Comparison of aggregates properties from "West Java and Banten Province" and "Northern Ireland"

Oleh :
Djoko Widajat

RINGKASAN

Berbagai tipe agregat terdapat di Propinsi Jawa Barat dan Banten serta Irlandia Utara yang merupakan kekayaan berharga untuk pembangunan jalan raya. Terdapat perbedaan tipe spesifik agregat pada masing-masing negara yaitu andesite di Propinsi Jawa Barat dan Banten serta basal olivine di Irlandia Utara.
Korelasi dari data phisik dan mekanik mengindikasikan bahwa tipikal agregat dari Irlandia Utara lebih rapat dan kuat dibandingkan dengan agregat dari Propinsi Jawa Barat dan Banten.

SUMMARY

Many types of aggregates are found in West Java and Banten Province and Northern Ireland where they are regarded as a valuable resource that is used to construct highways. There is a distinct difference in the specific types of aggregates present in each countries i.e. andesite in West Java and Banten Province and olivine basalt in Northern Ireland.
Correlation of physical and mechanical data indicates that Northern Ireland aggregates are typically denser and stronger than the West Java and Banten aggregates.

I. INTRODUCTION

Road aggregate is one of the main material used for highway construction. Road aggregate quarries are found through out the West Java and Banten Province of Indonesia and Northern Ireland of United Kingdom. The purpose of this study is to compare the engineering properties of aggregates used to determine whether similarities occur between relationships. This is particularly interesting given the distance between countries and the processes that have occurred since their formation.

II. SOURCES OF AGGREGATES IN WEST JAVA AND BANTEN PROVINCE

This section describes the occurrence and location of aggregates sources. A simple geology map is shown in Figure 1.
West Java (Banten included) physiographically and structurally is divided into four East West trending belts (Bemmelen, 1970). The volcanisms of these belts are:

- The southern mountain was predominantly pyroxene andesite formed in the lower Miocene and marine sediments with minor amounts of volcanic constituents, which formed in the middle Miocene.
- The Bandung zone was mainly basaltic with the younger products are andesitic which was formed at the end of the Neogene.
- The Bogor zone was mainly olivine basaltic to pyroxene andesitic volcanoes, which was formed at the neogene.
- The lowland plan of Batavia is an alluvial and marshy area.

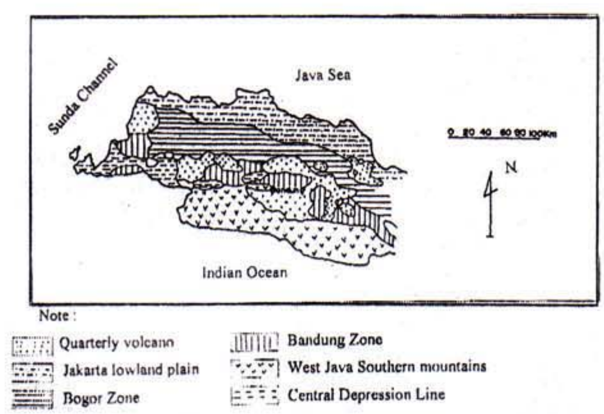

Figure 1. Simple geology map of West Java Province (Banten Province included) (Geological Research and Development Centre, 1992)

In this region aggregate is quarried in large quantities either as bedrock material or as unconsolidated gravel. Figure 2 shows the distribution of approximately 600 samples that have been collected from this area. This shows that 53% of the data was from unconsolidated material with 40% of bedrock material. The bedrock and unconsolidated materials are comprised of differing geological types of material.

The following is a brief explanation of the terminology used by surveyors and geologists to describe the material present in the field.

- Bedrock materials consist of massive rock that requires crushing to sizes appropriate for use in highway construction. The main groups include igneous extrusive (lava flows), igneous intrusive, igneous pyroclastic, detritus sedimentary, biochemical sedimentary and metamorphic types.
- Unconsolidated materials are those that are not termed as being bedrock i.e. they typically occur as loose unconsolidated deposits. Only the larger particles require crushing. The main groups include alluvium, Lake Deposits, colluviums, beach deposits, terrace/old alluvial/deltaic deposits, weathered bedrock, residual soil, volcanic debris/ash/sand and laterite types. A basic field description for this type of material, based on the range of particle sizes present is shown in Table 1.

Table 1
Field description sizes of unconsolidated materials

Class	Size limits (mm)	Term
1	> 600	Large boulder
2	200 – 600	Boulder
3	75 – 200	Cobble
4	4.75 – 75.00	Gravel
5	0.075 – 4.75	Sand
6	0.005 – 0.075	Silt
7	< 0.005	Fine silt/clay

The potential bedrock and unconsolidated aggregate sources in these provinces have been classified into groups such as basalt and andesite. The distribution of groups are shown in Figures 3 and 4. It can be seen from Figure 3 that andesite is the highest proportion of material type of bedrock sources found in the provinces followed by basalt and breccia type.

Figure 4 shows the distribution of unconsolidated materials, it can be seen that the proportion of andesite or basalt type are almost found in the sample location have been taken.

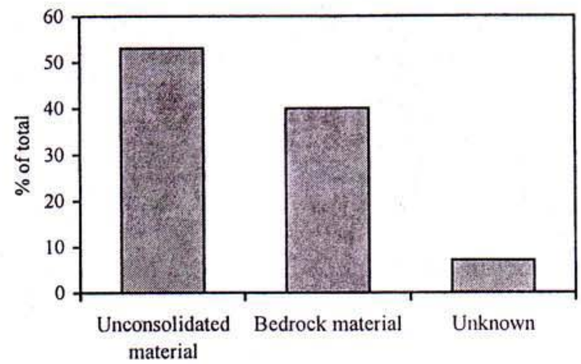

Figure 2. Distribution of types of material

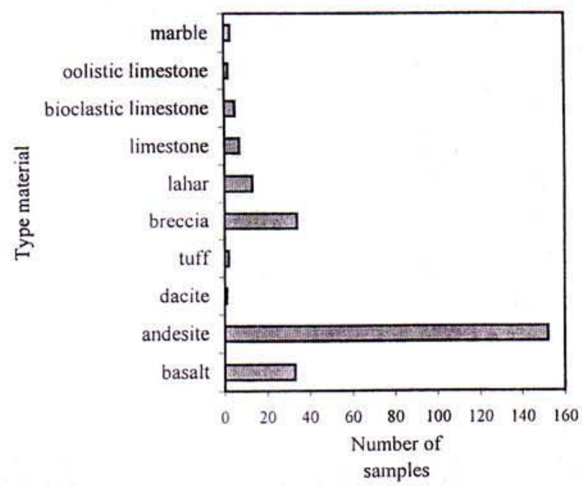

Figure 3. Summary of bedrock sources

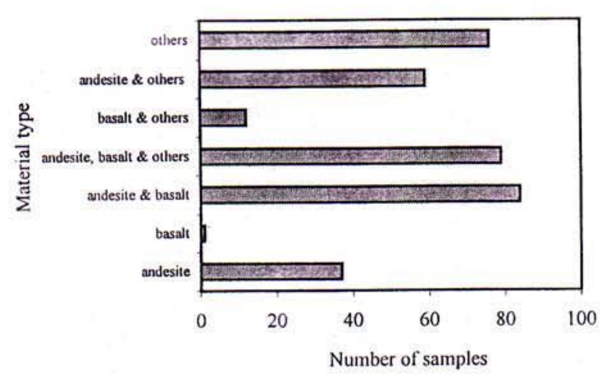

Figure 4. Summary of unconsolidated sources

An indication of the potential volume of aggregate in the 20 districts of West Java and Banten Province is shown in Table 2. The sources are located throughout the provinces. It shows the proven and potential volume of road material in each district. Although some quarries do not produce the material at present, it can be seen that the availability of aggregate resources is considerable and offers considerable scope for the future of road development. Of the potential 260 million m3 of aggregate Bandung and Bogor districts in particular have huge potential sources.

Table 2
Potential aggregate reserves in West Java and Banten Province (IRE, 1989)

District name	Proven volume (m3x10,000)	Potential volume (m3x10,000)	Cumulative potential volume (m3x10,000)
Pandeglang	53.75	505.75	505.75
Lebak	80.75	875.75	1381.50
Bogor	1421.00	4354.50	5636.00
Sukabumi	94.25	632.00	6368.00
Cianjur	41.75	244.50	6612.50
Bandung	1116.50	7043.25	13655.75
Garut	114.25	1377.25	15033.00
Tasikmalaya	1204.25	2302.00	17335.00
Ciamis	85.00	340.50	17675.50
Kuningan	245.00	1454.75	19130.25
Cirebon	455.75	455.75	19586.00
Majalengka	970.25	970.25	20556.25
Sumedang	654.75	654.75	21211.00
Indramayu	135.25	135.25	21346.25
Subang	461.25	461.25	21807.50
Purwakarta	777.25	777.25	22584.75
Karawang	952.50	952.50	23537.25
Bekasi	573.25	573.25	24110.50
Tangerang	350.50	1408.00	25518.50
Serang	129.00	760.50	26279.00

III. AGGREGATE RESOURCES IN NORTHERN IRELAND

Road aggregate is quarried throughout Northern Ireland. A simple geology map is shown in Figure 5. The main types of aggregate quarried and their production figures for 1999 are shown in Table 3 and Figure 6. In terms of quantity produced, basalt is the most important with 33% of the total, followed by limestone and sand and gravel.

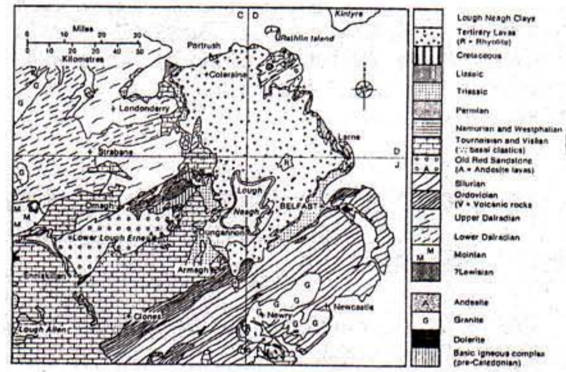

Figure 5. Simple geology map of Northern Ireland

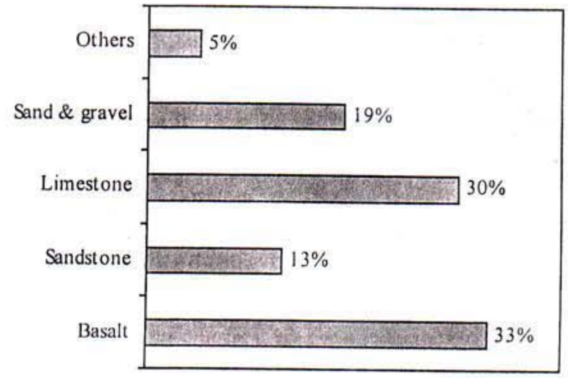

Figure 6. Mines and quarries production in Northern Ireland (Department of Economic Development, 1999)

Table 3
Northern Ireland aggregate statistics (Department of Economic Development, 1999)

Mineral	Quantity (tonnes)	% of total
Basalt	9,538,000	32,87
Sandstone	3,615,000	12,46
Limestone	8,771,000	30,22
Sand and gravel	5,517,000	19,01
Others	1,579,000	5,44
Total	29,020,000	100,00

Basalt is the main type of aggregate quarried in Northern Ireland and occurs across an area of approximately 4000 km2 in Counties Antrim and Londonderry. It was formed approximately 60 million years ago when two major cycles of sub aerial volcanic activity resulted in the accumulation of a thick lava pile known as the tertiary Antrim

Lava group (the location can be seen from the symbol of tertiary lava in Figure 5). The basalt quarried typically consist of olivine rich basalt with smaller amounts of tholeittic types (Lyle 1980, Woodward 1997).

IV. WEST JAVA AND BANTEN PROVINCE ANDNORTHERN IRELAND AGGREGATE PROPERTIES

The following describes a comparison of basic physical (water absorption and Specific Gravity) and mechanical (Los Angeles Abrasion Value) properties for aggregates from the two regions. These properties have been considered since the 1920's. For example, a maximum Water Absorption value of 2% is typically used to indicate aggregate soundness.

Hosking (1974) described a study of the effect of different degrees of porosity on the properties of a number of porous synthetic materials. As there was no standard method of determining the porosity of crushed rock aggregates for road making purposes, Hosking gave a derivation of apparent Porosity, which could be determined from the BS 812 values of Saturated Surface Dry relative Density and Water Absorption.

The source of the West Java data is a Road Material Inventory (IRE, 1989) that was carried out in West Java by the Institute of Road Engineering. The project was part of the 1988-1989 IBRD funded Technical Assistance and Research Project (TARP). A laboratory test program was carried out to assess the quality of aggregate. It determined the following properties: Water absorption, Specific gravity, Los Angeles Abrasion, Aggregate Impact Value, Aggregate Crushing Value and Particle Size distribution.

The following additional information was determined for a limited number of samples: Ten Percent fines value, Point Load Strength, Angularity and Flakiness, Organic content, Aggregate stripping and Sodium Sulfate soundness.

The fine aggregate was tested, where appropriate, for the following: Atterberg Limit, Minimum dry density, optimum moisture content, California Bearing Ratio.
The source of the Northern Ireland data has been taken from a study by Woodward (1995).

4.1. Correlation of Specify Gravity and Water Absorption data.

Figure 7 shows the relationship between Water Absorption and Specific Gravity (on saturated surface dry basis) for aggregate from west Java and Northern Ireland. It can be seen that the Northern Ireland aggregate is more dense for a given Water Absorption. This relates to the predominant type of material found in each country i.e. less dense andesite in West Java and Banten Province and more dense olivine basalt in Northern Ireland.

It may also be observed that a good correlation exists between the two variables i.e. the Specific Gravity for both aggregate locations tends to decrease as the value of water Absorption increases i.e. high absorption aggregates tend to have corresponding high porosity and so a reduced Specific Gravity. Figure 7 shows that most of the aggregates from both countries have Water absorption value less than 5%.

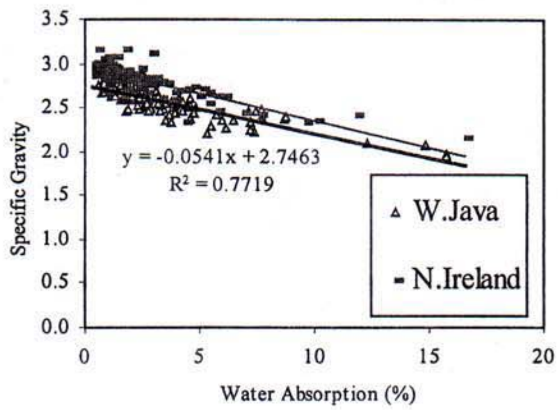

Figure 7. Water Absorption v. Specific Gravity for West Java (Banten included) and Northern Ireland aggregates.

4.2. Correlation of Water Absorption and Los Angeles Abrasion data

Figure 8 shows the correlation between Water absorption and Los Angeles Abrasion value. It should be pointed out that the Northern Ireland data was determined using the EN 1097 – 2: 1998 test method whereas the West Java and Banten data was obtained using the ASTM method (C131– 96).

The aggregate size tested in Northern Ireland is a combination of aggregate retained on a 10 mm sieve size and passing a 12.50 mm sieve size combined with aggregate retained on a 12.50 mm sieve and passing a 14 mm sieve. The West Java and Banten test aggregate was retained on a 10 mm sieve and passing a 20 mm sieve.

Despite this, Figure 8 shows reasonable correlation between variables and agreement between countries in terms of the best-fit line through the data. It shows that increasing Water Absorption causes a decrease the Los Angeles Abrasion value i.e. high Water Absorption aggregates will suffer more degradation.

It is suggested that the Los Angeles Abrasion value may be predicted if the Water Absorption value is known.

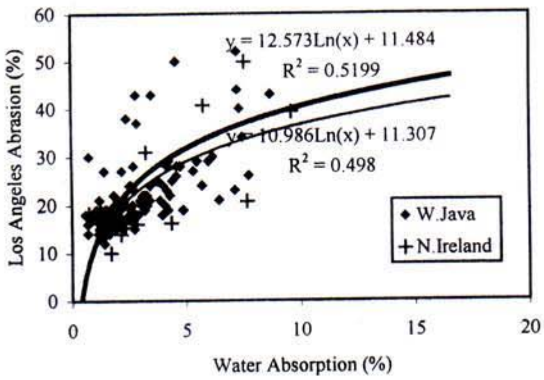

Figure 8. Plot of Water Absorption V. Los Angeles Abrasion value for West Java (Banten included) and Northern Ireland aggregates.

V. CONCLUSION

The specific aggregate types present in West Java and Banten Province generally is andesite, whereas in Northern Ireland is olivine basalt.

In both countries the geological history of these have had an influence on their physical, mechanical and soundness properties. They have different climates at present i.e. West Java (Banten included) is a tropical climate and Northern Ireland is regarded as a cold region. However, the Northern Ireland basalts were formed in a hot climate 60 million years ago and so have many of the typical weathered profiles associated with tropical weathering condition (Woodward, 1995). Correlation of physical and mechanical data shows that the Northern Ireland basalts are typically denser and stronger than the West Java and Banten andesites.

VI. ACKNOWLEDGEMENTS

The writer wishes to express his gratitude to Dr. Woodward, W.H.D, for permission to use Northern Ireland aggregates laboratory data.

Reference:

1. COOK, J.R. and MOESTOFA, B. (1989). **Road inventory for West Java and Part of South Sumatra**. Research Report 11.072.PT.89A. Institute of Road Engineering, Bandung, Indonesia.
2. DARSOPRAJITNO, H.S. (1997). **Pengetahuan umum geologi**. Pusat Litbang Geologi & Sumber daya mineral Departemen Pertambangan dan Energi, Bandung.
3. HOSKING, J.R. and TUBEY, L.W. (1969). **Research on low grade and unsound aggregates**. Laboratory Report LR 293. Road Research Laboratory, Crowthorne, UK.
4. INSTITUTE OF ROAD ENGINEERING (1989). **A Road Inventory for West Java**. Research Report. Bandung, Indonesia, Vol.1 – Vol. 20.
5. VAN BEMMELEN, R.W. (1970). **General geology of Indonesia and adjacent archipelagos.** Published by Martinus Nijkoff, The Hague.
6. WOODWARD, W.H.D. (1995). **Laboratory prediction of surfacing aggregate performance.** PhD thesis. University of Ulster at Jordanstown. Northern Ireland.

Penulis :

Djoko Widajat, DR., MSc., *Ajun Peneliti Madya, Bidang Bahan dan Perkerasan Jalan, Pusat Litbang Prasarana Transportasi, Badan Litbang Departemen Pekerjaan Umum.*