THE USE OF LIMESTONE AGGREGATE IN CONCRETE

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ABSTRACT.

Concrete structure is made up of cement, aggregate and water. In building construction the aggregates commonly used are limestone and granite. Three quarters of concrete is made up from aggregate, thus the selection of aggregate should be in the prime condition. To produce a good, strength and high quality concrete the materials used should be in accordance to standard specification. JKR standard specification for building works mentioned that the use of limestone is limited to super structure only whereas for substructure granite aggregate should be used. Due to this problem statement this study is carried out to investigate whether chemical attack in limestone aggregate is the source of problem for sub structure (concrete structure below ground level). This study involved in testing of limestone and granite aggregates. The scope of study includes the investigation on the strength, bonding and chemical attack in the concrete. The main objective of the research is to study the properties of lime stone related to strength and its performances. The method of study to be carried out is through the appropriate test. The types of testing required are sieve analysis, flaky and elongation index test, cube test and aggregate crushing value test. All the tests have been carried out and the results had been recorded in appropriate table and graph. Discussion on the analysis of the results is explained to provide more information about the effect of chemical and the behavior of concrete properties. Lastly the conclusion had been done and one recommendation had been introduced for future work.

ABSTRAK.

Struktur konkrit terdiri daripada simen, batu baur dan air. Di dalam pembinaan bangunan, batu baur yang biasa di gunakan ialah terdiri daripada batu kapur dan granit. Tiga suku daripada kandungan konkrit ada lah terdiri daripada batu baur, oleh yang demikian pemilihan batu baur amat lah penting sekali. Untuk menghasilkan konkrit yang baik, kuat dan berkualiti tinggi, maka penggunaan bahan-bahan hendaklah memenuhi spesifikasi piawai. Di dalam spesifikasi Piawai JKR menyatakan bahawa penggunaan batu kapur di hadkan hanya untuk struktur dari tanah keatas sahaja, manakala bagi struktur di bawah tanah hendaklah menggunakan granit. Berdasarkan kepada petikan ini, maka satu kajian untuk menyiasat samaada serangan dari tindak balas kimia merupakan masalah bagi binaan struktur di bawah aras tanah. Kajian ini melibatkan ujian terhadap batu baur jenis batu kapur dan granit. Bidang kajian termasoklah penyiasatan berhubung dengan kekuatan, ikatan dan tindak balas kimia di dalam konkrit. Objektif utama kajian ini adalah untuk mengkaji ciri-ciri batu baur yang berkaitan dengan kekuatan dan keupayaannya. Kaedah kajian ini adalah melalui beberapa ujian yang sesuai. Jenis-jenis ujian tersebut ialah analisis ayakan, indek leper dan indek pemanjangan, ujian kiub dan nilai hancur batu baur. Semua ujian ini telah dijalankan dan keputusannya telah direkodkan dalam bentuk jadual dan geraf. Perbincangan mengenai analisis daripada keputusan ujian akan memberikan maklumat berhubung dengan kesan tindak balas kimia terhadap perilaku dan sifat konkerit. Akhir sekali di sertakan satu kesimpulan dan juga satu cadangan untuk kajian di masa depan.

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LIST OF SYMBOLS

B.S	-	British Standard
>	-	More than
<	-	Less than
G25	-	Grade 25
Mg SO_4	-	Magnesium Sulphate
Na NO_3	-	Natrium Nitrate
Ca O	-	Calcium Oxide
Mg O	-	Magnesium Oxide
CO_2	-	Carbon Dioxide
S1,S2,ect	-	Sample in Chemical Solution
S.O	-	Superintendent Officer
ACV	-	Aggregate Crushing Value
JKR	-	Jabatan Kerja Raya
Fe O	-	Ferrous Oxide
Mn O_2	-	Manganese Dioxide
Ca(OH)	-	Calcium Hydroxide
Mpa	-	Mega Pascal
Psi	-	Ib/square in.
Ca CO_3	-	Calcium Carbonate (Limestone)

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CHAPTER 1

INTRODUCTION

1.1 Introduction.

Since concrete is the most important part in structural construction, the aggregate content should be in a form of good strength for structural purposes. Concrete is made up of aggregate, cement and water. Through this combination of materials, three – quarter of the mix is governed by aggregate. The aggregate itself is categorized as fine and course aggregate.

In this study, the scope of research will be focused on the use of coarse aggregate using lime stone material. Before further discussion, it shall be better to have knowledge and clear understanding about the lime stone material and its properties and performances.

Lime stone is one of the aggregate to be used in concrete, other than that are granite, basalt, Quardz, Gneis, Gabbro, Sand stone, Felsit ect. The classification of the aggregates according to BS 812 :Part 1 :1975 as stated from table 1.1 in this chapter.

Figure 1.1 : Sample of Limestone Aggregate (Source from Kg. Ulu Gali, Raub**,** Pahang)

Table 1.1: Classification of natural aggregates according to rock type (BS 812 : Part 1 :1975)

Basalt Group	**Flint Group**	**Gabbro group**
Andesite Basalt Basic porphyrites Diabase Dolerites of all kinds including theralite and teschenite. Epidiorite Lamprophyre Quartz-dolerite Spilite	Chert Flint	Basic diorite Basic Gneiss Gabbro Hornblende-rock Norite Peridotite Picrite Serpentinite
Granite Group Gneiss	**Gritstone Group (including fragmental volcanic rocks)**	**Hornfels group** Contact-altered rocks

Granite Granodiorite Granulite Pegmatite Quartz-diorite Syenite **Limestone Group** Dolomite Limestone Marble Schist Group Phyllite Schist Slate All severely sheared rocks.	 Arkose Greywacke Grit Sandstone Tuff **Porphyry Group** Aplite Dacite Felsite Granophyre Keratophyre Microgranite Porphyry Quartz-porphyrite Rhyolite Trachyte	of all kinds except marble. **Quartzite Group** Ganister Quartzitic sandstones Re-crystallized quartzite.

Page 110: Properties of Concrete – A.M. Neville

1.2 Back ground of the research

Limestone and granite are two types of aggregates commonly used in industrial construction. For JKR project, the used of limestone aggregate is limited to super structure only whereas for substructure there is no recommended to use limestone below ground level. Due to this statement the study is to be carried out to find what source of the problems in related to concrete below ground level. One of the problems in the ground level is about chemical attack, so

that a few numbers of laboratory test should be carried out to get the results for analysis purposes.

In conjunction to this matter, the problem arises is based on the JKR specification mention under Section D (Concrete Work) item 3.0 for aggregate contents.

From Item 3.3 Coarse Aggregates:

Standard Specifications For Building works page 35 standard specification for building works written as below:-

"The coarse aggregate shall be crushed hard stone except that for work below ground level, only crushed granite will be used. The aggregate shall not contain clay lumps exceeding 1% by weight. A representative dry sample shall not show an increase in weight exceeding 8% after immersion in water when tested according to the method in M.S. 7.5. It shall be well shaped and not flaky with the flakiness index not exceeding 35%. The maximum nominal size of coarse aggregate shall be 19mm."

Through the statement above, it is understood that the use of limestone aggregate was not recommended in building works below ground level. Since concrete work is the importance structure, understanding about the material properties shall be significantly in the advanced condition. A few tests to get the strength should be carried out in the laboratory and the results can be analyzed. The results obtained can be compared to the standard specification for building's work. So, through this study I would like to further the use of limestone in a certain area as alternative to granite aggregate.

The main reason to study this topic is to get better knowledge and to bare in mind **whether " Chemical Attack below ground level "** source of the problem in using limestone concrete structure. In the preparation of this thesis, many factors should be considered and there must be some references towards the study for getting clear information and understanding about the chemical attack in

concrete structure. At the end of this study, a conclusion can be made according to the results obtained through the laboratory tests.

1.3 Significance of the research.

In construction industries, the use of aggregates is the most importance material in composition of concrete. Places having granite aggregate should have no problem in construction projects, but for places without granite the problems will be arises and cost incurred become higher. Due to this reason this study should be carried out in the approaching method to overcome the problem as well as beneficial to local people.

The advantages of this study are:-

i) To provide some information about the used of limestone aggregate.
ii) Beneficial and economic value to local people.
iii) New finding during the test and methods required to overcome the problems.
iv) Have chances to explore the used of local material in construction industries.

1.4 Objective of the study.

In our country, stone can be selected from a certain area which is in the form of various types of materials such as granite, limestone, basalt, quardz, gneiss, gabbro, sand stone and others as stated in table 1.0 from the previous paragraph.

Area of easily granite formed shall have no problems for concrete structure, but for an area of without granite and limestone easily selected this might be incurred cost to import granite aggregate from other places. As a result,

this also will reduce the beneficial economic value for that particular place due to granite demand.

The main issue of this study is to identify weather the chemical reaction can affect the concrete structure from limestone aggregate below ground level. In the ground, there are various types of chemical reactions such as sulfate, chloride, nitrate, sodium, atrium and others soluble exist in that particular places. For this purpose, every places will have different soluble in the ground and its depend on the types of soil or rock for that particular area.

At the end of this study some information regarding limestone aggregate will be obtained from the test results. Due to the results required, the beneficial values of the study can be shared together and its will bring objectives as the followings:-

i) To study the limestone properties related to strength and its performances.

In this objective, the strength of the limestone should be obtained in many ways. One of the methods is cube test. However the method pertaining to this matter will be discussed on the next topic under chapter 2 under methodology section.

Through this objective, all the information should be collected and might be one of the proven sign to get a solution to the problem. If there is exist, it means that the limestone aggregate is no longer to be a selected and approved material in concrete structure. For this purpose, the specification of JKR should the one to refer and compared with the results of the tests.

ii) To compare the results with granite concrete and costing required.

As according to JKR specification in building works, the use of granite is the recommended aggregate in construction of JKR projects. For this particular situation, the comparison between limestone and granite is the options to get some information to public use and acknowledgement purposes.

Since granite concrete is no matter stronger and its characteristic strength is more than limestone concrete, so that the results of the cube tests is significantly functioning to this study. Because of the local interest to economic value, the cost incurred for both types of aggregate will be established to public information.

iii) To provide the information on demands of local material and its benefits.

Once the result of the tests is recorded, there are specifics analysis can be ascertained and very important factors to encourage people on the demands of each materials. For this particular objective, the demand on limestone is predictably on advanced because the study is focusing to the local materials on the beneficial aspects especially on the economic aim.

However, in promoting the local material demands there must be a specific reason and advantages to welcome people without prejudice. Through this study, it will provide some guide lines and references for really problems arise towards the specific solution otherwise there are no neglected inspiration exists. Once it's come through there are clear information to people involved in construction industries.

iv) As an alternative materials without prejudice.

If the concrete made of limestone aggregate can produce a strength and durability, therefore its performance is good for concrete structure. The important thing in construction technology is the material used is followed the specification and the test results should according to specification. Any materials set the specification, meaning that the material can be used for construction purposes. In the case of limestone, it also a type of aggregate involved in obtaining a good concrete provided the required test should followed the specification in the contract document.

1.5 Scope of the research.

The construction industries are becoming more challenging than ever before. To be competitive, the field of engineering related to the industries has to be established. One of the areas that can be established is the used of material in the construction purposes. A specific scope of study on the limestone aggregate is presented in this paper as to improve the knowledge in the field of construction technology.

1.5.1 Bond of aggregate :

The bond between aggregate and cement paste is essential to produce the flexural strength of concrete, but the nature of this bond is not fully understood. For this reason, an analysis needs to be conducted by performing specific tests in the laboratory. The flakiness index and elongation tests on the limestone aggregate are required that to prove the specification in JKR contract document is met. Bonding between aggregate and cement paste depends on the surface of the aggregate. Since the rough surface requires more bonding than the smooth surface, the texture of aggregate to be tested should comply to the requirement of standard specification.

Figure 1.2: Sample of aggregates (left is limestone, right is granite).

The aggregate used in the tests must comply to the standard grading which is through sieve analysis test with 4 kilogram of limestone aggregate sample. The test shall follow a proper procedure and the results are compared to the standard as tabulated in Table 1.2 below:-

Table 1.2: Coarse Aggregate (Nominal Size 20 mm) – Standard specification Section 2 to 6 M.S. 7.5

British Standard Sieve	20 mm	10 mm	5 mm
Percent passing (%)	100	25-55	0-10

The flakiness and elongation tests shall comply to the standard specification listed in Table 1.3 below:-

Table 1.3: Testing of aggregate (Refer Appendix B).

Properties	**Types of aggregate**	**Test Methods**	**Limits**
Grading	Coarse	M.S 7.5	As mention in Table 2.1
Elongation Index	Coarse	M.S 30	Not exceeding 30%
Flakiness Index	Coarse	M.S 30	Not exceeding 35%
Aggregate Crushing Value	Coarse	M.S 30	Not exceeding 40%

1.5.2 Strength of Aggregate

To get strong and good concrete, the crushing value and cube tests are recommended. Crushing strength of concrete and crushing value of aggregate shall be determined according to a specific strength mentioned in the specification for both limestone and granite. For the granite aggregate, the sample was initially immersed in the water and chemical solution ($MgSO_4$ + $NaNO_3$) for 28 days. The procedure is to discover the effect that water and chemical solution have on the strength of concrete. The crushing value test shall meet the standard in table 1.3 above. The cube strength test shall meet the specification in Table 1.4 below:-

Table 1.4: Minimum Strength Specification of Concrete Cube (150x150x150).

Equivalent nominal mix	**Minimum crushing Strength at 7 days and 28 days after mixing.**		**Maximum aggregate size**	**Minimum cement content per cubic meter of finished concrete**
	At 7 days	**At 28 days**		
	N/mm^2	N/mm^2	mm	Kg
1:1:2 (G30)		30	19	380
1:1$^1/_2$: 3(G25)	**17.0**	**25.5**	**19**	**361**
1 : 2 : 4 (G20)	14.0	21.00	19	321

Figure 1.3: Sample of concrete cube with 150 x 150 x150 in size.

1.5.3 Shulphate Reaction Below Ground Level

The chemical attack on the concrete below ground level is proven by immersing the cube samples of concrete grade 25 in solution of Magnesium sulphate plus Natrium Nitrate. The Magnesium Sulphate and natrium Nitrate are shown in figure 1.4 below. Twelve samples of cube were immersed in solution of Magnesium sulphate plus natrium nitrate and another twelve samples of cube were immersed in water. The samples are to be immersed in the solution and water, separately for 7 days, 14 days, 21 days and 28 days. To get more accurate information on the effect of chemical reaction on the granite and limestone aggregate, test a period of 7 days, 14 days, 21 days and 28 days was justified.

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