-structural element. No visible protection coating on timber surface on structural element	Light Heavy	m^2
405	Loose element	Any	Harmful	Any	Heavy	no. fixings

GUIDELINES FOR ASSESSMENT OF NATURE AND DEGREE OF DEFECTS IN PARTICULAR ELEMENTS

DEFECTS IN PARTICULAR ELEMENTS: 3.210 - WATERWAY						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
501	Siltation	Water current	Harmful	≤ 20% reduction of waterway > 20% reduction of waterway	Light Heavy	m^3
502	Debris accumulation and obstruction	Deposition	Harmful	< 20% reduction of waterway > 20% reduction of waterway and/or < 20% height at pier > 20% height at pier Otherwise	Light Heavy Light Heavy	m^3
503	Scour	Water current	Harmful	≤ foundation level or 6 times pile diameter Otherwise	Light Heavy	m^2 or m^3
504	Excessive afflux	Rainfall Inadequate bridge length	Harmful	≤ 250 mm > 250 mm	Light Heavy	m

DEFECTS IN PARTICULAR ELEMENTS: 3.220 - SCOUR PROTECTION, 3.230 - EMBANKMENTS AND 3.310 - FOUNDATIONS						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
511	Missing material	Any	Harmful	≤ 10% > 10%	Light Heavy	m^3
521	Scour	Water current	Harmful	No undermining Undermining	Light Heavy	m^3
522	Crack	Any	Harmless		Light	m^3 or m^2 or
	Settlement	Any	Harmful	Surface lower than foundation level or 6 x pile dimension Otherwise	Heavy Light	
	Bulging	Any	Harmful	≤ 300 mm > 300 mm	Light Heavy	Special Inspection

DEFECTS IN PARTICULAR ELEMENTS: 4.235 - REINFORCED EARTH						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
531	Bulging facing panels	Anchorages pulling out	Harmful	Any	Heavy	m^2
532	Cracking, spalling or breaking	Anchorages failing	Harmful	Any	Heavy	m^2
		Impact Movement Vandalism	Harmless	> 3 panels or > 10% of facing defective Otherwise	Heavy Light	

DEFECTS IN PARTICULAR ELEMENTS: 4.314 - ANCHOR						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
541	Instability	Overloading Poor construction	Harmful	Any	Heavy	Special Inspection

GUIDELINES FOR ASSESSMENT OF NATURE AND DEGREE OF DEFECTS IN PARTICULAR ELEMENTS

DEFECTS IN PARTICULAR ELEMENTS: 3.320 - ABUTMENTS/PIERS						Unit of Measurement
Code	**Appearance**	**Cause**	**Nature Mark S**	**Criteria for Assessment**	**Degree Mark R**	
551	Movement	Overturning Rotation Settlement Tilting	Harmful Harmful Harmful Harmful	Rotation < 1 in 12 in vertical plane Settlement < 50 mm No noticiable transverse (sideways) tilting Otherwise	Light Light Light Heavy	Special Inspection

DEFECTS IN PARTICULAR ELEMENTS: 4.326 - EARTHQUAKE RESTRAINT BLOCK						Unit of Measurement
Code	**Appearance**	**Cause**	**Nature Mark S**	**Criteria for Assessment**	**Degree Mark R**	
561	Loose	Any	Harmful	Any	Heavy	M^3
	Missing	Any	Harmful	Any	Heavy	

DEFECTS IN PARTICULAR ELEMENTS: 3.610 - BEARINGS						Unit of Measurement
Code	**Appearance**	**Cause**	**Nature Mark S**	**Criteria for Assessment**	**Degree Mark R**	
601	Loss of movement ability	Any	Harmful	Any	Heavy	no.
602	Improper seating	Any	Harmful	< 2mm gap > 2 mm gap > ⅓ of correct bedding area < ⅓ of correct bedding area	Light Heavy Light Heavy	no.
603	Crack or spalling in mortar pad	Any	Harmful	≤ 15% defective > 15% defective	Light Heavy	no.
604	Excessive movement	Any	Harmful	≥ 30 mm still possible < 30 mm still possible	Light Heavy	no.
	Excessive deformation	Any	Harmful	≤ 20% of depth of bearing > 20% of depth of bearing	Light Heavy	
605	DEFECTIVE MATERIAL Aged	Any	Harmless	≤ 25% through section > 25% through section	Light Heavy	no.
	Split, torn or cracked rubber bearing	Any	Harmless	≤ 2 mm wide > 2 mm wide	Light Heavy	
	Broken or missing parts	Any	Harmful	Any	Heavy	
606	Loose parts	Any	Harmful	Any	Heavy	no.
607	Dry metal bearing	Poor lubrication	Harmful	Any	Heavy	no.

GUIDELINES FOR ASSESSMENT OF NATURE AND DEGREE OF DEFECTS IN PARTICULAR ELEMENTS

DEFECTS IN PARTICULAR ELEMENTS: 4.421 - SLAB AND 4.502 - DECKING						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
701	Excessive Movement in longitudinal deck joint	Any	Harmful	Any	Heavy	m
702	Excessive deflection	Any	Harmful	≤ span/200 > span/200	Light Heavy	m^2

DEFECTS IN PARTICULAR ELEMENTS: 4.329 - WEEP HOLE, 4.507 - SCUPPER						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
711	Blocked	Any	Harmful	Any	Heavy.	no.
712	Missing material	Any	Harmful	Any	Heavy	no.

DEFECTS IN PARTICULAR ELEMENTS: 4.505 - RUNNING SURFACE						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
721	Slippery	Any	Harmful	Skidding on surface No skidding	Heavy Light	m^2
722	Potholed/Rough	Any	Harmless	≤ 20 mm deep > 20 mm deep	Light Heavy	m^2
	Crack	Any	Harmless	≤ 20 mm deep > 20 mm deep	Light Heavy	m^2
723	Heaving (rutting)	Any	Harmless	≤ 20 mm deep > 20 mm deep	Light Heavy	m^2
724	Excessive overlay	Any	Harmful	≤ 100 mm thick ≥ 100 mm thick	Light Heavy	m^2

DEFECTS IN PARTICULAR ELEMENTS: 4.506 - FOOTWAY/KERB						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
731	Slippery	Any	Harmful	Skidding on surface No skidding	Heavy Light	m^2
732	Potholed	Any	Harmless	≤ 20 mm deep > 20 mm deep	Light Heavy	m^2
733	Missing material	Any	Harmful	Any	Heavy	m^2

GUIDELINES FOR ASSESSMENT OF NATURE AND DEGREE OF DEFECTS IN PARTICULAR ELEMENTS

DEFECTS IN PARTICULAR ELEMENTS: 3.600 - DECK JOINTS						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
801	Uneven	Any	Harmless	≤ 30 mm variation in level > 30 mm variation in level	Light Heavy	m
802	Loss of movement ability	Any	Harmful	Span < 25 m Span > 25 m If pavement heaving at joint > 25 mm Otherwise	Light Heavy Heavy Light	m
803	Loose parts	Any	Harmful	Any	Heavy	m
	Loss of adhesion	Any	Harmless	≤ 25% of adhesion lost > 25% of adhesion lost	Light Heavy	
805	Broken or missing parts	Any	Harmful	Any	Heavy	m
806	Cracked asphalt due to joint movement	Any	Harmless	≤ 15 mm > 15 mm	Light Heavy	m

DEFECTS IN PARTICULAR ELEMENTS: 4.701 - GAUGE						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
901	Broken or missing parts	Any	Harmful	Any	Heavy	m

DEFECTS IN PARTICULAR ELEMENTS: 4.711 - ROAD SIGN, 4.712 - ROAD MARKING AND 4.713 - NO. PLATE						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
911	Wearing	Any	Harmless	> 25% non effective ≤ 25% non effective	Heavy Light	no. or m
912	Missing material	Any	Harmless	If bridge No. plate or statue Otherwise	Light Heavy	no. or m

DEFECTS IN PARTICULAR ELEMENTS: 4.721 - LIGHTING, 4.722 - LIGHTING POST AND 4.723 - POWER CONDUIT						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
921	Aged material Deterioration	Any	Harmless	> 25% deteriorated ≤ 25% deteriorated	Heavy Light	no. or m
922	Missing material	Any	Harmless	Danger of electrocution Otherwise	Heavy Light	no. or m

DEFECTS IN PARTICULAR ELEMENTS: 4.731 - UTILITIES						Unit of Measurement
Code	Appearance	Cause	Nature Mark S	Criteria for Assessment	Degree Mark R	
931	Malfunction	Any	Harmless	Dangerous	Heavy	m

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

BRIDGE INSPECTION MANUAL

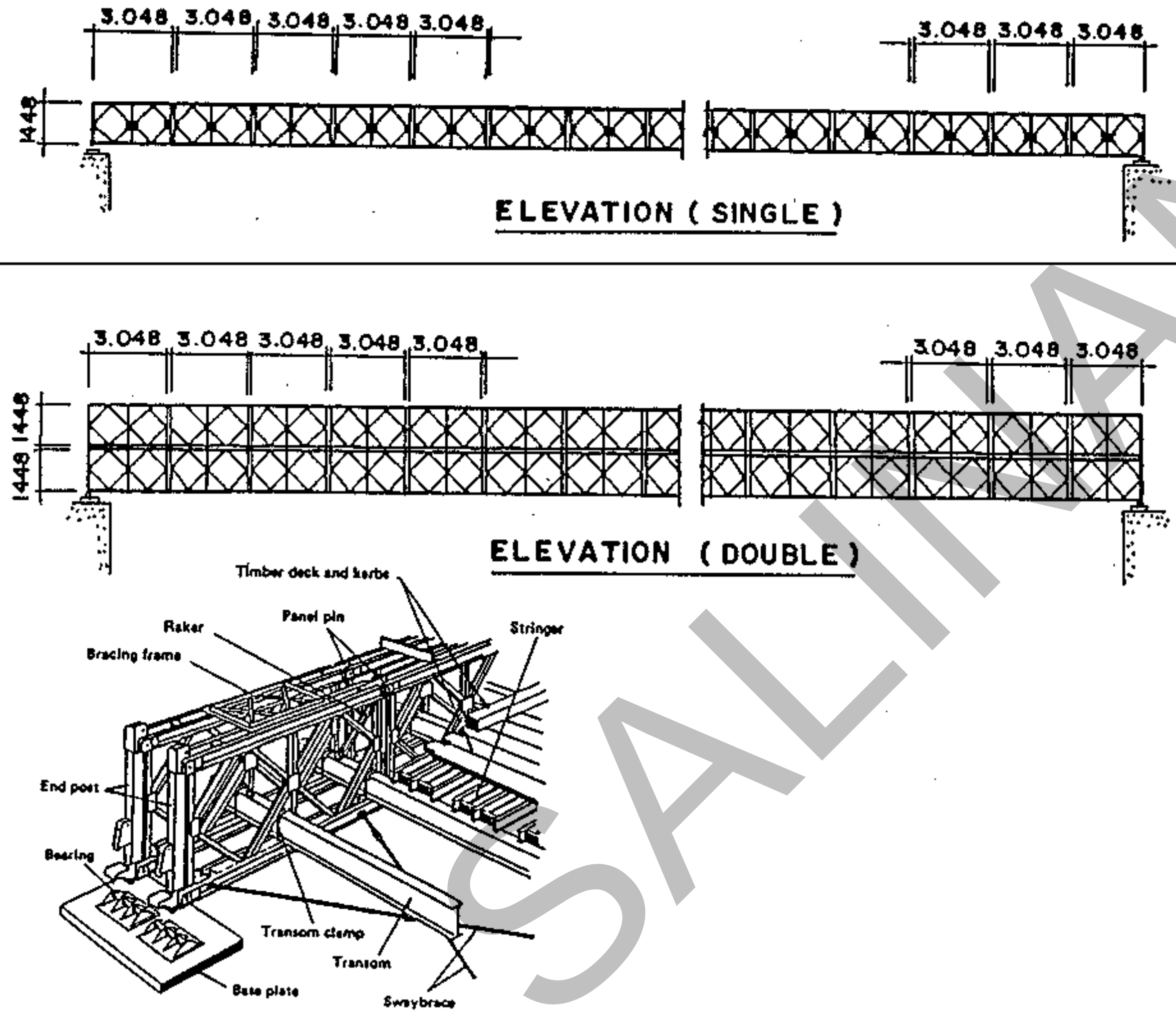
APPENDIX 3

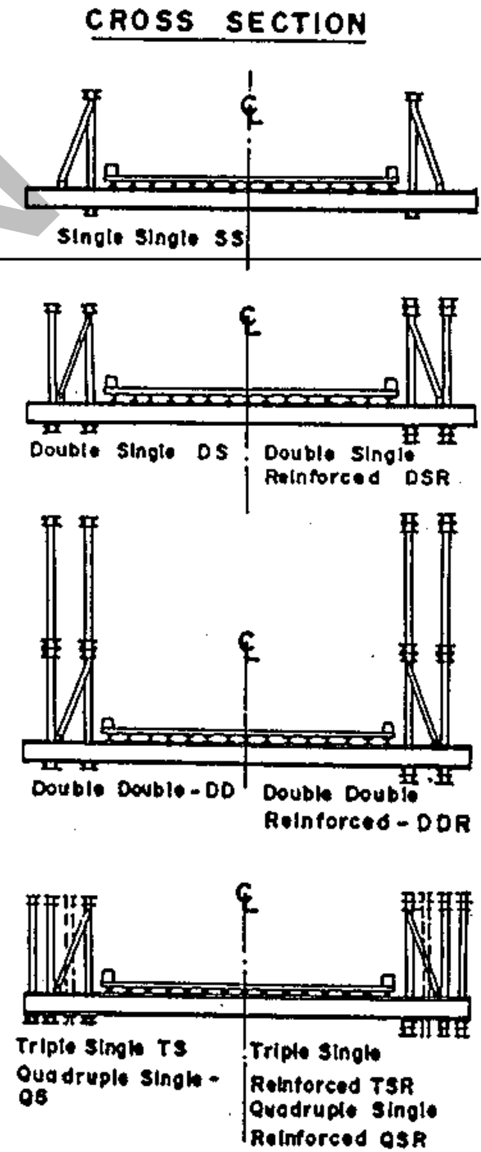
STANDARD BRIDGE SUPERSTRUCTURES

BRIDGE MANAGEMENT SYSTEM
BMS
A PROJECT JOINTLY FUNDED BY INDONESIA AND AUSTRALIA

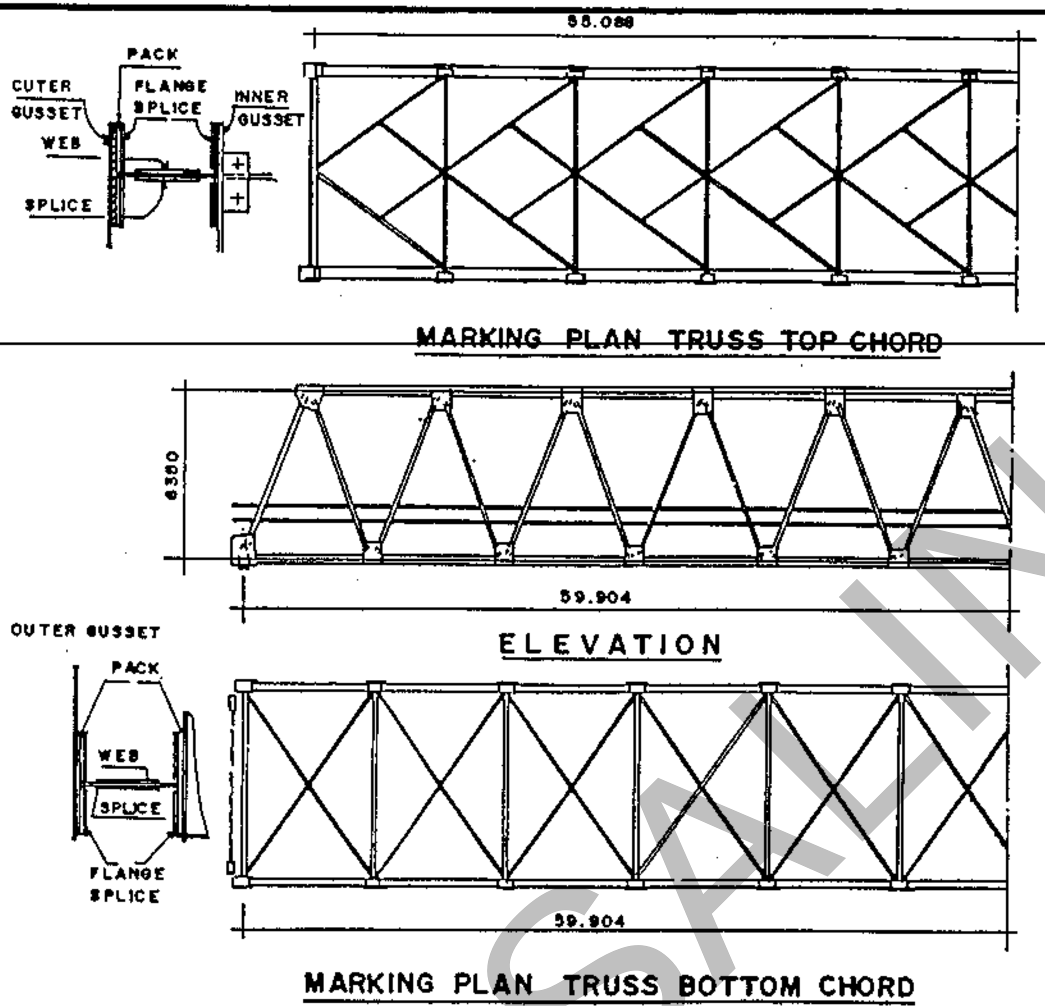
FEBRUARY 1993

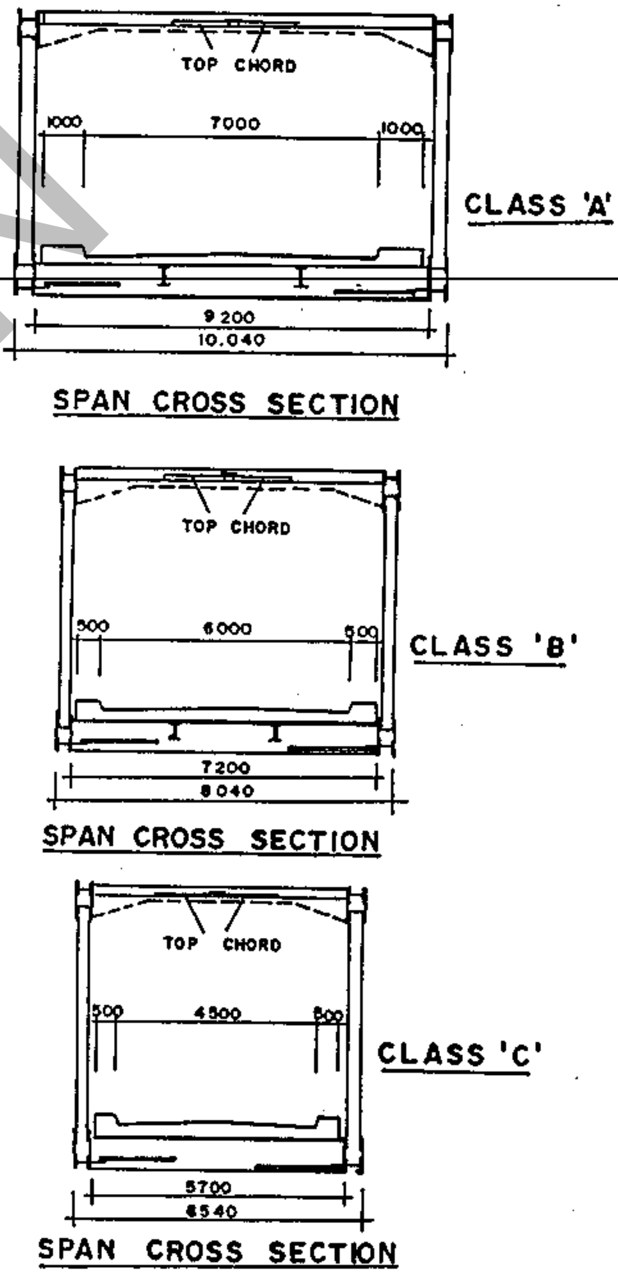
DOCUMENT No. **BMS2-M.E**





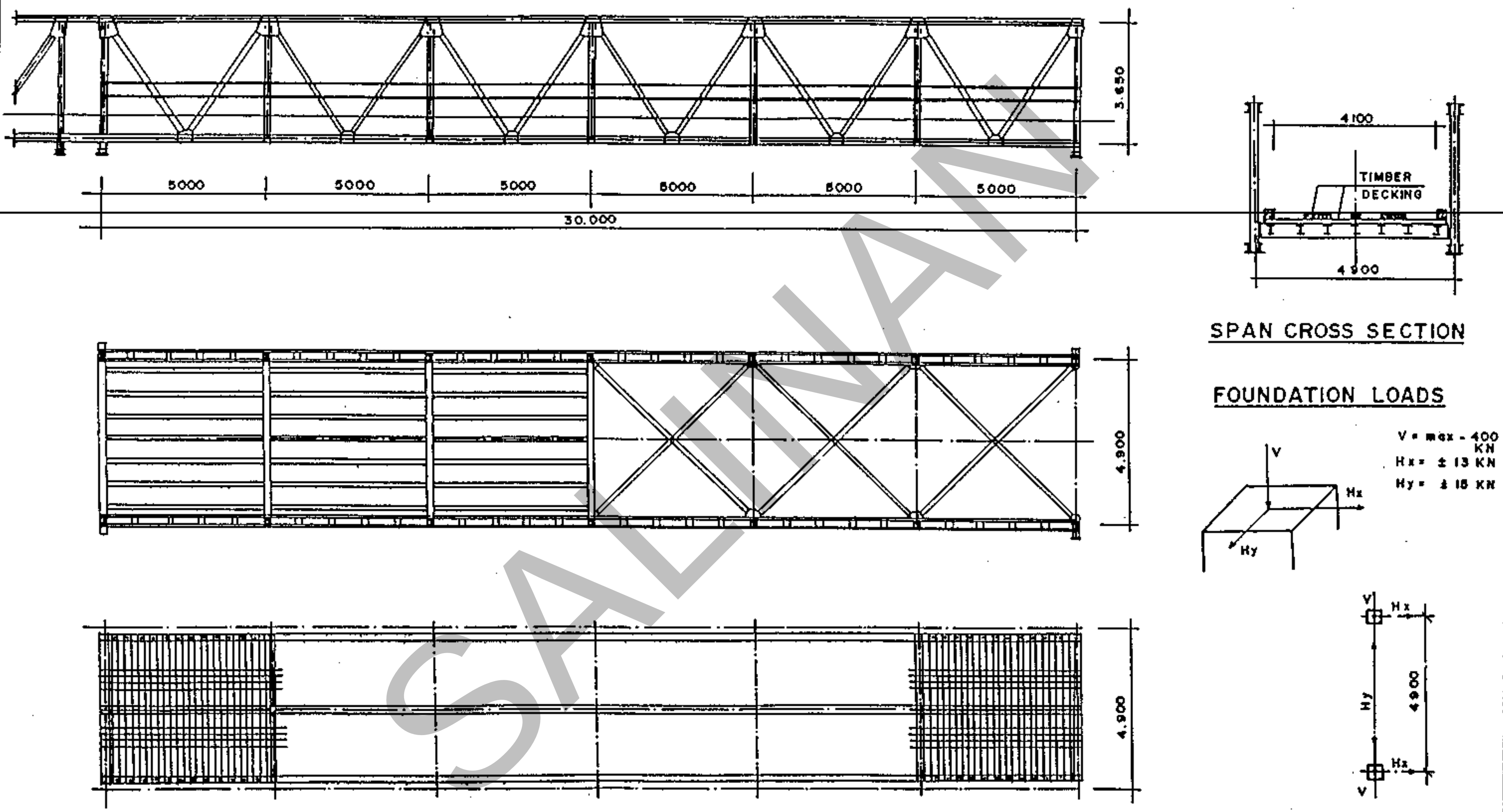
BAILEY BRIDGES - TYPE RBW / SBW



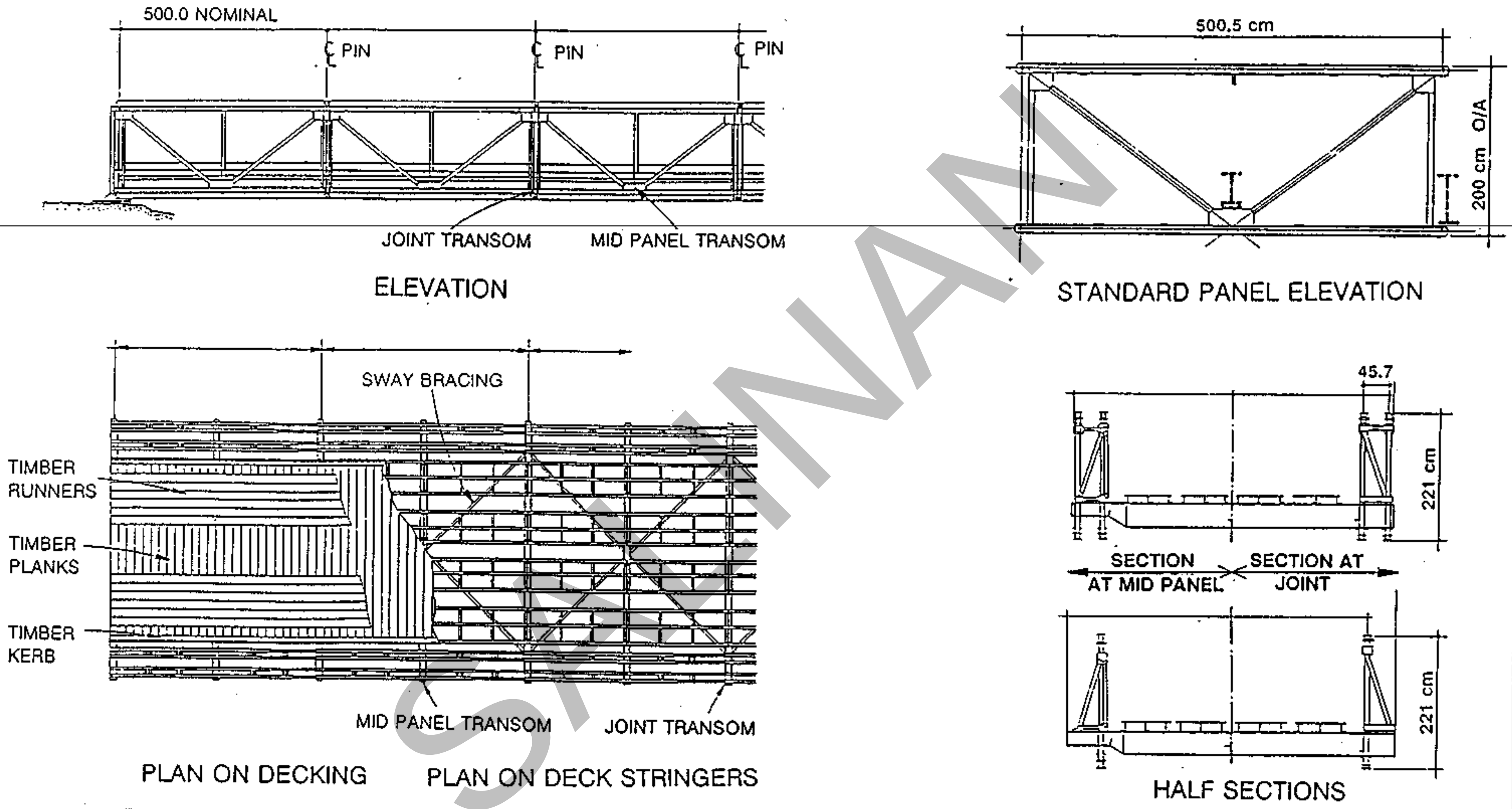


AUSTRALIAN TRUSS BRIDGE - TYPE. R B A

SPAN - 30 M TO 60 M. CLASS A,B & C



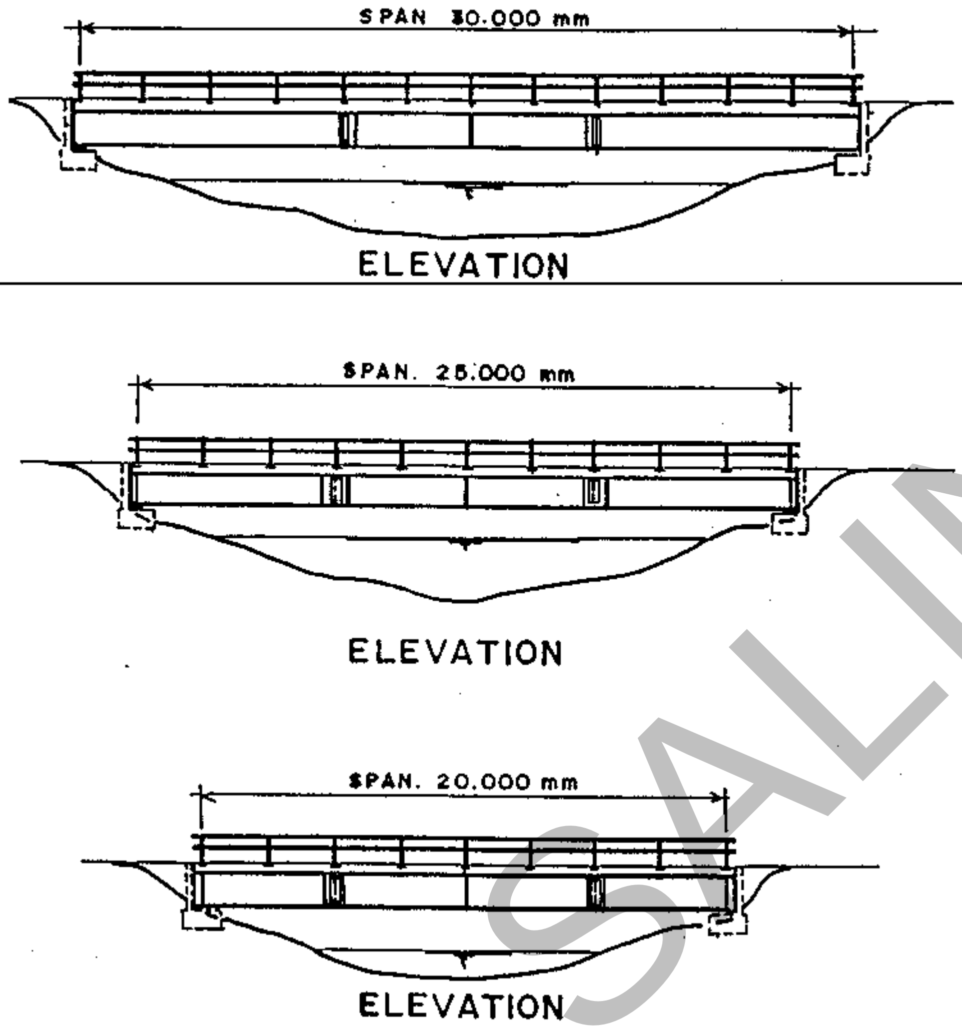
AUSTRALIAN BRIDGE - TYPE. R B S

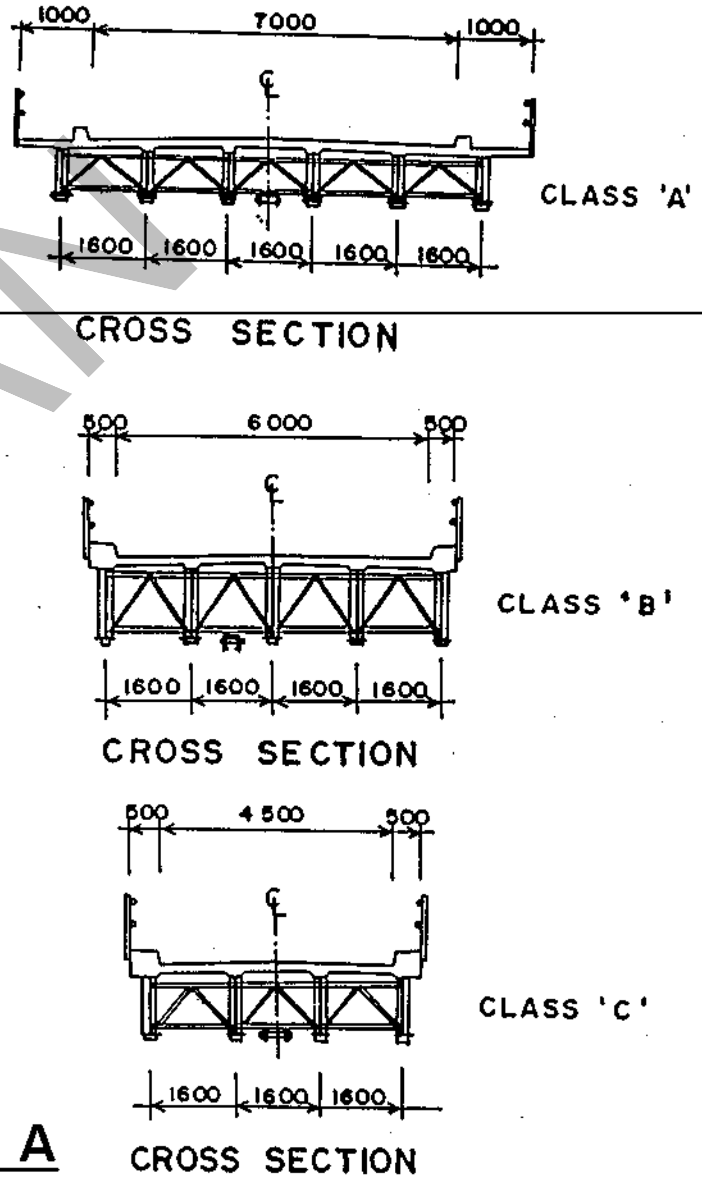


AUSTRALIAN TRANSPANEL BRIDGES-TYPE RBT

SPANS 10 M TO 50 M

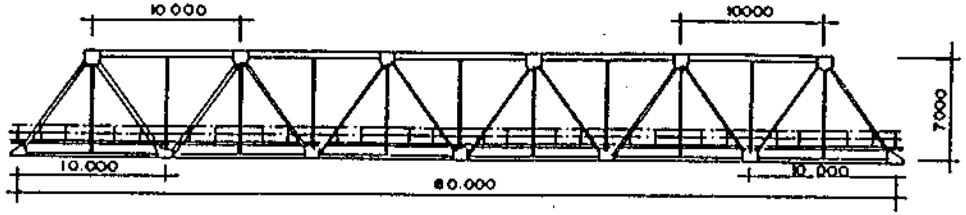
NOTE: ALL MEMBERS ARE GALVANIZED



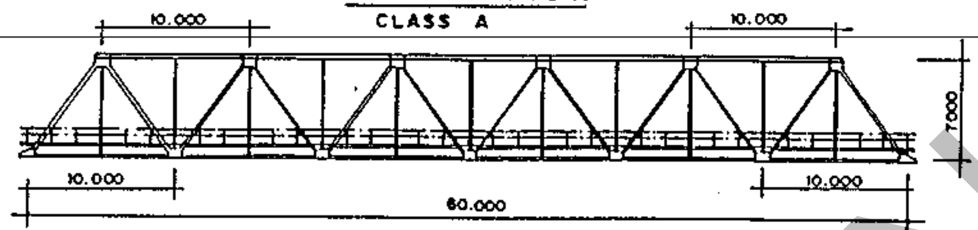


AUSTRALIAN GIRDER BRIDGES - TYPE. G B A

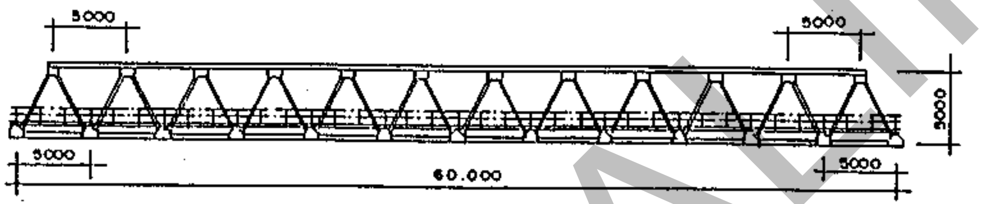
SPANS - 20,25 & 30 M. CLASS A,B & C



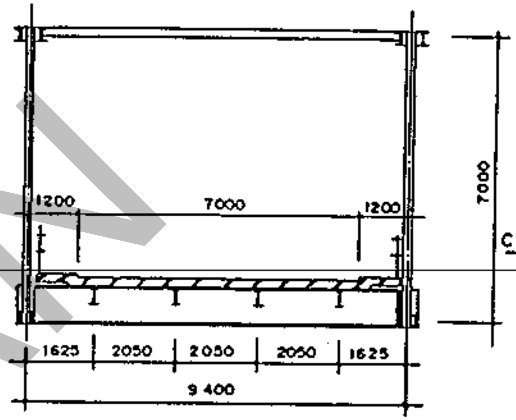
ELEVATION
CLASS A



ELEVATION
CLASS B

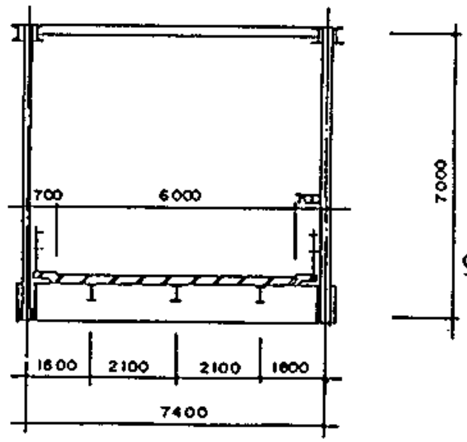


ELEVATION
CLASS C

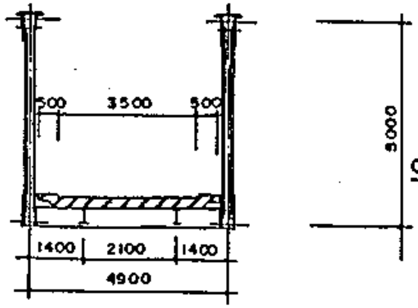


CLASS A

SPAN CROSS SECTION

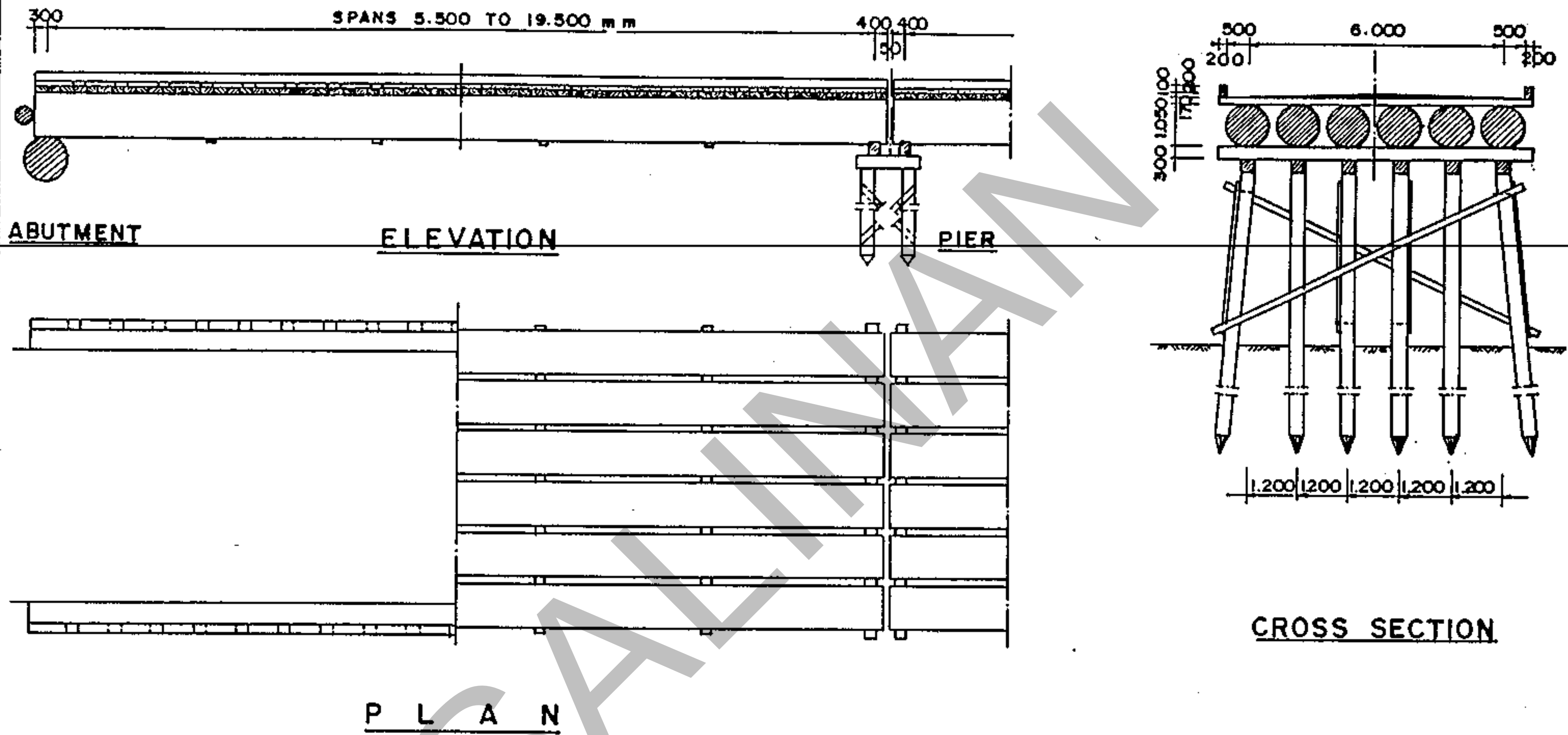


CLASS B



CLASS C

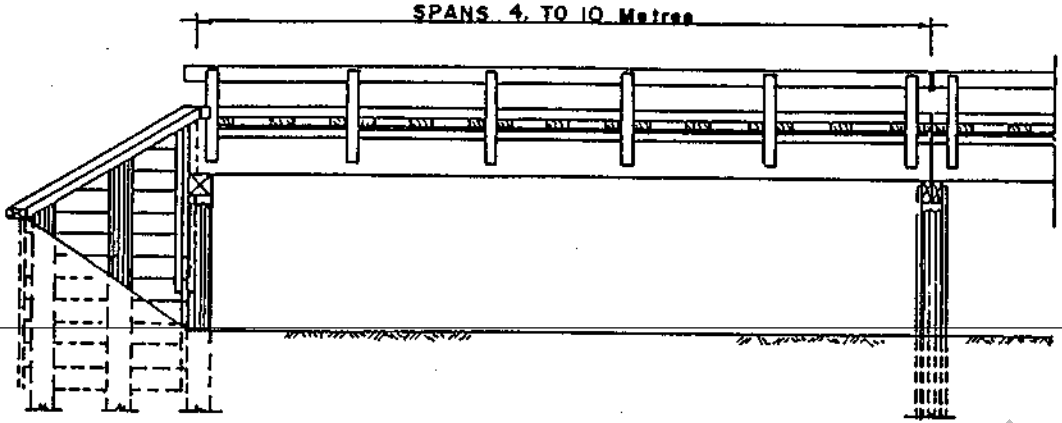
DUTCH TRUSS BRIDGE - TYPE. R B B



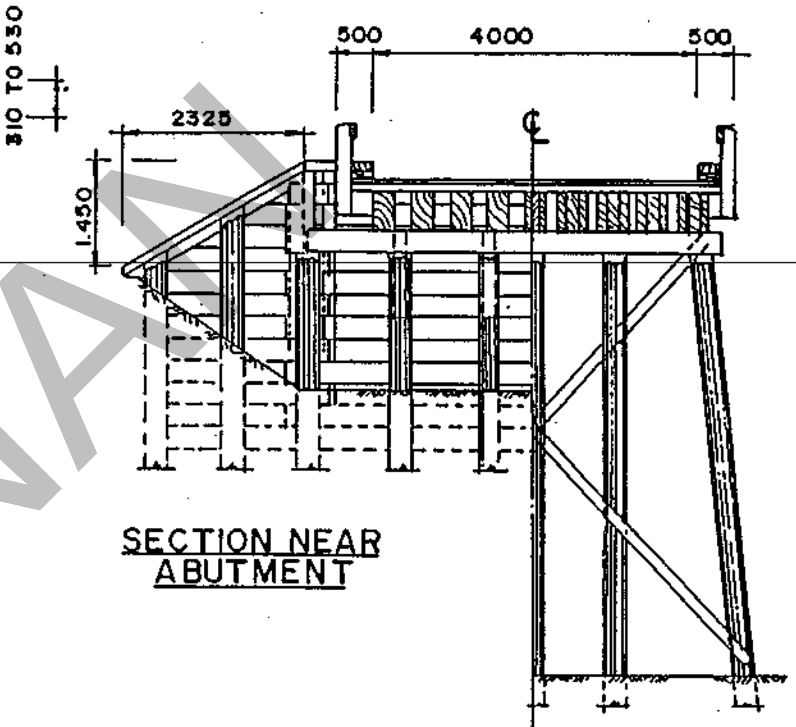
TIMBER BRIDGE - TYPE. G K I

SPANS - 5.500 MM TO 19.500 MM

GIRDER 350 MM TO 1250 MM

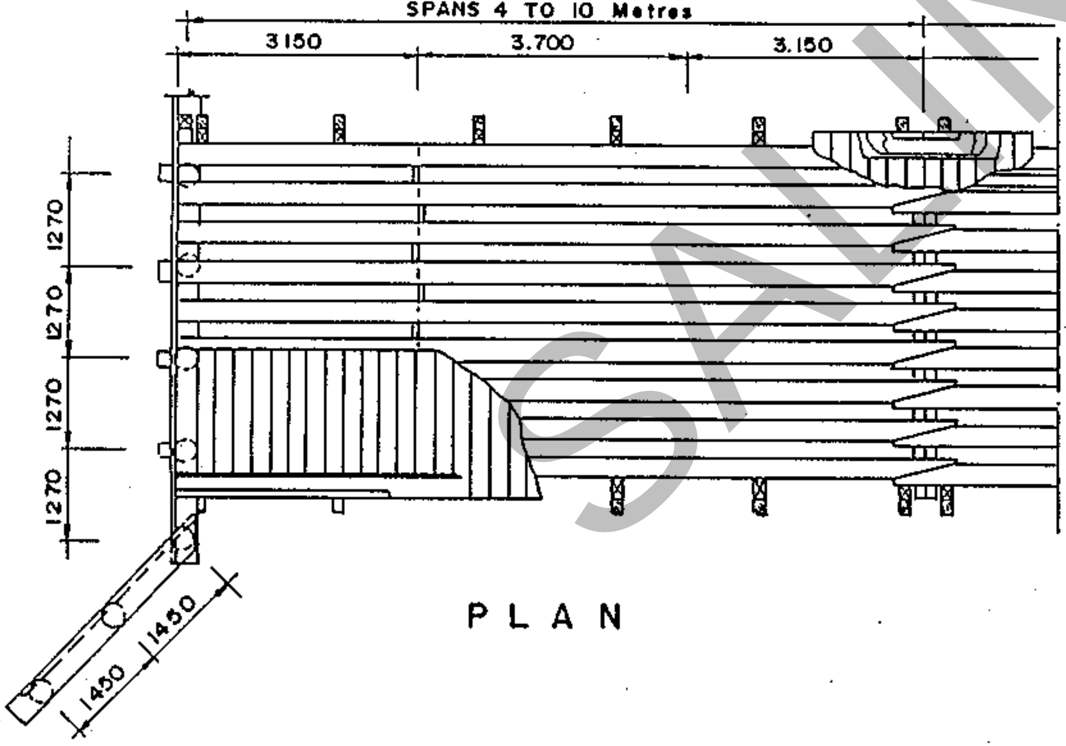


ELEVATION



SECTION NEAR ABUTMENT

SECTION NEAR PIER

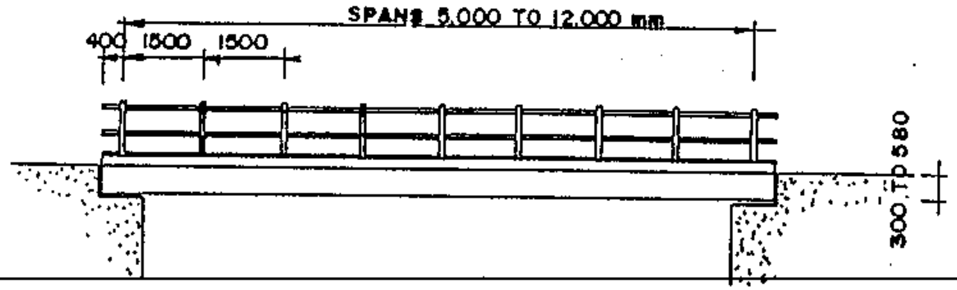


PLAN

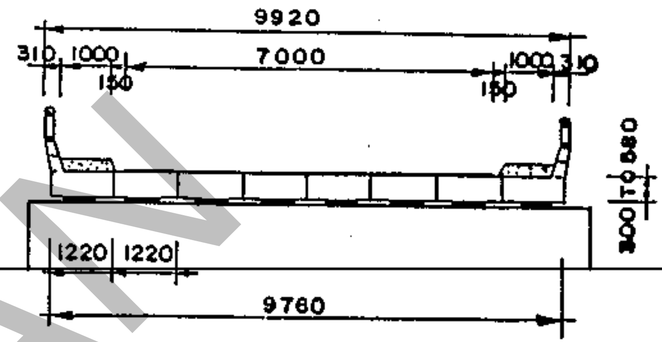
TIMBER BRIDGE - TYPE. G K I

SPANS - 4.000 MM TO 10.000 MM

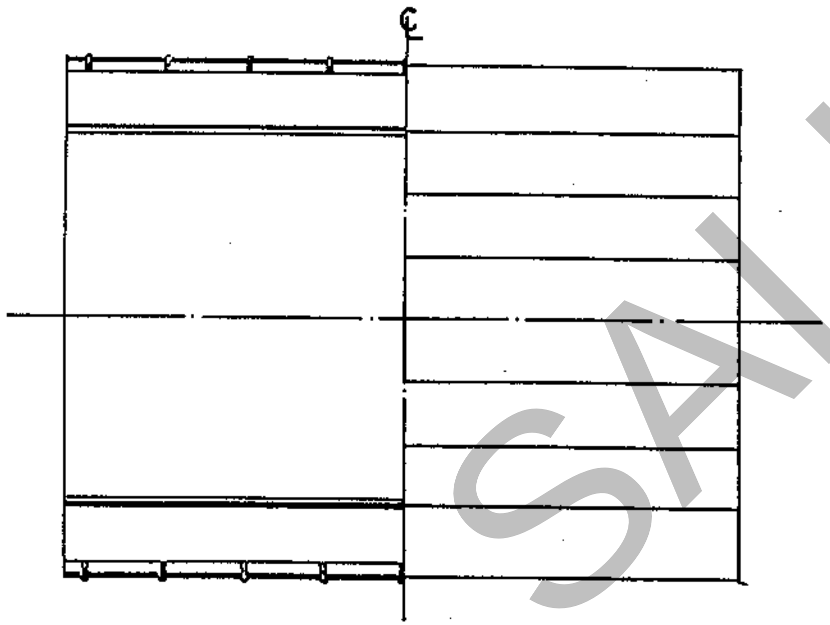
GIRDER 310 MM TO 530 MM



ELEVATION



CROSS SECTION

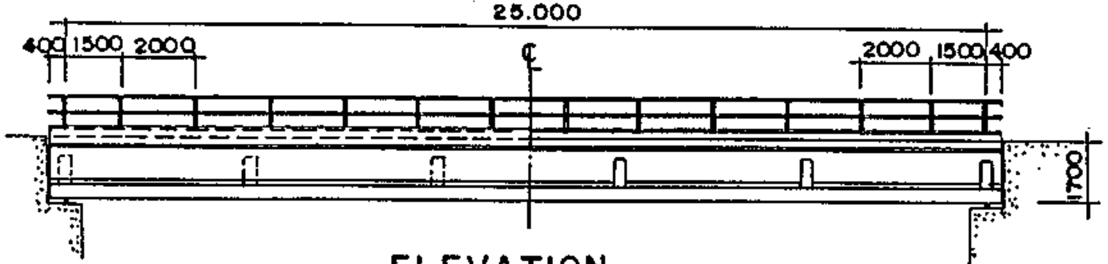


P L A N

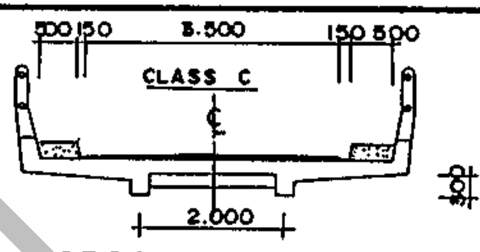
FLAT SLAB BRIDGE - TYPE. P T I

SPANS - 5.000 MM TO 12.000 MM

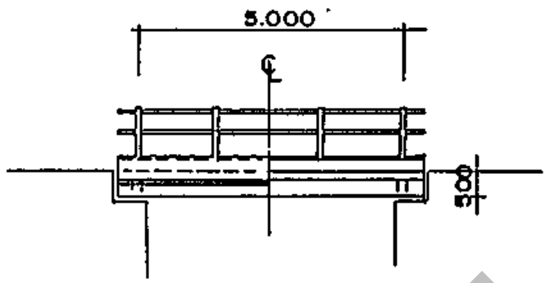
GIRDER 300 MM TO 580 MM



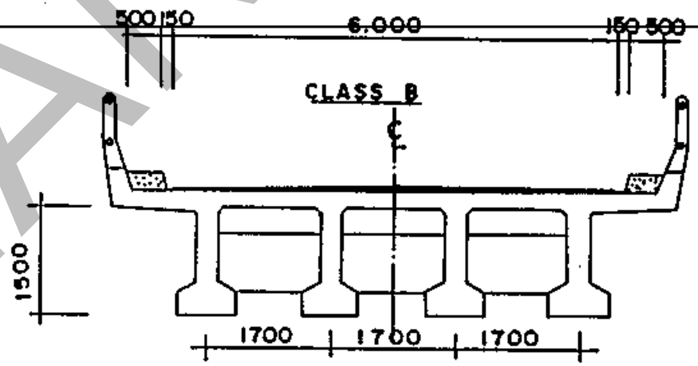
ELEVATION



CROSS SECTION



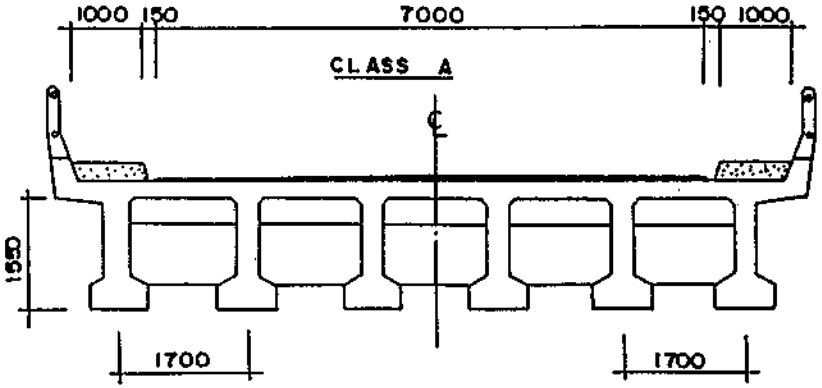
ELEVATION



CROSS SECTION

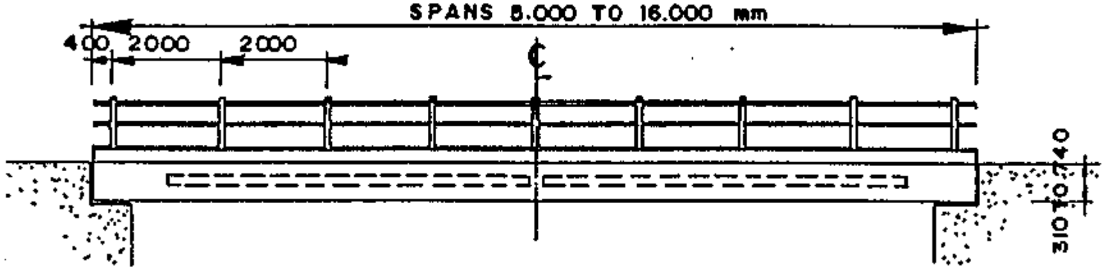
STANDARD PRECAST REINFORCED CONCRETE BEAM BRIDGES - TYPE. G T I

SPANS - 5 M TO 25 M. CLASS A,B & C

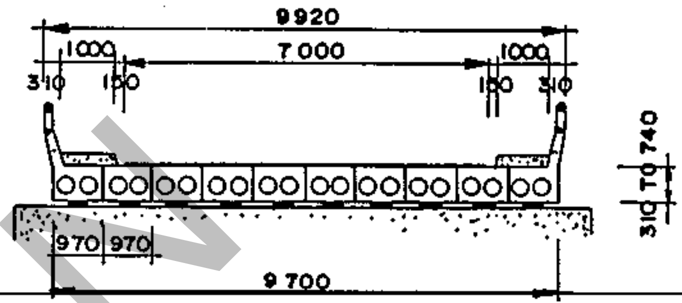


CROSS SECTION

BEAM DEPTH VARIES FROM 300 MM TO 1550 MM

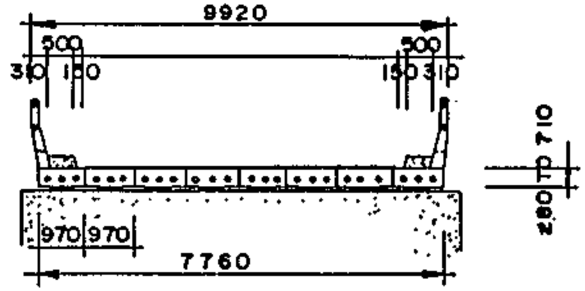


ELEVATION



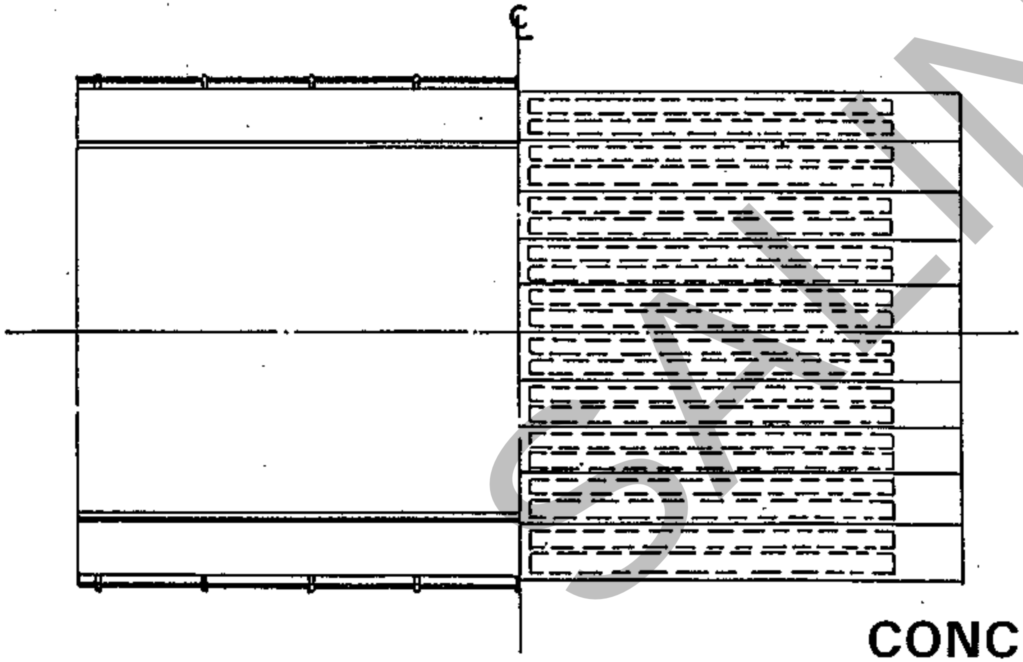
CROSS SECTION

CLASS 'A'



CROSS SECTION

CLASS 'B'



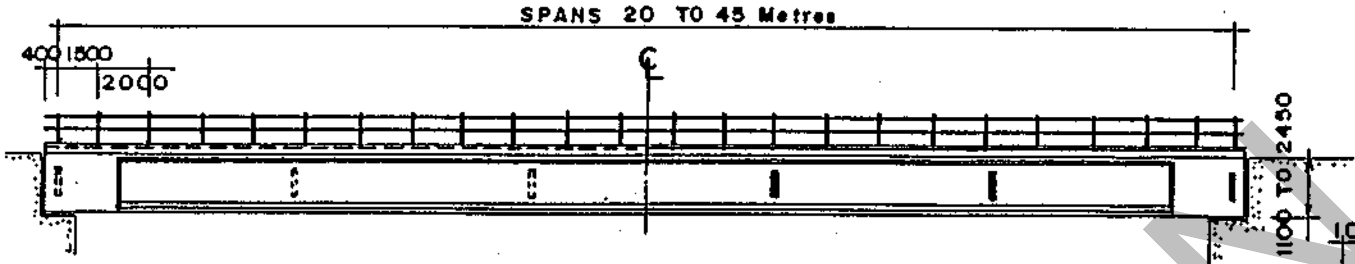
P L A N

CONCRETE SLAB BRIDGES - TYPE. P T I

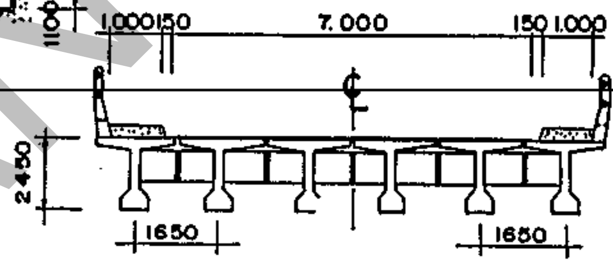
SPANS - 5.000 MM TO 16.000 MM

CLASS 'A' GIRDER 310 MM TO 740 MM

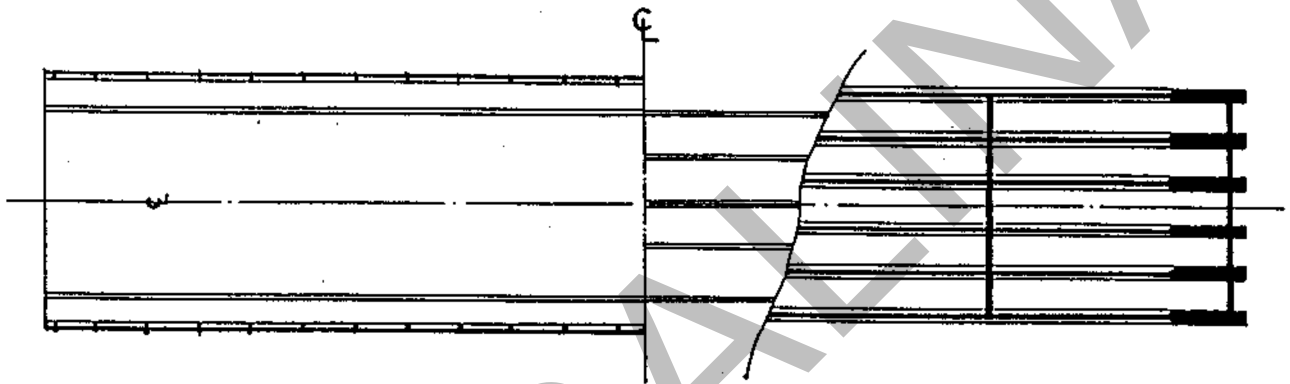
CLASS 'B' GIRDER 280 MM TO 710 MM



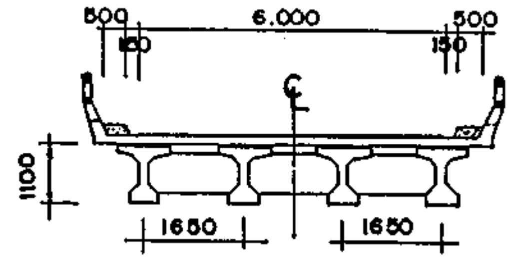
ELEVATION



CROSS SECTION
CLASS 'A'



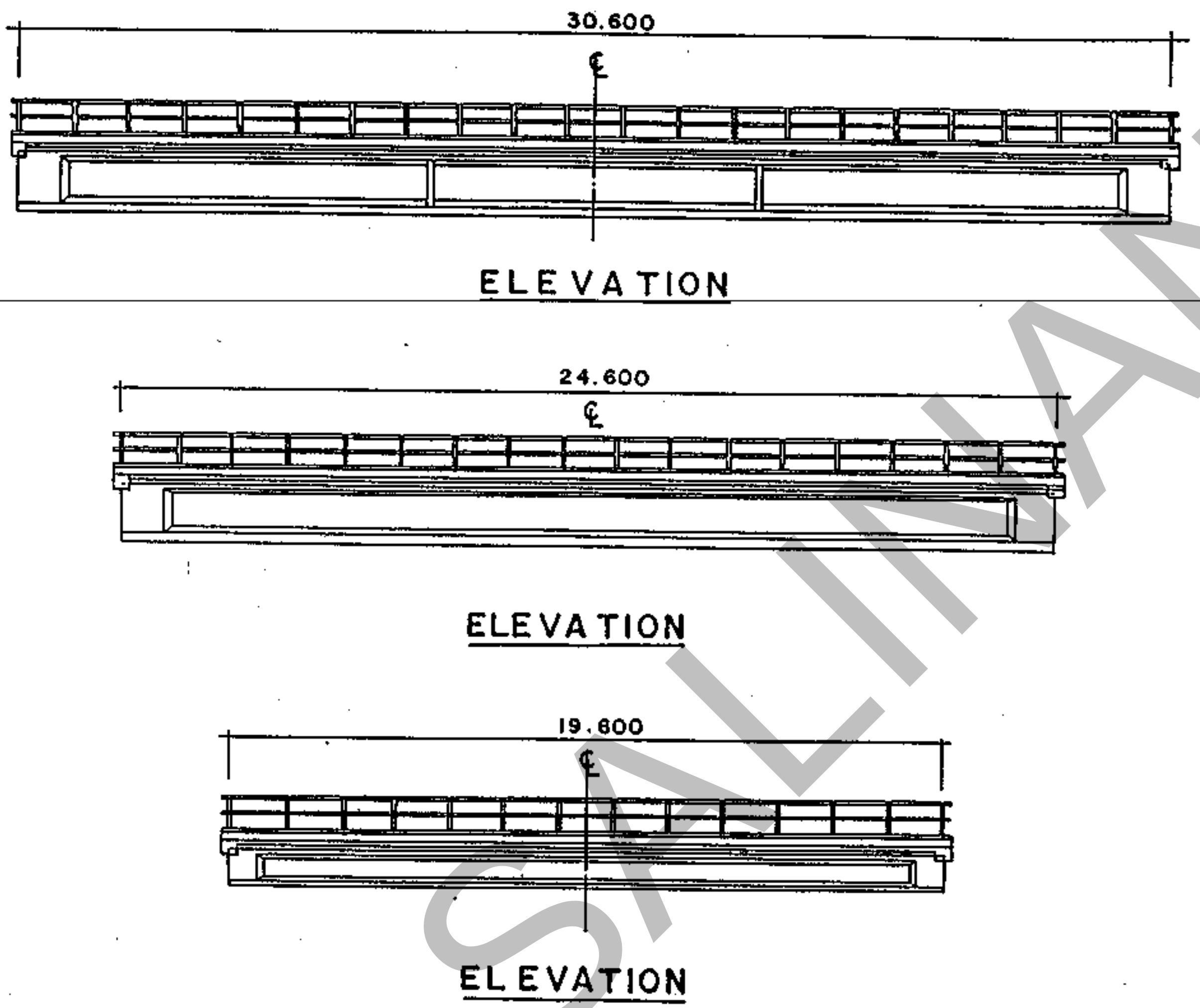
P L A N

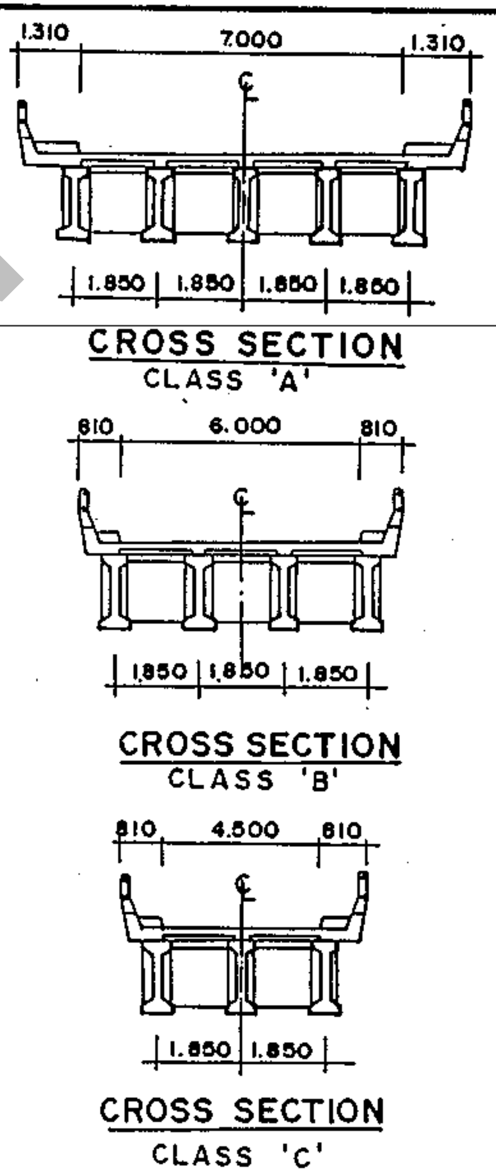


CROSS SECTION
CLASS 'B'

STANDARD PSC BRIDGES - TYPE. G P I

SPANS - 20 M TO 45 M. CLASS A & B

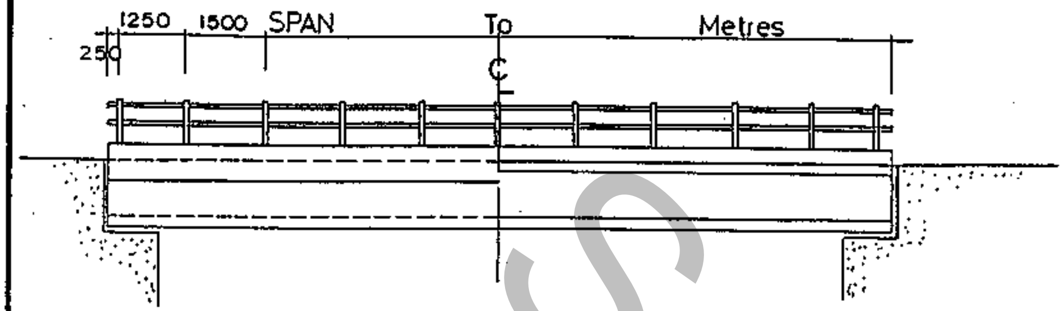




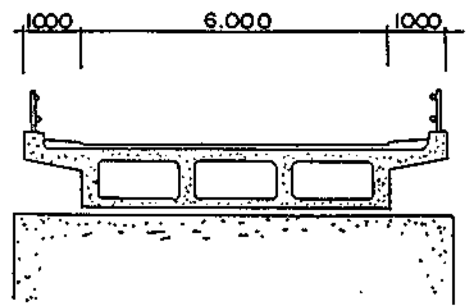
PRECAST POST TENSIONED PSC BEAM TYPE. G P I

SPANS - 13.60 M TO 30.60 M.

BEAM DEPTH VARIES FROM 900 MM TO 1.600 MM



ELEVATION



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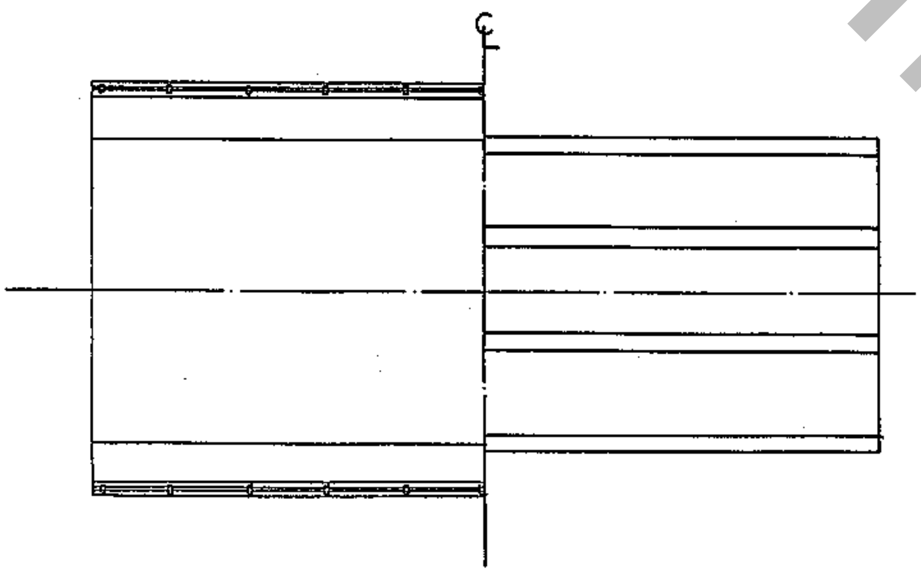
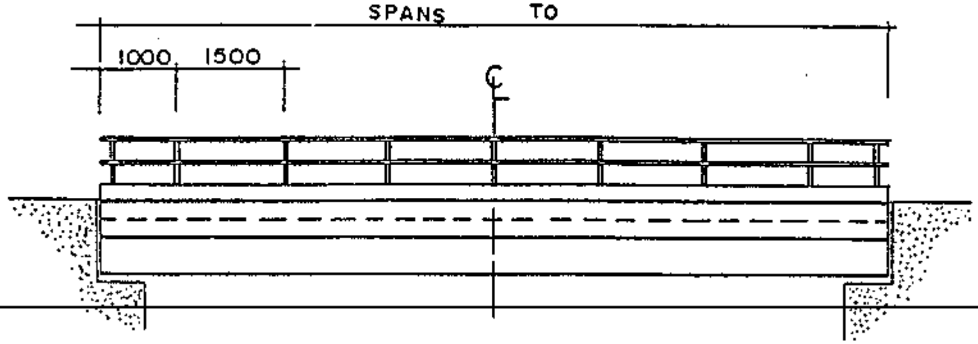


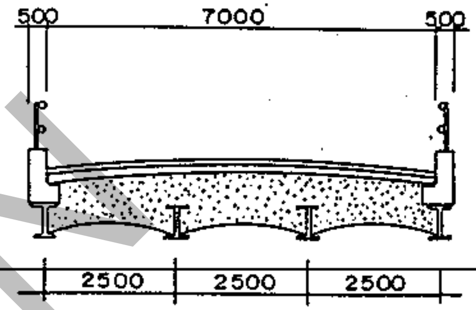
P L A N

INDONESIAN CONCRETE BOX GIRDER BRIDGE - TYPE. G P I

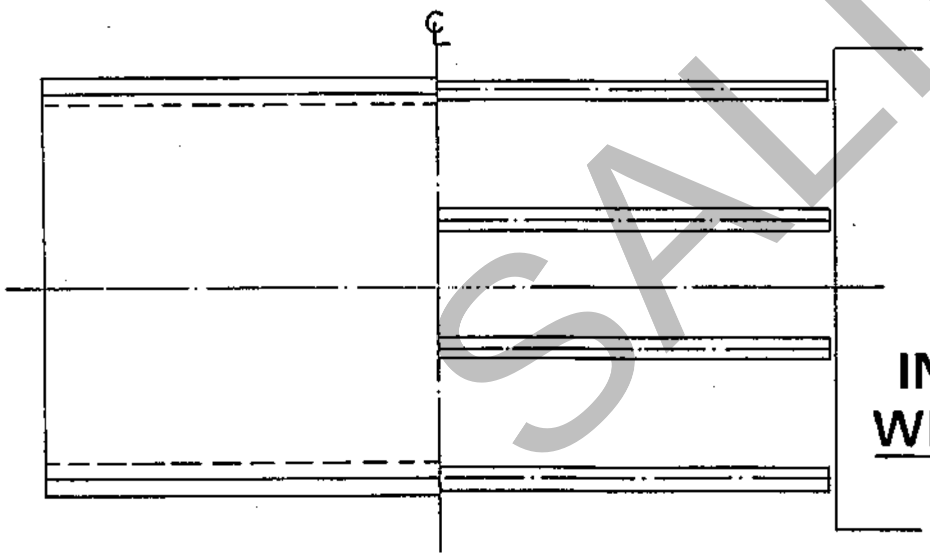
SPANS - MM TO MM



ELEVATION



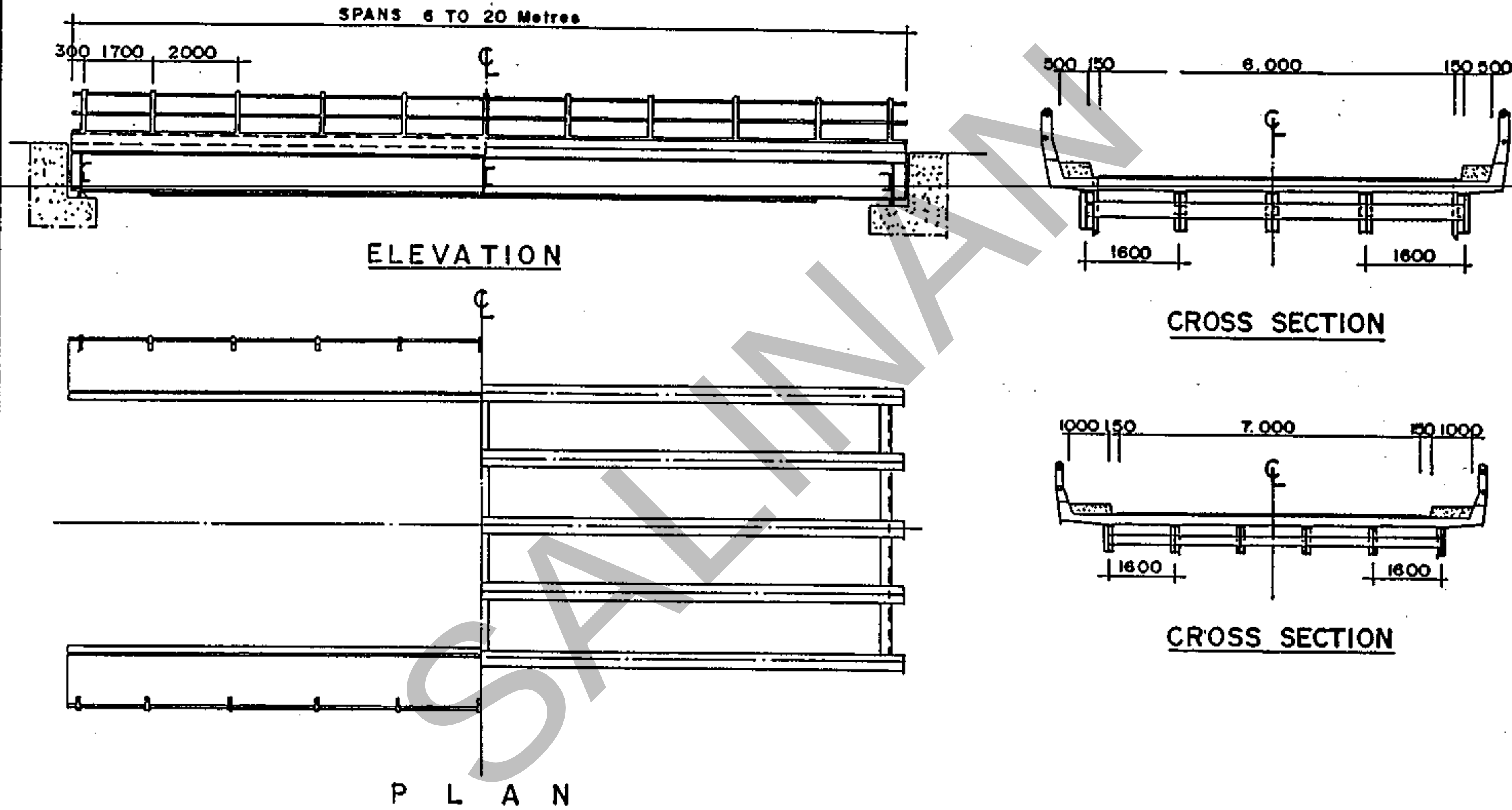
CROSS SECTION



P L A N

INDONESIAN STEEL GIRDER BRIDGE WITH JACK-ARCH DECK - TYPE. G B I

SPANS - MM TO MM . GIRDER - MM TO MM

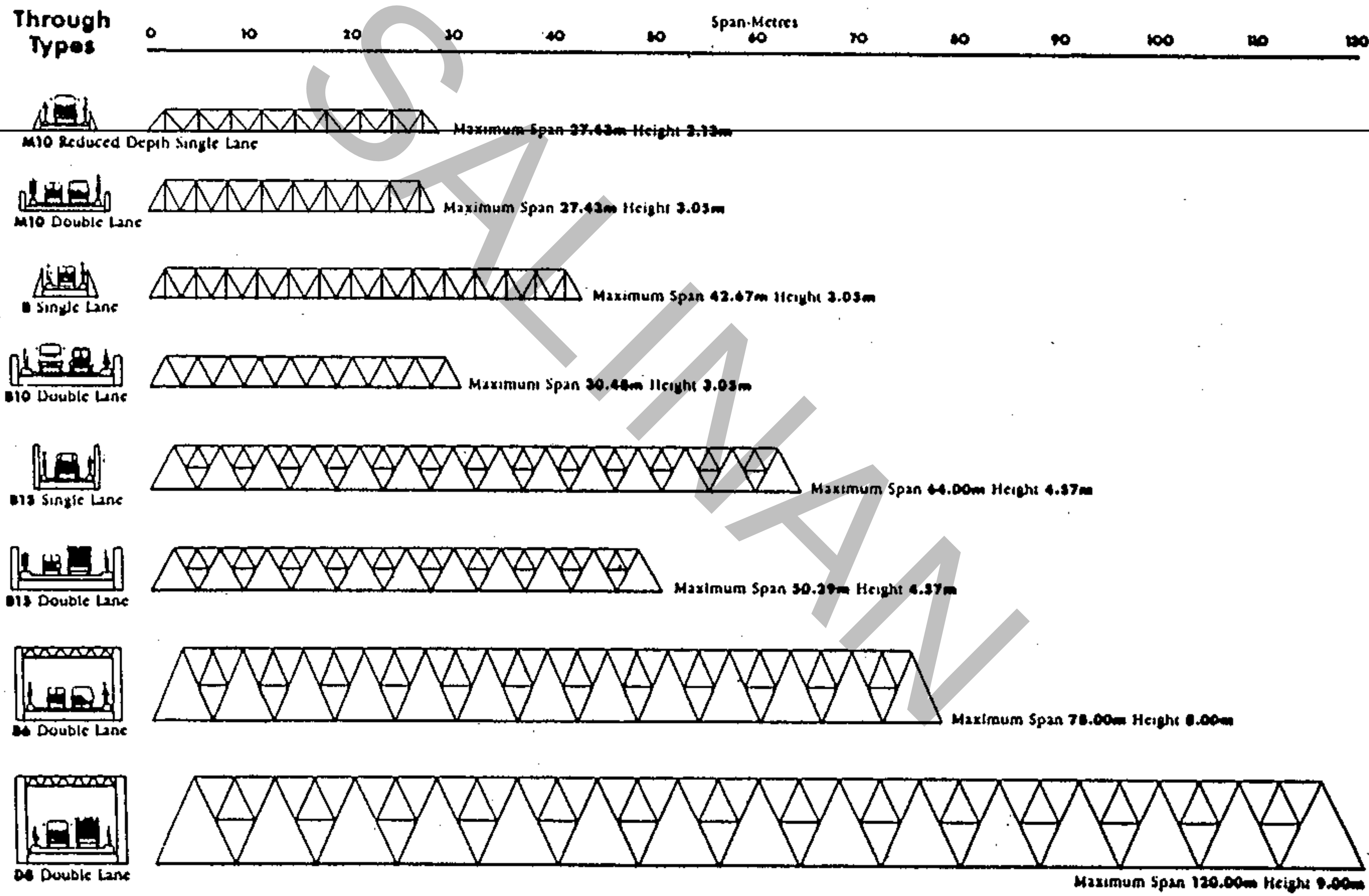


INDONESIAN GIRDER BRIDGES - TYPE. G B I

SPANS - 6 M TO 20 M. CLASS A & B

GIRDER 24 WF 68 TO 33 WF 200

CALLENDER-HAMILTON BRIDGES - TYPE. R B U



CALLENDER - HAMILTON BRIDGE - TYPE. R B U

Panjang teoritis bentang jembatan = panjang tiap panel X jumlah panel.

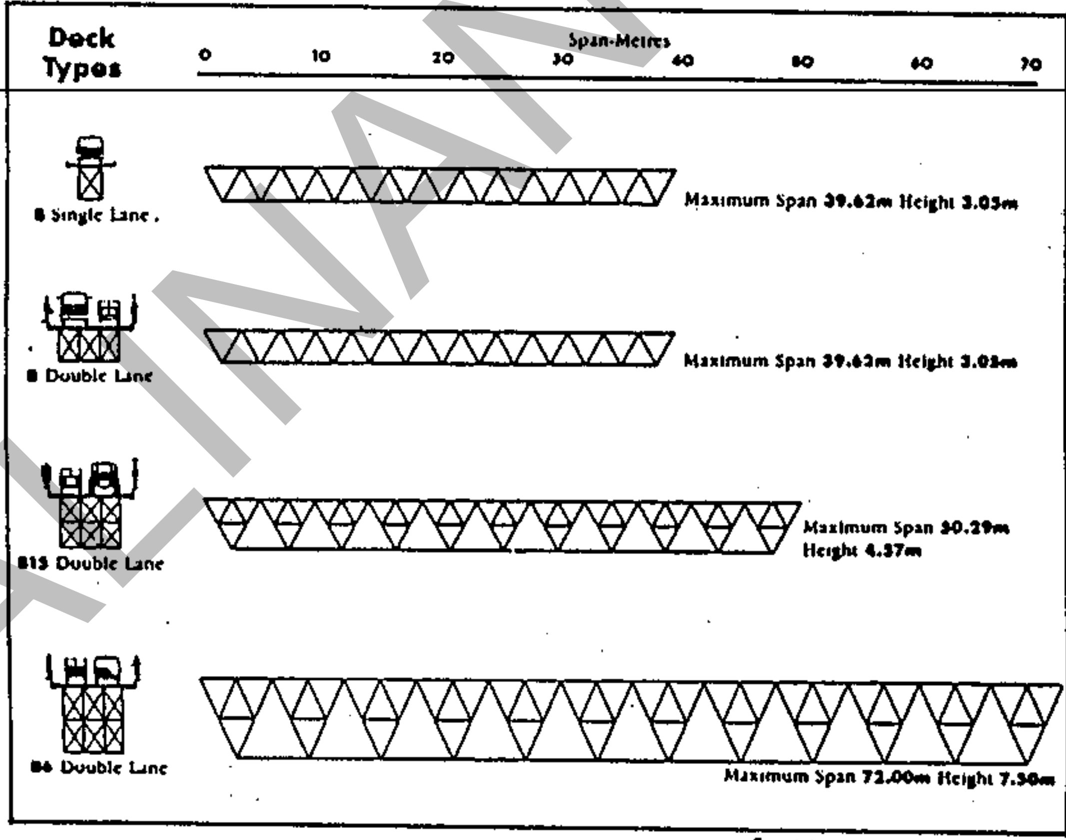
TYPE B : Panjang tiap panel = 3.048 m
Tinggi panel = 3.048 m

TYPE M 10 : Panjang tiap panel = 3.048 meter
Tinggi panel = 3.048 meter

TYPE B 15 : Panjang tiap panel = 4.572 meter
Tinggi panel = 4.572 meter

TYPE B 6 : Panjang tiap panel = 6 meter
Tinggi panel = 8 meter

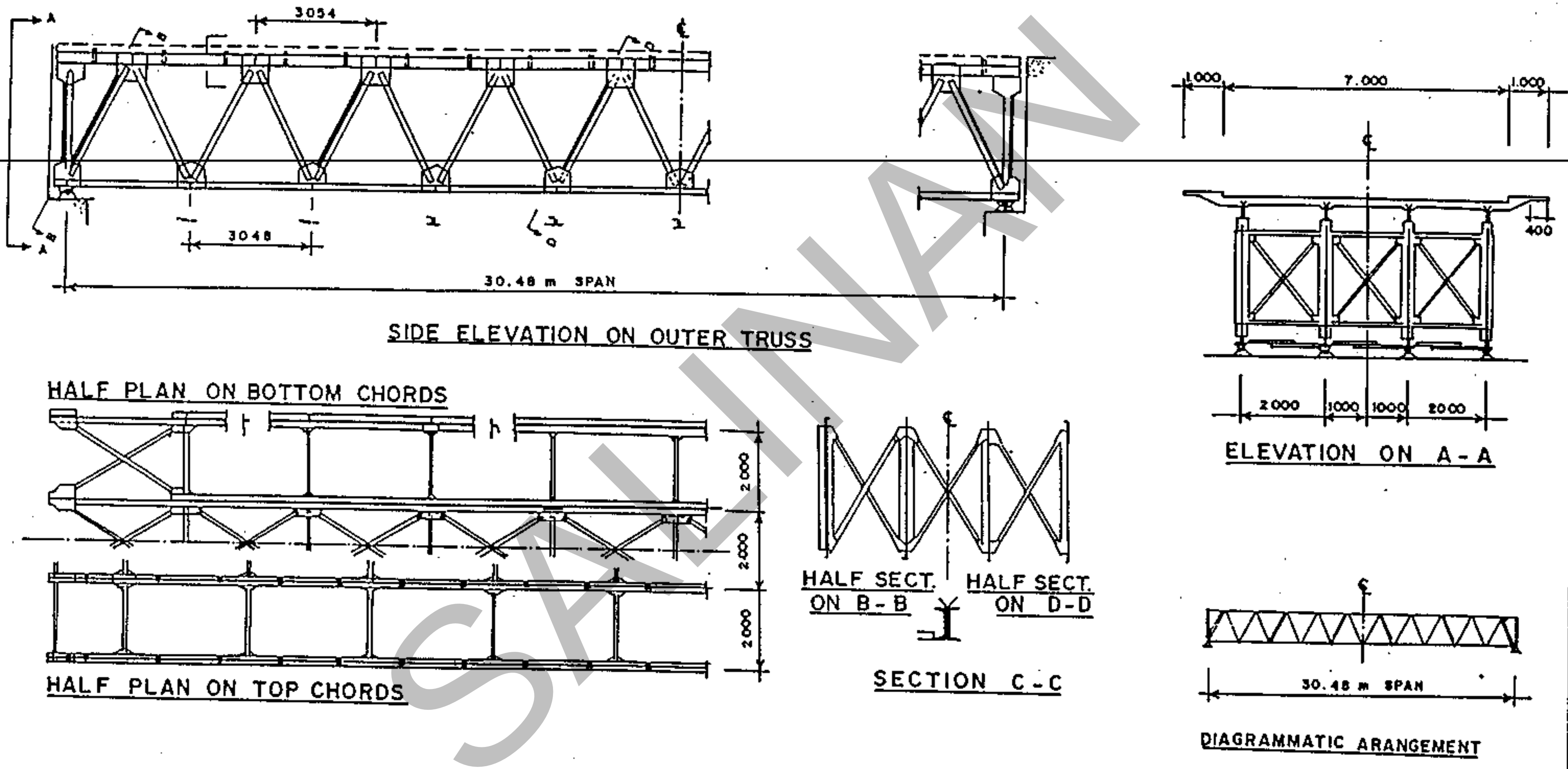
TYPE D 8 : Panjang panel = 8 meter
Tinggi panel = 9 meter



* Untuk lantai beton

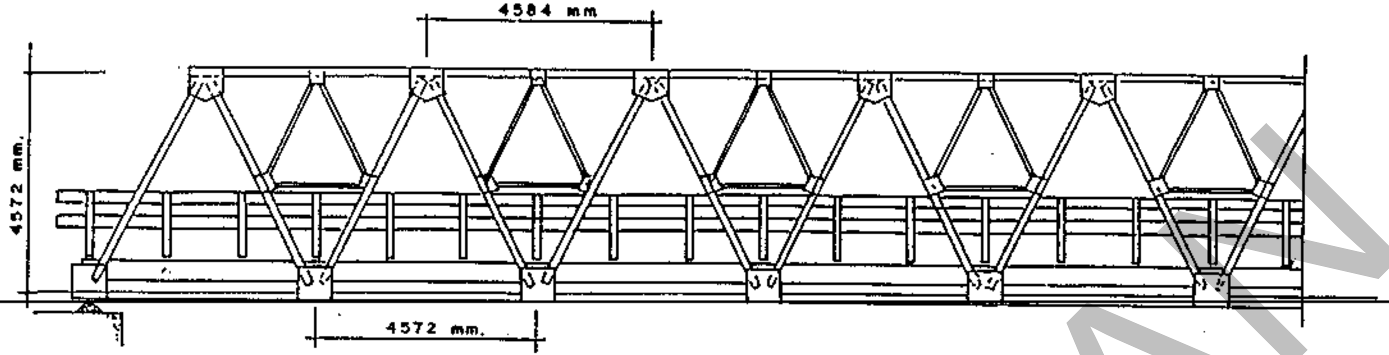
*** LEBAR JALUR LALU LINTAS KENDARAAN :**

Single Lane = 3.50 metre + kerb
Double Lane = 5.50 - 6.0 metre + 0.50 m kerb pada kedua sisi (KLAS B)
Double Lane = 7.0 metre + 1.00 metre trotoir pada kedua sisi (KLAS A)

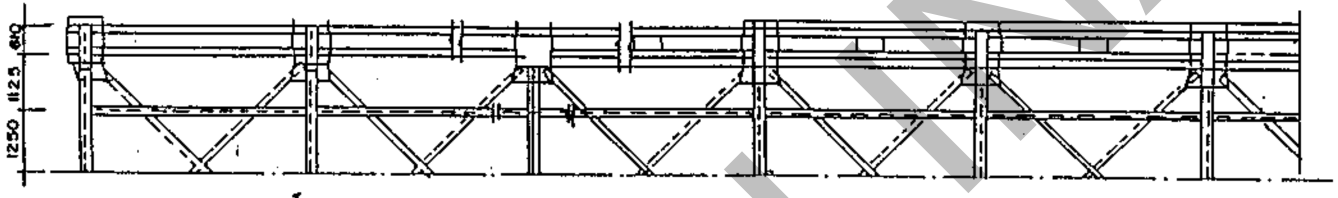


CALLENDER - HAMILTON BRIDGE - TYPE. R B U

TYPE - B DECK SPANS - 30.48 & 39.62 M.

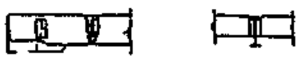


SIDE ELEVATION



PART PLAN ON BOTTOM CHORD

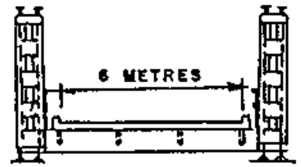
PART PLAN ON TOP CHORD



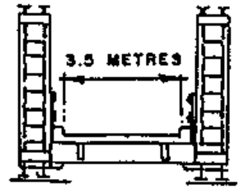
SECTION B-B   SECTION A-A

BINA MARGA LOADING CLASS 'A'
TRUSS LOADING 100 %
DECK LOADING 100 %

BINA MARGA LOADING CLASS 'B'
TRUSS LOADING 70 %
DECK LOADING 100 %

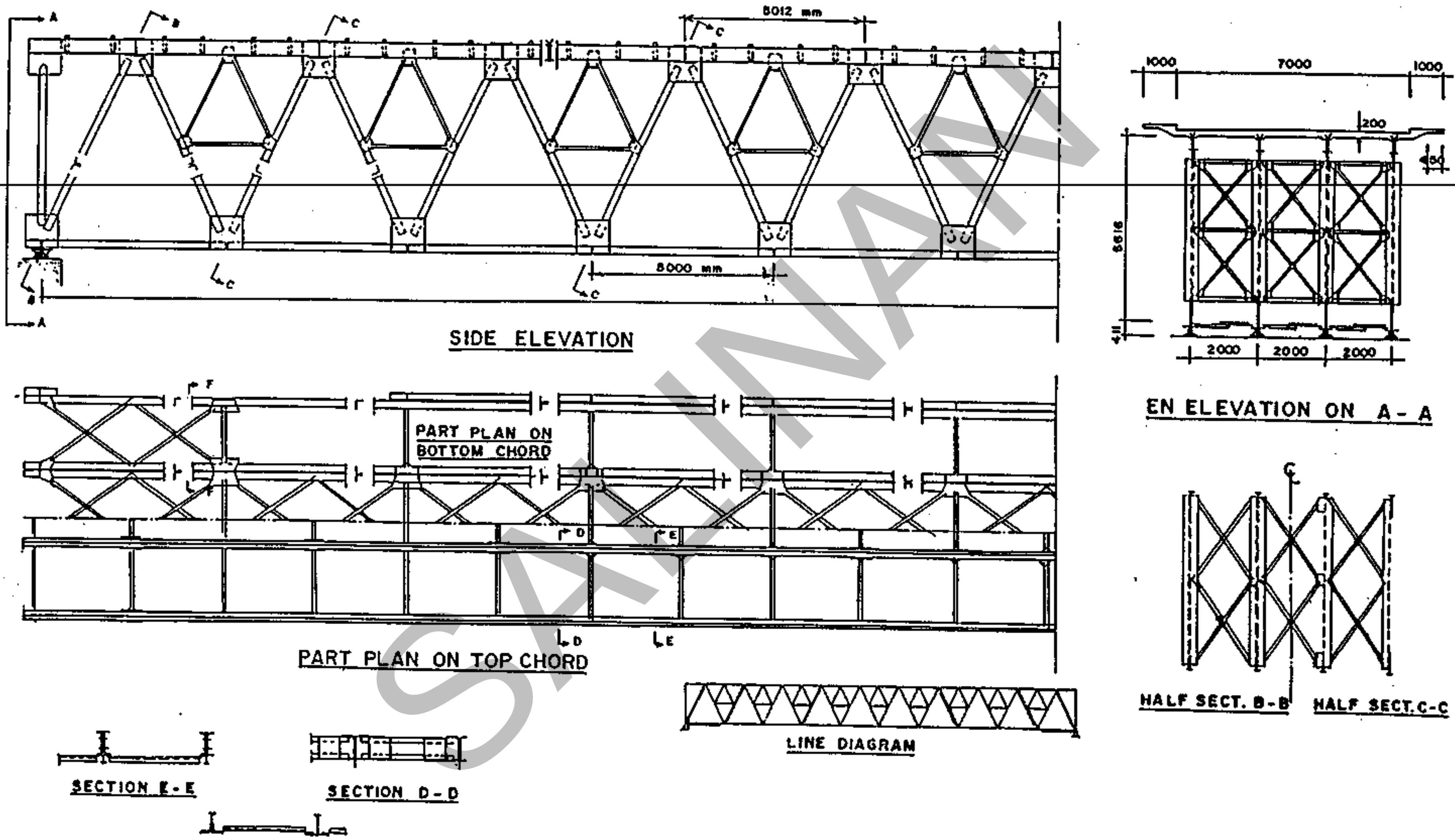


BINA MARGA LOADING CLASS 'C'
TRUSS LOADING 70 %
DECK LOADING 100 %



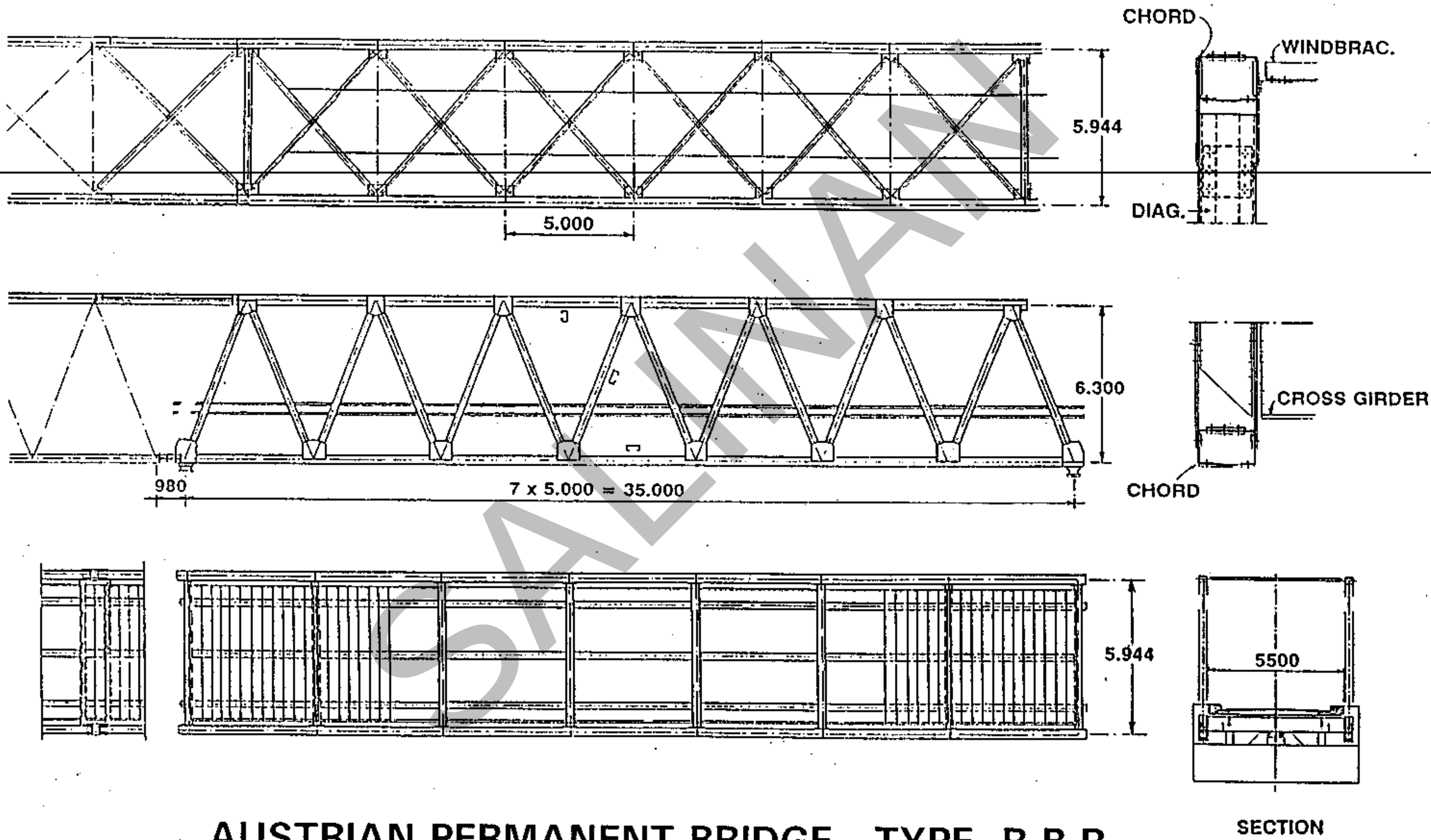
CALLENDER - HAMILTON BRIDGE - TYPE. R B U

TYPE - B15 SPANS - 41.15 M TO 59.44 M.

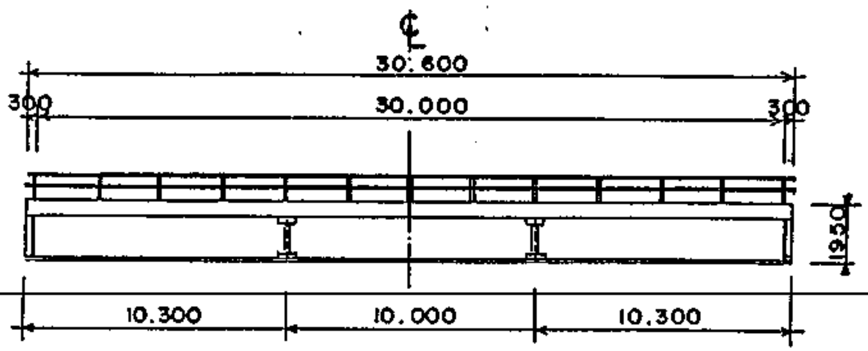


CALLENDER - HAMILTON BRIDGE - TYPE. R B U

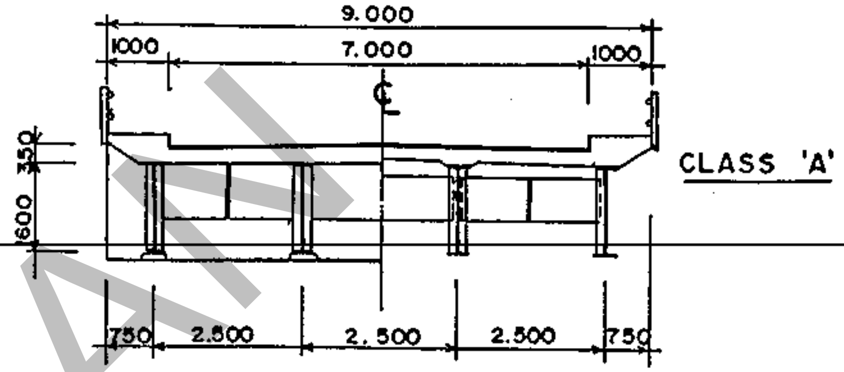
TYPE - D5 DECK SPANS - 50,55 & 70 M.



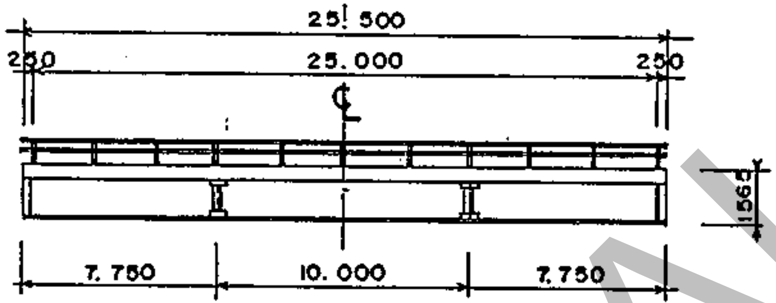
AUSTRIAN PERMANENT BRIDGE - TYPE. R B R



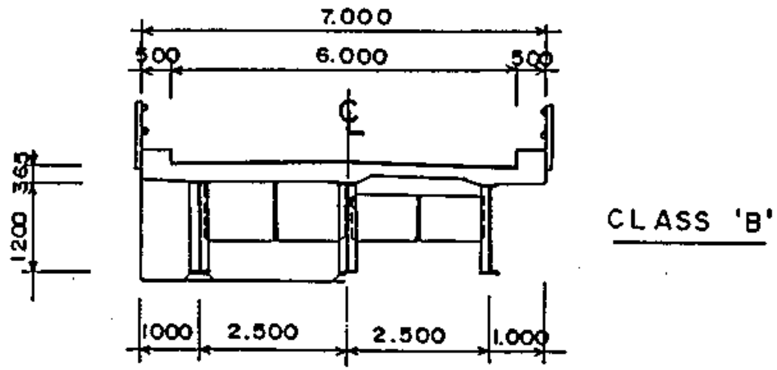
ELEVATION



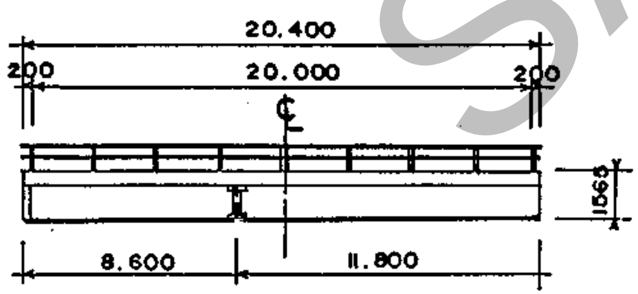
CROSS SECTION



ELEVATION



CROSS SECTION



ELEVATION

JAPAN GIRDER BRIDGES - TYPE. G B J

SPANS - 20,25 & 30 M. CLASS A & B

DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

BRIDGE INSPECTION MANUAL

APPENDIX 4

PHOTOGRAPHS

BRIDGE MANAGEMENT SYSTEM
BMS
A PROJECT JOINTLY FUNDED BY INDONESIA AND AUSTRALIA

FEBRUARY 1993

DOCUMENT No. **BMS2-M.E**

APPENDIX 4

PHOTOGRAPHS

PHOTOGRAPHS

This Appendix includes photographs of various aspects of bridges which illustrate bridge type, components, situations where Emergency Action, minor repairs or Routine Maintenance are required.typical defects, and condition ratings.

The photographs are grouped as follows :

- Crossing types
- Substructures
  - Foundation Types
  - Abutment Types
  - Pier Types
- Superstructures
  - Culverts
  - Suspension Bridge
  - Girders
  - Arches
  - Trusses
- Emergency Action/Repair Work
- Routine Maintenance
- Defects/Condition Ratings

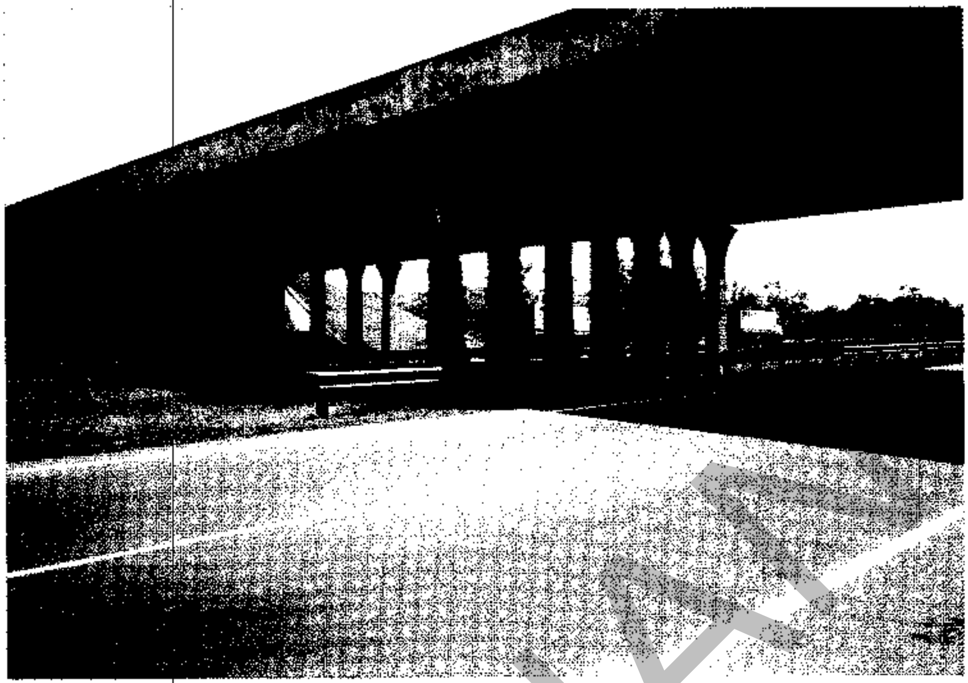


*Figure A4.1 - Crossing Type JN
Road Crossing*

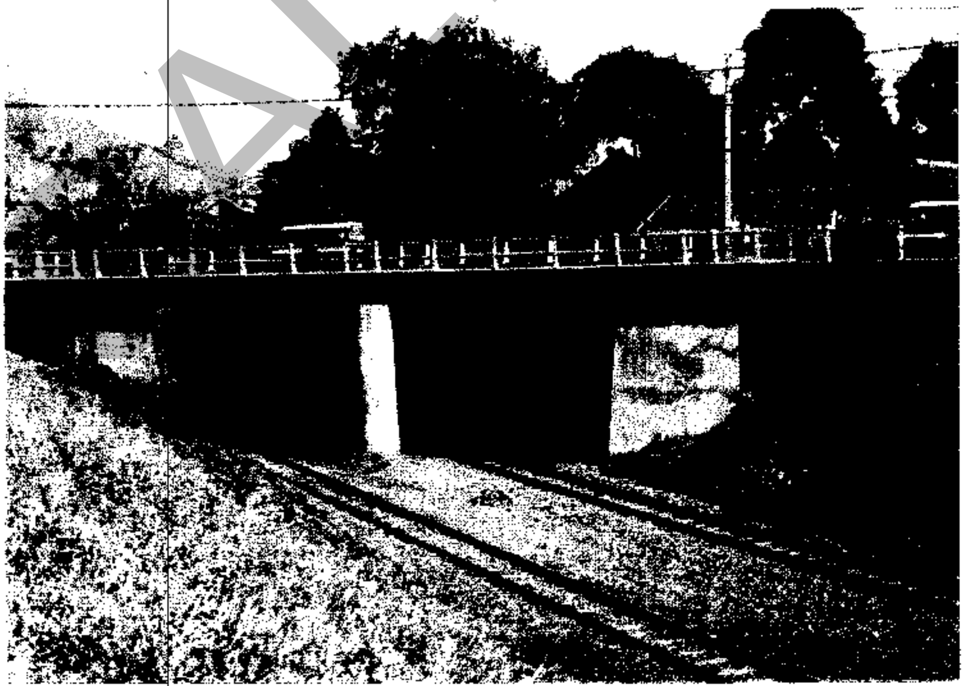


*Figure A4.2 - Crossing Type KA
Railway Crossing*

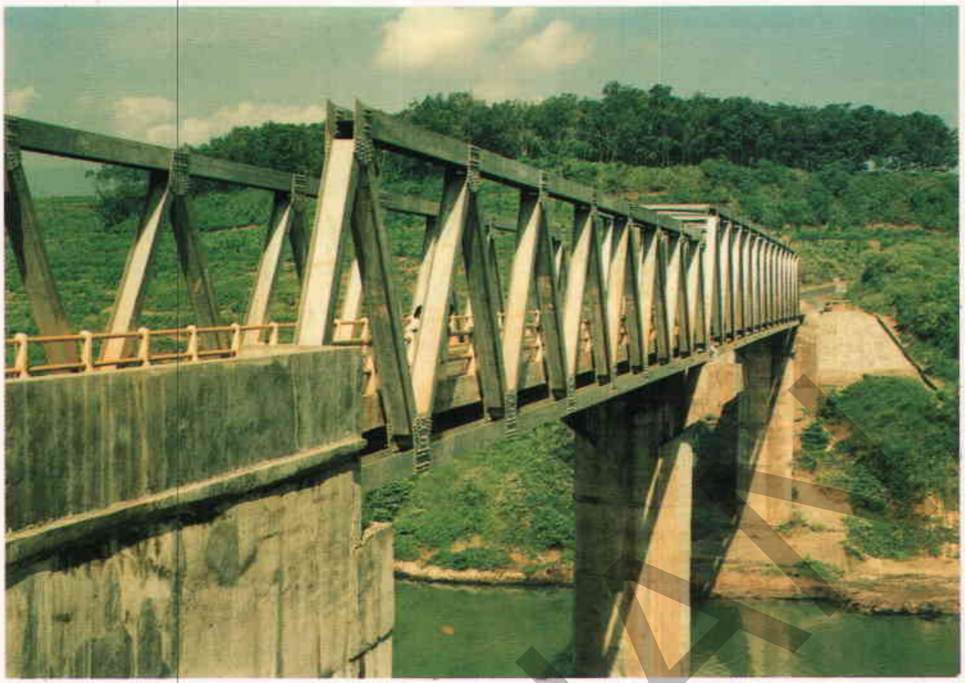


*Figure A4.3 - Crossing Type S
River Crossing*

*Figure A4.4 - Crossing Type S
River Crossing*

Figure A4.5 - Foundation Type T
Driven Pile

Figure A4.6 - Foundation Type SU
Caisson
(Note Excessive Stream Degredation)

Figure A4.7 - Foundation Type TU
Screw Pile

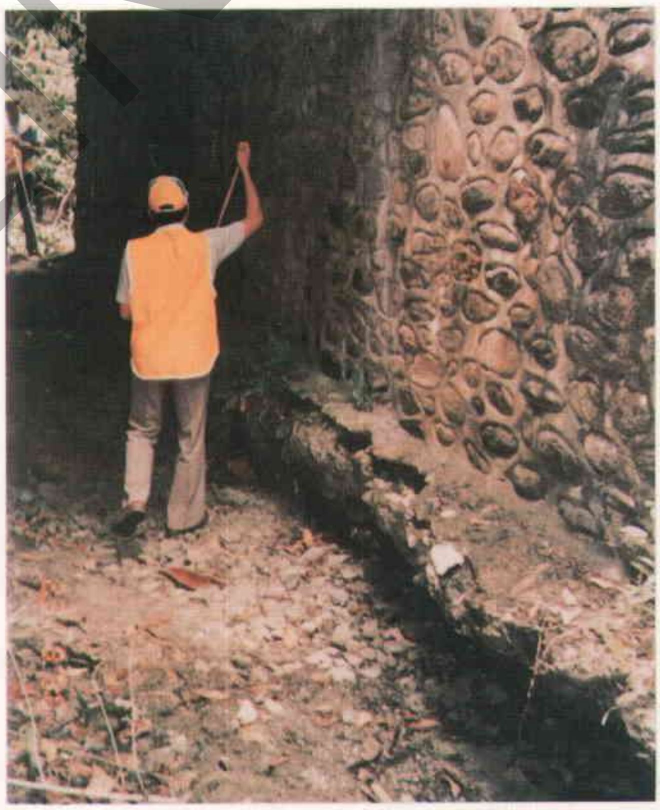


Figure A4.8 - Foundation Type LS
Spread Footing
(Note dangerous scouring)

Figure A4.9 - Abutment Type A
Cap

Figure A4.10 - Abutment Type B
Retaining Wall

***Figure A4.11 - Abutment Type K
Special Abutment***

Figure A4.12 - Pier Type C
Pile Cap

Figure A4.13 - Pier Type P
Solid Wall

*Figure A4.14 - Pier Type S
Single Column*

*Figure A4.15 - Pier Type D
Two Column*

Figure A4.16 - Pier Type T
Three or More Column

Figure A4.17 - Superstructure Type BTI
Indonesian Box Culvert

Figure A4.18 - Superstructure Type YTI
Indonesian Concrete Pipe Culvert

Figure A4.19 - Superstructure Type YBI
Indonesian Steel Pipe Culvert

Figure A4.20 - Superstructure Type ABI
Indonesian Pipe Arch Culvert

Figure A4.21 - Superstructure Type TBI Suspension Bridge

Figure A4.22 - Superstructure Type TBI Suspension Bridge

*Figure A4.23 - Superstructure Type GBJ
Japanese Steel Girder*

*Figure A4.24 - Superstructure Type GBO
Old Dutch Steel Girder*

Figure A4.25 - Superstructure Type GBI
Indonesian Steel Girder (Painted)

Figure A4.26 - Superstructure Type GBL
Canadian Steel Girder
(Heavy Section & Painted)

Figure A4.27 - Superstructure Type GKI Indonesian Timber Girder

Figure A4.28 - Superstructure Type GKI Indonesian Timber Girder

Figure A4.29 - Superstructure Type GTI Indonesian Concrete Girder (Girder Cast on Site)

Figure A4.30 - Superstructure Type GKI Indonesian Concrete Girder

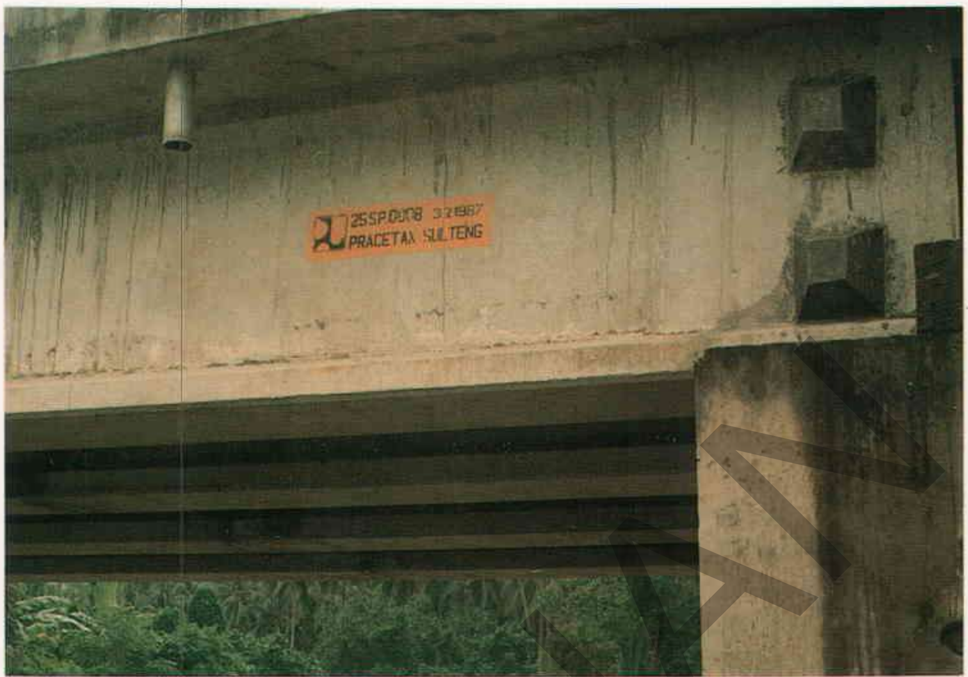


Figure A4.31 - Superstructure Type GPI Indonesian Prestressed Concrete Girder

Figure A4.32 - Superstructure Type LTI
Indonesian Beam Arch (under deck type)

Figure A4.33 - Superstructure Type LTI
Indonesian Beam Arch (under deck type)

Figure A4.34 - Superstructure Type LTI Indonesian Beam Arch (through type)

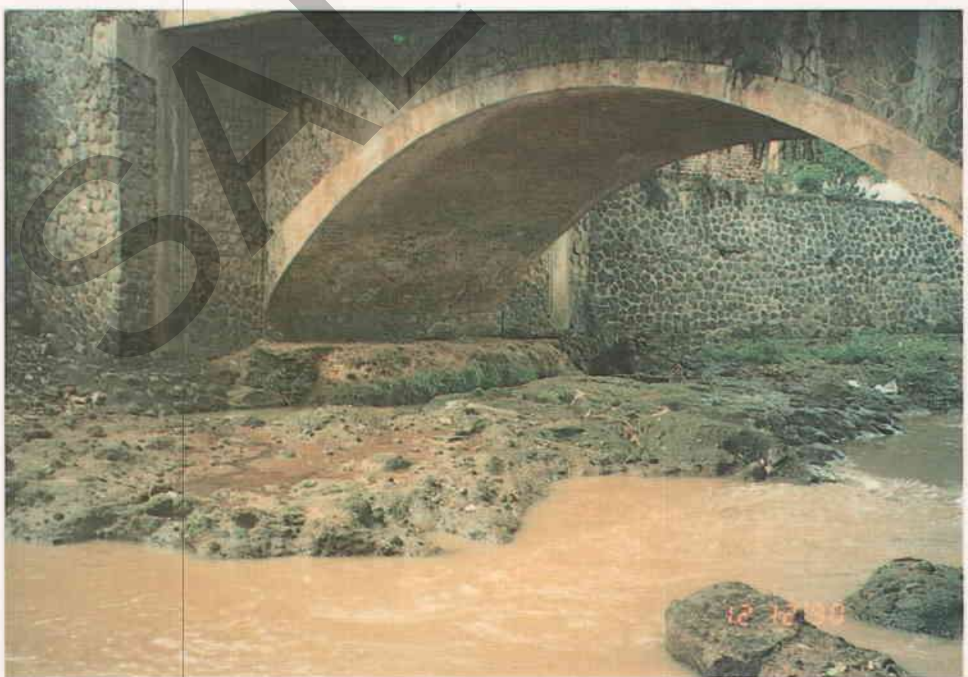


Figure A4.35 - Superstructure Type ETI Indonesian Concrete Arch

*Figure A4.36 - Superstructure Type RBU/SBW
Bailey Type Bridge (Old 1946 Type)*

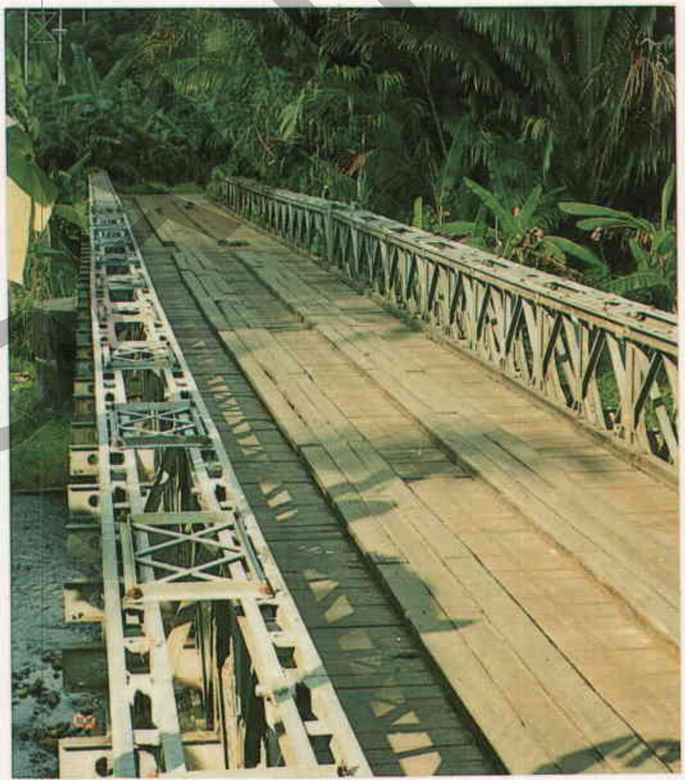


*Figure A4.37 - Superstructure Type RBW/SBW
Bailey Type Bridge Series 100*

Figure A4.38 - Superstructure Type RBW/SBW
Bailey Type Steel Truss Bridge (Acrow Type)

Figure A4.39 - Superstructure Type RBP
Australian Steel Truss (Semi Permanent)

Figure A4.40 - Superstructure Type RBA
Australian Steel Truss

Figure A4.41 - Superstructure Type RBB
New Dutch Steel Truss
(Long Spans with Verticals)

Figure A4.42 - Superstructure Type RBB
New Dutch Steel Truss
(Short Spans with no Verticals)

Figure A4.43 - Superstructure Type RBD
Old Dutch Truss
(Short Spans with no Verticals)

*Figure A4.44 - Superstructure Type RBU
Callender Hamilton Steel Truss (Type C)*

*Figure A4.45 - Superstructure Type RBU
Callender Hamilton Steel Truss (100 mm Special)*

*Figure A4.46 - Superstructure Type RBU
Callender Hamilton Steel Truss (Short Span)*

*Figure A4.47 - Superstructure Type RBU
Callender Hamilton Steel Truss (Deck Type)*

Figure A4.48 - Superstructure Type RBJ
Japanese Steel Truss

Figure A4.49 - Superstructure Type RBL
Russian Steel Truss

Figure A4.50 - Dangerous Walkway
Emergency Action Required

Figure A4.51 - Missing Handrails on Narrow Bridge
Emergency Action Required

Figure A4.52 - Obstruction, Scour and Stream Degradation

Figure A4.53 - Solution - Bottom Controller Constructed and Stream Bed Returns to Original Bed Level

Figure A4.54 - Dangerous Deck Condition
Emergency Action Required

Figure A4.55 - Dangerous Deck Condition
Emergency Action Required

Figure A4.60 - Damaged Truss Vertical Strengthened

Figure A4.61 - Extra Girder Used to Redistribute Load Across Damaged Truss Section

Figure A4.62 - Temporary Props under Weak Timber Girder

Figure A4.63 - Diagonal of RBU Truss Damaged by Impact

Figure A4.64 - Unsecured Hangers on Suspension Bridge Emergency Action Required

Figure A4.65 - Sheet Piles Constructed to Prevent Scouring of Abutment

Figure A4.66 - Rubbish and Debris Need Removal
Routine Maintenance Required

Figure A4.67 - Rubbish in Bottom Chord of Truss can accelerate corrosion
Routine Maintenance Required

Figure A4.68 - Excessive Vegetation causing cracking of masonry
Routine Maintenance Required

Figure A4.69 - Example of Good Routine Maintenance
Keeping the Anchor Area at a Suspension Bridge Clean

Figure A4.70 - Dirty Crossheads and Bearings Routine Maintenance Required

Figure A4.71 - Excessive Vegetation in Trusses Routine Maintenance Required

Figure A4.72 - Debris needs to be cleared

Figure A4.73 - Debris needs to be cleared

Figure A4.74 - Potholed Deck needs minor repairs

Figure A4.75 - Example of Good Routine Maintenance with Well Maintained Timber Deck Planks

Figure A4.76 - Pot Hole in Deck and Dirt and Vegetation along Kerb needs minor repairs and cleaning

Figure A4.77 - Poor Deck Drainage Routine Maintenance Required

Figure A4.78 - Minor Repairs to Handrails Required

Figure A4.79 - Poor Bridge Approach Drainage Causing Scouring

Figure A4.80 - Axle Load Sign in Poor Condition Routine Maintenance Required

Figure A4.81 - Width Gauge Damaged by Impact

Figure A4.82 - General Degrading of Stream Bed

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.212	*Main Channel*	*503*	*Scour*											*1*	*1*	*1*	*0*	*0*	*3*

Figure A4.83 - Scouring of Foundation causing abutment to settle
Deck is unsupported at both abutments

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.212	*Main Channel*	*503*	*Scour*											*1*	*1*	*1*	*0*	*1*	*4*
4.323	*Abutment*	*551*	*Movement*											*1*	*1*	*1*	*1*	*1*	*5*

Figure A4.84 - Scour at Abutment 1

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)					Condition Mark						Condition Mark					
				A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.212	*Main Channel*	*503*	*Scour*	*A1*	-	*2*	-	*1*	*1*	*1*	*0*	*1*	*4*	*1*	*1*	*0*	*0*	*1*	*3*
4.224	*Beaching*	*103*	*Broken Masonry*	*A1*	-	*2*	-	*1*	*1*	*1*	*0*	*1*	*4*	*1*	*1*	*0*	*0*	*1*	*3*

Figure A4.85 - Foundation Settlement at Pier

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.311	*Piles*	*551*	*Settlement*	*P1*	-	-	-	*1*	*1*	*1*	*1*	*1*	*5*	*1*	*1*	*0*	*1*	*1*	*4*

Figure A4.86 - River Bed Degraded Exposing the Caissons and Affecting Stability

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.212	*Main Channel*	*503*	*Scour*											*1*	*1*	*1*	*0*	*1*	*4*

Figure A4.87 - All Columns in Pier 6 Extensively Cracked

Defective Element		Defect		Location				Level 5						Level 3 - 4					
								Condition Mark						Condition Mark					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.322	*Column*	*202*	*Cracking*	*P6*				*1*	*1*	*1*	*0*	*0*	*3*	*1*	*1*	*0*	*0*	*0*	*2*

Figure A4.88 - Missing Earthquake Restraint at Abutment 2

Defective Element		Defect		Location				Level 5						Level 3 - 4					
								Condition Mark						Condition Mark					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.326	*E/Q Restraint*	*561*	*Missing*	*A2*	-	-	-	*1*	*1*	*1*	*1*	*0*	*4*	*1*	*1*	*0*	*1*	*0*	*3*

Figure A4.89 - Bridge Circlip Missing at 5th Panel on Chord on Left Side of Bridge

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	Condition Mark S	R	K	F	P	NK	Condition Mark S	R	K	F	P	NK
4.455	*Circlip*	*305*	*Circlip Missing*	*B1*	*5*	*1*	*1*	*1*	*1*	*1*	*0*	*0*	*3*	*1*	*1*	*0*	*0*	*0*	*2*

Figure A4.90 - Missing Gusset Plate

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.469	*Gusset Plate*	*305*	*Missing*	*B1*	*1*	*2*	*2*	*1*	*1*	*0*	*1*	*0*	*3*	*1*	*1*	*0*	*0*	*0*	*2*

Figure A4.91 - Bridge collapsed due to fire

Defective Element		Defect		Location				Level 5 Condition Mark						Level 3 - 4 Condition Mark					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
3.450	*Truss*	*303*	*Deformed*											*1*	*1*	*1*	*1*	*1*	*5*

Figure A4.92 - Concrete girder system all in poor condition due to very poor quality concrete

Defective Element		Defect		Location				Level 5						Level 3 - 4					
								Condition Mark						Condition Mark					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
3.410	Girder System	201	Poor Quality											1	1	1	0	0	3

Figure A4.93 - All Concrete Girders with Extensive Spalling

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
3.410	*Girder System*	*201*	*Spalling*											*1*	*1*	*1*	*0*	*0*	*3*

Figure A4.94 - Surface Protection Lost and Minor Corrosion of Steel on the Entire Girder System

Defective Element		Defect		Location				Level 5						Level 3 - 4					
								Condition Mark						Condition Mark					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
3.410	*Girder System*	*301*	*Surface Protection*											*1*	*1*	*1*	*0*	*0*	*3*
3.410	*Girder System*	*302*	*Corrosion*											*1*	*0*	*1*	*0*	*0*	*2*

Figure A4.95 - Collapsed Girder

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	Condition Mark S	R	K	F	P	NK	Condition Mark S	R	K	F	P	NK
4.411	*Girder*	*402*	*Collapsed*	*B1*	-	*2*	-	*1*	*1*	*1*	*1*	*0*	*4*	*1*	*1*	*0*	*0*	*0*	*2*

Figure A4.96 - Scuppers too short directing water onto girder

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.507	*Scupper*	*306*	*Too Short*											*1*	*0*	*1*	*0*	*1*	*3*

Figure A4.97 - Blocked Scuppers Causing Flooding on Deck

Defective Element		Defect		Location				Level 5						Level 3 - 4					
								Condition Mark						Condition Mark					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.507	*Scupper*	*711*	*Blocked*											*1*	*1*	*0*	*1*	*1*	*4*

Figure A4.98 - Extensively Cracked Deck

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.502	*Deck Slab*	*202*	*Cracking*	*B1*				*1*	*1*	*0*	*1*	*1*	*4*	*1*	*1*	*0*	*1*	*1*	*4*

Figure A4.99 - All Steel Deck Stingers Corroded in Span 1

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.224	*Deck Stringer*	*302*	*Corrosion*	*B1*				*1*	*1*	*1*	*0*	*1*	*4*	*1*	*1*	*1*	*0*	*0*	*3*

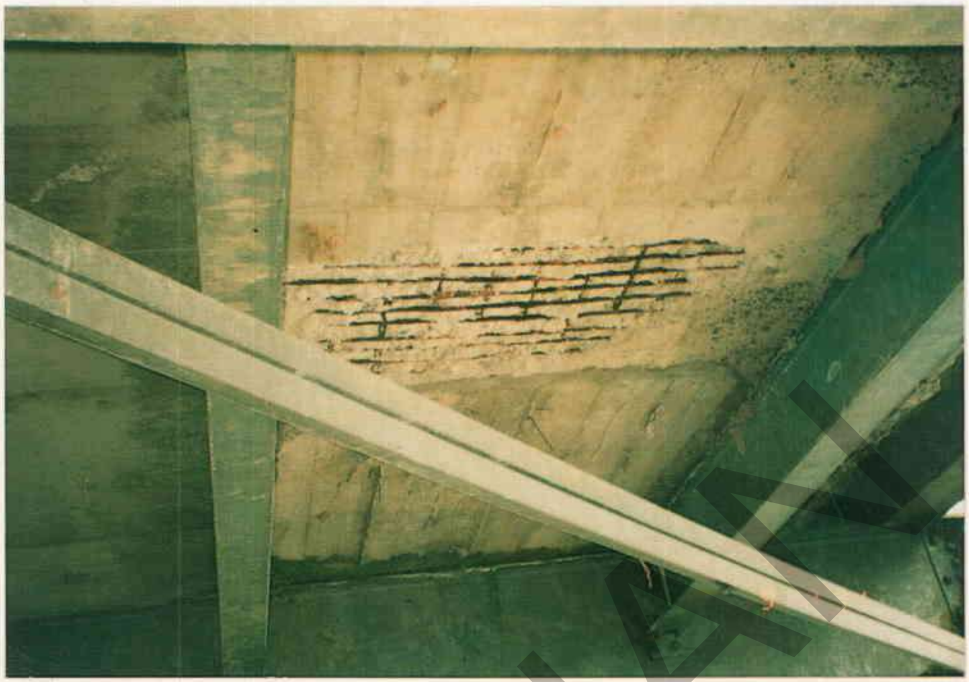


Figure A4.100 - Concrete Spalling under Deck Slab Small Area

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.502	*Deck Slab*	*201*	*Spalling*	*B2*	*2*	*1*	-	*1*	*1*	*0*	*0*	*0*	*2*	*1*	*1*	*0*	*0*	*0*	*2*

Figure A4.101 - Isolated Crack in Concrete Deck Span 2

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.502	*Deck*	*202*	*Cracking*	*B2*				*1*	*1*	*0*	*0*	*0*	*2*	*1*	*1*	*0*	*0*	*0*	*2*

Figure A4.102 - All Bearings Jammed because bolts are too long

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.611	*Steel Bearing*	*601*	*Jammed*											*1*	*1*	*1*	*1*	*0*	*4*

Figure A4.103 - All Bearings Siezed

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)	A/P/B	X	Y	Z	Condition Mark S	R	K	F	P	NK	Condition Mark S	R	K	F	P	NK
4.611	*Steel Bearing*	*601*	*Siezed*											*1*	*1*	*1*	*1*	*0*	*4*

Figure A4.104 - Cracked Asphalt at Expansion Joints both Abutments

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)					Condition Mark						Condition Mark					
				A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
3.600	*Deck Joint*	*806*	*Cracked Asphalt*											*1*	*1*	*1*	*1*	*0*	*4*

Figure A4.105 - Broken Parapet at Abutment 2

Defective Element		Defect		Location				Level 5						Level 3 - 4					
Code	Description (optional)	Code	Description (optional)					Condition Mark						Condition Mark					
				A/P/B	X	Y	Z	S	R	K	F	P	NK	S	R	K	F	P	NK
4.624	*Parapet*	*103*	*Broken*	*A2*	-	*1*	-	*1*	*1*	*0*	*1*	*0*	*3*	*1*	*1*	*0*	*0*	*0*	*2*