STUDY ON W H PROPERTIES OF CONCRETE CONTAINING 0%, 5%, 15% AND 25% QUARRY DUST AS FINE AGGREGATE REPLACEMENT

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ABSTRACT

Nowadays people are playing more attention to the sustainability in construction field. So, an engineers are finding the ways to improve the quality of the concrete using industrial waste such fly ash, quarry dust, polymer and silica. One of the methods is to mix the quarry dust with the concrete. In this research, a quarry dust waste was added in the different proportion by weight of cement. The effect of quarry dust as a sand replacement in concrete were investigated 36 numbers with dimension 150mm x150mm 150mm and beam specimen with dimension 150mm x 150mm x 750mm were prepared. Four different mix design containing 0% ,5%, 15% and 25% of quarry dust were designed as sample A, sample B, sample C and sample D respectively. Water cement ratio of 0.54 was constant. Cube samples were tested at age 7, 14 and 28 days while beam specimen were prepared at age 28 days. The slump test for sample A, sample B, sample C and sample D were 75 mm,35 mm,65 mm and 70 mm are respectively. All sample were fail in true slump. The compression strength of sample A, sample B, sample C and sample D were 29.82N/mm^2, 29.38N/mm^2, 29.43N/mm^2 and 30.18N/mm^2 are respectively. The flexural strength of sample A, sample B, sample C and sample D were 2.99 Mpa, 2.94Mpa,2.95Mpa and 3.10Mpa respectively.

ABSTRAK

Pada masa kini, manusia menumpukan lebih perhatian kepada kekuatan struktur dalam bidang pembinaan. Oleh itu, jurutera mencari cara untuk meningkatkan kualiti konkrit dengan menggunakan sisa industri seperti abu terbang, debu kuari, polimer dan silika. Salah satu kaedahnya adalah dengan mengantikan debu kuari dengan pasir didalam konkrit. Dalam kajian ini, sisa debu kuari telah ditambah dalam bahagian yang berbeza dengan berat simen. Kesan debu kuari sebagai pengganti pasir di dalam konkrit telah disiasat 36 bilangan kiub dengan dimensi 150mm 150mm x150mm dan spesimen rasuk dengan dimensi 150mm x 150mm x 750mm disediakan. Empat campuran reka bentuk yang berbeza yang mengandungi 0%, 5%, 15% dan 25% debu kuari telah direka sebagai sampel A, sampel B, sampel C dan D sampel masing-masing. Nisbah air simen 0.54 adalah malar atau tetap. Sampel kiub diuji pada umur 7, 14 dan 28 hari manakala spesimen rasuk disediakan pada usia 28 hari. Ujian kemerosotan bagi sampel A, sampel B, sampel C dan sampel D 75 mm, 35 mm, 65 mm dan 70 mm adalah masing-masing. Sampel semua telah gagal dalam kemerosotan benar. Kekuatan mampatan sampel A, sampel B, sampel C dan sampel D 29.82N/mm2, 29.38N/mm2, 29.43N/mm2 dan 30.18N/mm2 adalah masing-masing. Kekuatan lenturan Sampel A, Sampel B, Sampel C dan D Sampel adalah 1.27 Mpa, 0.64 Mpa, 1.00 Mpa dan 1.37 Mpa masing.

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LIST OF ABBREVIATIONS

BS	=	British Standard
ASTM	=	American Society for Testing and Materials
w/c	=	Water-cement ratio
CP	=	Code of Practise
kg/m^3	=	Kilogram per meter cube
MPa	=	Mega Pascal
g/m^3	=	Gram per meter cube
^oC	=	Celsius
^oF	=	Fahrenheit
h	=	Hour
g	=	Gram
Kg/m^3	=	Kilogram per meter
N	=	Newton
N/mm^2=	=	Newton per millimeter square
mm	=	Millimeter
kN	=	Kilo newton
QD	=	Quarry Dust

CHAPTER 1

INTRODUCTION

1.1 Introduction

Cement usually in powder form acts as a binding agent when mixed with water and aggregates. This combination has been poured and hardens into the durable material with which are all familiar. Concrete is strong in compression, as the aggregate efficiently carries the compression load. Fine aggregate concrete consists of a mixture of Portland cement, fine aggregate (sand) and water. Sand, as one of the most accessible natural resources, has been used mostly as a construction material since the earliest days of civilization. It is defined as continuously graded unconsolidated material present on the earth's surface as a result of the natural disintegration of rocks.

The main natural and cheapest sources of sand are riverbeds and these natural resources are depleting very fast. Sand mining is the removal of sand from their natural configuration. Sand is used for all kinds projects like land reclamations and structure construction. Environmental problems occur when the rate of extraction of sand, gravel and other materials exceeds the rate at which natural processes generate these materials. The morphologies of the mining areas have demonstrated the impact of mining with the process to destroy the cycle of ecosystems. Sand mining is great importance to the Malaysia economy. It should however, be recognized that the process of prospecting, extracting, concentrating, refining and transportation minerals have great potential for disrupting the natural environment.

In addition, the large scale depletion of these sources creates environmental problems. River sand is most commonly used as fine aggregate in the production of concrete poses the problem of acute shortage in many areas. Whose continued use had started posing serious problems with respect to its availability, cost and environmental impact. In other a situation the quarry dust as fine aggregates can be an economic alternative to the river sand.

1.2 Problem Statement

Nowadays, sand is one of vital component for concrete. There is a great demand for construction and demand of sand was continuously high from time to time, as a result it has become a problem in the production of sand. The impact of this result sand has become highly price and also scarce. Excessive in stream sand mining causes the degradation of rivers. In stream mining lowers the stream bottom, which may lead to bank erosion. Depletion of sand in the streambed and along coastal areas causes the deepening of rivers and estuaries and the enlargement of river mouths and coastal inlets. The effect of mining compounded causes an effect of sea level rise. Any volume of sand exported from the streambeds and coastal areas is loss to the system.

Sand mining can cause effects riparian habitat, flora and fauna. All species require specific habitat conditions to ensure long term survival. These have caused major habitat disruptions that favored some species over others and caused overall declines in biological diversity and productivity. In most streams and rivers, habitat quality is strongly linked to the stability of channel bed and banks. Unstable stream channels are inhospitable to most aquatic species. For example, human activities that accelerate stream bank erosion, such as sand mining because stream banks to become net sources of sediment that often have severe consequences for aquatic species.

The most important effects of sand mining on aquatic habitats are bed degradation and sedimentation which can have substantial negative effects on aquatic life. There might be a shortage of sand and also source of sand has been scarce in the future and the ecological system can be affected. It is important to realize that there are other sources of sand available for construction. Therefore, a research has to be made to overcome this problem. The research that can be done by replacing alternative materials from factory waste such quarry dust.

1.3 Objective of Study

The main objectives of this research are as follows;

i. To determine the workability of fresh concrete containing 0%,5%,15% and 25 % of quarry dust as fine aggregate replacement.

ii. To determine the compressive strength of concrete by using different percentages of quarry dust as fine aggregate replacement

iii. To determine the flexural strength of concrete using quarry different percentages of quarry dust as fine aggregate replacement.

1.4 Scopes of Study

The research focus on the cube made and also takes an account on a few factors such as material, cement, sand and quarry dust percentages .

The scopes of study are as follows:

i. Making testing on the cubes and beams.
ii. To determine analysis and make conclusion from the result obtained

This experimental study focus on workability and mechanical properties of concrete containing of different percentages of quarry dust as fine aggregates in term of compressive and flexural strength. All the tests to determine the compressive strength and workability of concrete containing different percentages of quarry dust as fine aggregates has been held at Makmal Konkrit dan Bahan, Fakulti Kejuruteraan

Awam dan Alam Sekitar, Universiti Malaysia Pahang,Gambang. The optimum mix has been selected after the test to achieve a sufficient strength. Type of concrete to be used is concrete grade 35 because follow the Jabatan kerja Raya (JKR) standards.

For this experimental study, 36 cubes with dimension of 150 mm x 150 mm x 150 mm and 12 beams sample with dimension of 150 mm x 150 mm x 750 mm has been prepared. There are four different mix proportion of 0% ,5%, 15%, and 25% of quarry dust has been designated as sample A, sample B, sample C and sample D respectively.

Table 1.1: Cube Test Mix Proportion

Material	Mix A (0%)	Mix B (5%)	Mix C (15%)	Mix D (25%)
Cement (kg)	350	350	350	1350
River Sand (kg)	725	688.75	616.25	543.75
Quarry Dust (kg)	0	36.25	108.75	181.25
Coarse Aggregate (kg)	1185	1185	1185	1185
Water (Litres)	190	190	190	190

Mix proportion for mixes above in terms of ratio to (Cement : River Sand : Quarry Dust) as follow:

Mix A = 1 : 2.07 : 0.00

Mix B = 1 : 1.97 : 0.10

Mix C = 1 : 1.76 : 0.31

Mix D = 1 : 1.55 :0.52

CHAPTER 2

LITERATURE REVIEW

2.1 History of Concrete

For more than 10 years, starting in the mid-1970s, an unprecedented construction boom transformed Middle Eastern nations into modern industrial societies. It is now common for reinforced concrete structures built during that time in the region to experience durability problems. This case history is based on an investigation of deterioration of reinforced concrete structures completed within the last few years at a large industrial facility in the Arabian Gulf (Jerome P. O'Connor,1994).The Assyrians and Babylonians used clay as the bonding substance or cement. The Egyptians used lime and gypsum cement.In 1756, British engineer, John Smeaton made the first modern concrete (hydraulic cement) by adding pebbles as a coarse aggregate and mixing powered brick into the cement. In 1824, English inventor, Joseph Aspdin invented Portland Cement, which has remained the dominant cement used in concrete production. Joseph Aspdin created the first true artificial cement by burning ground limestone and clay together. The burning process changed the chemical properties of the materials and Joseph Aspdin created a stronger cement than what using plain crushed limestone would produce (Mary Bellis;2011).

Concrete is the most widely used construction material because of its flow ability in to complicated forms i.e. it is ability to take any shape while wet and its strength development characteristics when it hardens. Concrete requires consumption of virgin materials. It requires cement, water and suitable aggregates. Its production involves a number of operations according to prevailing site conditions (Kulkarni, 2009).The ingredients of widely varying characteristics can be used to produce concrete of acceptable quality. The strength, durability and other characteristics of concrete depend upon the properties of its ingredients. In concrete fine and coarse aggregate constitute about 75% of the total volume. It is therefore, important to obtain right type and good quality aggregate at site. The aggregates form the main matrix of concrete or mortar. The most commonly used fine aggregate is Natural River or pit sand (Kulkarni, 2009).

2.2 Introduction to Concrete

Basically, concrete is consist of cement, sand, coarse aggregate and water. The cement that commonly used in construction is Portland cement and coarse aggregate is usually made of gravel, limestone or granite. Concrete has two physical conditions which are fresh and hardened states. Fresh condition is when the concrete mix has just produced and still having workability to be casted into moulds or containers. During hardened condition, concrete has begun to built up its initial strength and will increase until achieve the expected strength.

2.2.1 Concrete

Concrete is strong in compression and the best way to take advantage of this property is by building structures that are inherently self supporting and don't need a lot of iron reinforcing. Since most building here in Mexico is with concrete, it is easier to let your imagination go wild. Local builders have been working with Ferro-cement, Styrofoam panels, plastered straw bale, and soil-Crete. I have had the most success with light weight concrete. Light weight concrete differs from heavy concrete by its use of naturally light weight materials (aggregates) such as pumice (volcanic stone) in place of the sand and gravel used in ordinary structural concrete mixes. It only weighs half as much. Not all concrete is ugly, hard, cold and difficult to work with. There exists a whole range of light weight concretes which have a density and compressive strength very similar to wood. They are easy to work with, can be nailed with ordinary nails, cut with a saw, drilled with woodworking tools, and easily repaired. We believe that ultra-light weight concrete is one of the most fundamental bulk building materials of the future (Steve, 2000).

The other major part of concrete besides the cement is the aggregate. Aggregates include sand, crushed stone, gravel, slag, ashes, burned shale, and burned clay. Fine aggregate is used in making concrete slabs and smooth surfaces. Coarse aggregate is used for massive structures or sections of cement. Whether there are other alternatives that can be used in case of outages problems for the raw material. The use of materials that can be classified as waste materials can be used as an additive to concrete raw materials. Concrete is a material used in building construction, consisting of a hard, chemically inert particulate substance that known as an aggregate and that is bonded together by cement and water (Kulkarni, 2009).

2.2.2 Cement

Normally type of cement used to produce concrete is Portland cement. Portland cement was patented by an English engineer who named Joseph Aspdin in 1824. Its colour is similar to Portland limestone which quarried from the English Isle of Portland. Therefore the name "Portland" was given based on the colour similarity. The main chemical composition of Portland cement is oxides of calcium, silicon, aluminium and iron. These ingredient constitute four major compounds, they are tricalcium silicate (C_3S), dicalcium silicate (C_2S), tricalcium aluminate (C_3A) and tetraclcium aluminoferrite (C_4AF).With the presence of gypsum, clinker of Portland cement will be produced. The manufacturing of Portland cement creates about 5 percent of human CO_2 emissions (Fountain & Henry, 2009).

2.2.3 Aggregate

Aggregates of concrete can be divided into two types which are fine and coarse aggregates. Fine aggregates type is represented by sand. The supply of sand is much more than coarse aggregate. Most of the sand is obtained from the river while sea sand can also be used after desalination (Dhir et.al,1999). Coarse aggregates type is gravel which usually comes from crushed rock, like granite and basalt. As one of the main ingredients of concrete, large scale gravel mining is usually implemented. The manufacturing process of gravel involves dredging, washing and sieving (Dhir et.al,1999).

2.2.4 Water

The most important agent in producing concrete is water (H_2O) because cement is anhydrous and it will not have any reaction with sand and coarse aggregate without water. The amount of water mixed into concrete will affect the quality of the concrete especially strength and durability. For best strength, durability, and other desirable properties, concrete should be placed with the minimum quantity of mixing water consistent with proper handling (John Wiley & Sons, 1981).when water is mixed together with Portland cement ,a reaction which called "hydration" will carry out. This reaction is exothermic as heat energy will be released. During this process, the cement paste will bind the aggregates together, fills the voids within it and allows the fresh concrete to flow easily. Hydration involves many different reactions but usually will occur at the same time. As the reactions start, the products of the cement hydration process gradually to bond the sand and gravel particles together and also other components of the concrete to form a solid mass that is concrete. The main product that contributes most of the concrete cement gel. The reaction to form this compound is as follow;

Notation: $C3S + H_2O \longrightarrow CSH\ (gel) + CaOH$

Standard: $Ca3SiO5 + H_2O \longrightarrow (CaO) *(SiO_2)*(H_2O)(gel) + Ca\ (OH)_2$

Balanced: $2Ca2SiO5 + 7H_2O \longrightarrow 3(CaO)* 2(SiO_2)*\$(H_2O)(gel) + 3Ca\ (OH$

2.3 Properties of Concrete

Concrete has relatively high compressive strength, but significantly lower tensile strength, and as such is usually reinforced with materials that are strong in tension high water content results in a higher fluidity and greater workability. Increased water content also results in bleeding. another effect of increased water content can also be that cement slurry will escape through joints of formwork.

2.3.1 Workability

Workability is the ability of fresh concrete to be handled, transported and filled into the mould or container properly with the desired work such as vibration and compaction. Workability can be affected by water content, shape and size of aggregates, level of hydration and sometime can be modified by adding chemical additives. The concrete with good workability can obtain suitable level of plasticity and uniformity which will influence the quality of hardened concrete (John Wiley & Sons, 1981).John Wiley and Sons (1981) were states that," The importance of plasticity and uniformity is emphasized because these essential to workability have marked influence on the serviceability and appearance of the finished structure."

2.3.2 Sand Properties

The global consumption of natural sand is very high due to extensive use of concrete. In particular, the demand of natural sand is quite high in developing countries owing to rapid infrastructural growth. In this situation, developing countries are facing a shortage in supply of natural sand. Natural sand deposits are being depleted and causing serious threat to environment as well as the society. Increasing extraction of natural sand from river beds is causing many problems loosing water-retaining sand, strata, deepening of the river courses and causing bank slides, loss of vegetation on the bank of rivers, exposing the intake well of water supply schemes etc are few examples. This paper investigates to find the viable solution to the declining availability of natural sand. Due to current levels of construction in urban and rural areas, natural sand deposits are being depleted, manufactured sand is suitable for use as a fine aggregate in concrete. Manufactured sand offers a viable alternative to the use of natural sand. (Kulkarni, 2009).

Most of the aggregate used in our country are river sand as fine aggregate and crushed rock as coarse aggregates. The stone particles comprising to sand should be hard and sound. They should not be covered with deleterious materials like clay lumps and should be clean. They should not contain organic or chemically reactive impurities. River sand is becoming a very scarce material. Sand mining from our rivers becomes objectionable. It has now reached a stage where it is killing all our rivers day by day. Traditionally, natural sand has been used in most of the construction activities till recently. Natural sand is weathered and worn out particles of rocks and is of various grades and sizes depending on the amount of weathering (Kulkarni, 2009).

2.4 Propertes of Quarry Dust

From quarry industry, the quarry dust production goes as waste. The source of quarry dust was from the plan Industries Sdn Bhd Batu Pahat, Perlis. The quarry dusts are sieved until the fine aggregate was achieved is close to sand fine aggregates. The sizes of the quarry dust fine aggregate are between 2.36mm to 150µm.Other concrete mix component is crush stone (Mohd Mustafa Al Bakri, kamarudin H, Che Mohd Ruzaidi, Shamsul baharin &Nur Khairiatun Nisa, 2006).

The quarry dusts should be used in construction works because from the statistic waste is high, then the cost of construction would be saved significantly and the natural resources would be used efficiently. When the quarry dust is observed with eyes, their size is very close to sand. Thus the quarry dust may be examined the physical properties by using the standard of fine aggregate. After testing the properties, the following results are obtained: fineness modulus=3.682, specific gravity=2.71, absorption=0.47%, organic impurities of mineral dust number 5 (by comparing with organic plate), unit weight=1695kg/m3,bulking of quarry dust = 33.333%,clay and silt =4.34%,soundness of quarry dust by use of be used instead of sand because several properties are close to sand.

Examining of quarry dust to replace sand in concrete by using the water cement ratio of 0.45 the average compressive strength of concrete specimens at 28 days is 323.36 ksc. The arisen problem during the mixing process of concrete by using quarry dust to replace sand is drying of the concrete then the water is needed more than normally. Hence this research aims to study about admixture type E for the concrete and the general properties of concrete and iii) compressive strength of the concrete specimens. (Prachoon Khamput, 2005).

Table 2.1: Physical Properties of Quarry Dust and Sand

Property	Quarry Rock Dust	Natural Sand	Test Method
Specific gravity	2.54-2.60	2.6	IS 2386 (part III) 1963
Bulk relative density (kg/m3)	1720-1810	1460	IS 2386 (part III) 1963
Absorption (%)	1.20-1.50	Nil	IS 2386 (part III) 1963
Moisture Content (%)	Nil	1.5	IS 2386 (part III) 1963
Fine particles less than 0.075mm (%)	12-15	6	IS 2386 (part I) 1963
Sieve Analysis	Zone II	Zone II	IS 383 - 1970

Table 2.2: Chemical Characteristics of Quarry Rock Dust and River Sand

Material	Fe_2O_3 %Wt	MnO %Wt	Na_2O %Wt	MgO %Wt	K_2O_3 %Wt	Al_2O_3 %Wt	CaO %Wt	SiO_2 %Wt	Test Method
Quarry Rock Dust	1.22	0.07	3.0	0.33	5.34	13.63	1.28	75.25	IS 4032-1968
River Sand	1.75	0.03	1.37	0.77	1.23	10.52	3.21	80.78	

Source: Hameed and Sekar (2009)

Quart dust is made while blasting, crushing and screening coarse aggregate. Quarry dust has rough, and angular particles, and such causes a gain in strength due to better interlocking and concomitant loss in workability. The use of quarry dust sometimes causes an increase in the quantity of cement requires to maintain workability. A survey of samples from 6 quarry dust suppliers in the Galle region of Sri Lanka revealed that they were all more well grade than river sand provided by a supplier from the same region (Chaturanga Lakshani Kapungamage , 2004).

Table 2.3: Physical Characteristics of Quarry Rock Dust and River Sand

Material	Fineness modulus	Effective size (mm)	Coefficient of uniformity	Coefficient of Gradation
Quarry Rock Dust	2.35	0.22	4.50	2.20
River Sand	2.20	0.20	6.00	2.00

Source: Hameed and Sekar (2009)

Table 2.4: Moisture Content of Quarry Rock Dust and River Sand.

Material	Moisture Content (%)	
	Wet	Dry
Quarry Rock Dust	24.25	2.10
River Sand	25.00	2.50

Source: Hameed and Sekar (2009)

2.4.1 Effect of Quarry Dust to Fresh Concrete

The slump varied from 230 to 245 mm whereas the slump flow differed from 520 to 550 mm. In general, a slump higher than 200 mm and a slump flow greater than 500 mm impart a good flowing ability. Hence the slump and slump flow results indicated a good flowing ability of the concretes. Test results showed that quarry waste fine aggregate enhanced the flowing ability of the concretes. It can be seen from the test result concrete containing quarry dust as fine aggregates provided higher slump and slump flow than any other concretes. This is primarily due to deviation in gradation of quarry dust as fine aggregates. From the test, the quarry dust as fine aggregates had more materials coarser than 1.18, 2.36, and 4.75 mm sieve sizes. Also, higher fractions finer than 150 and 300 µm sieves were present (Safiuddin et al,2007).

2.4.2 Effect of Quarry Dust to Hardened Concrete

The 28 and 56 days compressive strength of the concrete varied from 40 to 47 MPa. Concrete containing quarry dust as fine aggregates provided about 7 to 9% lower compressive strength than normal concrete. This is probably due to unfavorable gradation and excessive flakiness of quarry dust as fine aggregates. Quarry dust provided a flakiness index of 55%. The maximum allowable flakiness index of aggregates is generally limited to 40%. cc Some bleeding water and air voids are generally formed underneath the flaky particles. It may cause a negative impact on the compressive strength of concrete. (Md. Safiuddin, S.N. Raman and M.F.M Zain ,2007).

It is found that using of 70% of quarry dust, the concrete has maximum of compressive strength at both 7 and 28 days which are 292 and 415 ksc respectively. Increasing of quarry dust in proportion of 90% and 100% result in decreasing of compressive strength. Because size of quarry dust is laid between size of sand and stone, then using 70% of quarry dust will affect on well distribution of aggregate. Thus there is less space in concrete and result in maximum compressive strength more than 300 ksc. Hence it could be used to create the mixing concrete in general construction projects. At 28 days, the maximum compressive strength is 407ksc at 28 days. In the case using 100% of quarry dust, it is shown that the compressive strength is in the same level of the normal concrete. Moreover at 100% of quarry dust, it is still maximum case in which the compressive strength is larger than 70% and 90% of quarry dust. This might be caused by efficient infiltration of the quarry dust.

Concrete produced using quarry fines shows improvement in higher flexural strength, abrasion resistance, and unit weight All quarry dust replaced specimens with addition ofinhibitor have shown slight increase in flexural strength when compared to control specimen. it is found that bond strength of quarry dust replaced concrete specimens are more than the control specimen.(Dr.K.Kannan,M.Devi,2009). This statement were supported by A. Sivakumar and Prakash were said the addition of the quarry dust improved the strength properties of concrete. The 28 days compressive strength Of 25% replacement of sand with quarry dust of concrete is....higher than the controlled concrete sample.

2.5 Testing for Workability and Fresh Concrete

Three fresh concrete test are conducted and follow the standarts that are used as reference in this research are Slump Test BS 1881: Part 102:1983 ,Vebe Test BS 1881: Part 104:1983 and Compacting Factor Test BS 1881: Part 103:1983.

Meanwhile, two hardened test are conducted that are Concrete Compression Test BS 1881: Part 116:1983 and Flexural Strength Test BS 1881: Part118:1983.

2.5.1 Slump Test

The slump test is the most widely used, primarily because of the simplicity of the apparatus required and the test procedure. The test is suitable only for concretes of medium to high workability (that is having slump values of 25 mm to 125 mm). The slump test is limited to concrete with maximum size of aggregates of 38 mm. (Gambhir, 2004). Table 2.5 shows slump class according to BS EN 206-1:2000.

Table 2.5: Workability Category of Slump

Workability category	slump (mm)
Very Low	0-10
Low	10-30
Medium	30-60
High	60-180

Source: BS 1881: Part 102

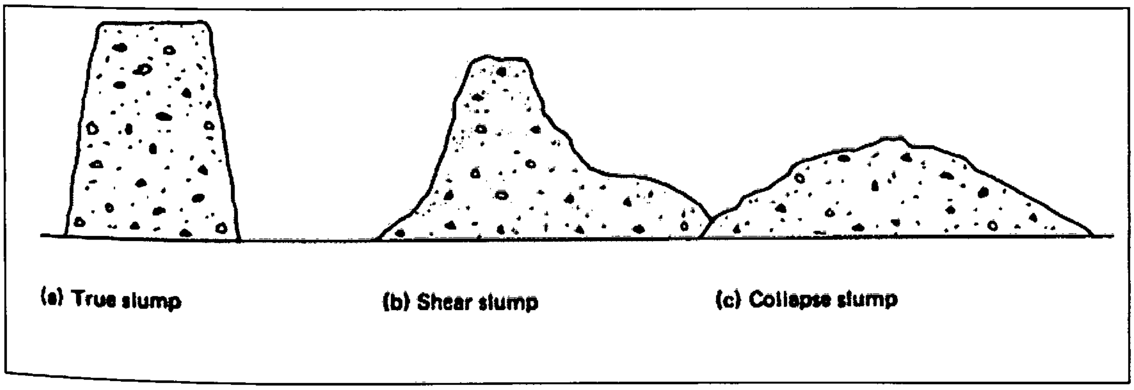

Figure 2.1 Type of Slump

Source: BS 1881: Part 102:1983

2.5.2 Compacting Factor Test

The workability of concrete has been defined as the amount of work required to place the concrete and to compact it thoroughly.It is simpler to apply a standard amount of work to the concrete and to measure its degree of compaction is defined as compacting factor which is measured by the density ratio for example the ratio of the density actually achieved in the test to the density of the same concrete fully compacted.The test is suitable for concrete with a maximum size of aggregate up to 40mm and it is described by 1881:Part 103:1983.

$$\text{Compacting Factor} = \frac{\text{Weight of partially compacted concrete}}{\text{Weight of fully compacted concrete}} \qquad \text{Formula1}$$

Table 2.6: Workability Category of Compacting Factor Test

Workability category	Compacting Factor
Very Low	0.7-0.75
Low	0.75-0.85
Medium	0.85-0.95
High	0.95-1.0

Source: BS 1881, Part 104