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Demolished Waste as Coarse Aggregates

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ABSTRACT:

There is a large amount of demolished waste generated every year in India and other developing countries. Since very small amount of this waste is recycled or reused. So, disposing this waste is a very serious problem because it requires a large amount of space. This study is a part of comprehensive program wherein experimental investigations have been carried out to evaluate the effect of partial replacement of coarse aggregate by demolished waste on compressive strength and workability of DAC (Demolished Aggregate Concrete). For the study 3, 7 and 28 days compressive strengths were recorded. The previous study on this project shows that the compressive strength of the DAC (Demolished Aggregate Concrete) is somehow resembles with the conventional concrete if used in a proper amount up to 80%. So in this study we have taken the demolished concrete aggregate 10%, 20%, 40%, 60%, 80% by weight of the conventional coarse aggregate and the concrete cubes were casted by that demolished concrete aggregate then further tests conducted such as workability , compressive strength for that DAC and the result obtained are found to be comparable with the conventional concrete.

INTRODUCTION

Concrete is basically made of aggregates glued by a cement materials paste, which is made of cement materials and water. Each one of these concrete primary constituents, to a different extent, has an environmental impact and gives rise to different sustainability issues [Mehta 2001, 2002]. The current concrete construction practice is thought unsustainable because, not only it is consuming enormous quantities of stone, sand, and drinking water, but also two billion tons a year of Portland cement, which is not an environment friendly material from the standpoint of energy consumption and release of green-house gases (GHG) leading to global warming. Furthermore, the resource productivity of Portland-cement concrete products is much lower than expected because they crack readily and deteriorate fast. Since global warming has emerged as the most serious environmental issue of our time and since sustainability is becoming an important issue of economic and political debates, the next developments to watch in the concrete industry will not be the new types of concrete, manufactured with expensive materials and special methods, but low cost and highly durable concrete mixtures containing largest possible amounts of industrial and urban byproducts that are suitable for partial replacement of Portland cement,

Recycle aggregate concrete

Recycled-aggregate concrete (RAC) for structural use can be prepared by completely substituting natural aggregate, in order to achieve the same strength class as the reference concrete, manufactured by using only natural aggregates [Corinaldesi et al. 1999]. This is obviously a provocation, since a large stream of recycled aggregates to allow for full substitution of

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natural aggregates is not available. However, it is useful to prove that to manufacture structural concrete by partly substituting natural with recycled aggregates by up to fifty percent is indeed feasible. In any case, if the adoption of a very low water to cement ratio implies unsustainably high amounts of cement in the concrete mixture, recycled-aggregate concrete may also be manufactured by using a water-reducing admixture in order to lower both water and cement dosage, or even by adding fly ash as a partial fine aggregate replacement and by using a super plasticizer to achieve the required workability [Corinaldesi & Moriconi 2001].

Durability

Aspects related to the durability of recycled aggregate concretes have already been studied. In particular, attention has been focused on the influence of concrete porosity on drying shrinkage and corrosion of embedded steel bars as well as on concrete carbonation, chloride ion penetration, and concrete resistance to freezing and thawing cycles [Corinaldesi & Moriconi 2002, Tittarelli & Moriconi 2002, Corinaldesi et al. 2001, 2002b, Moriconi 2003]. Results showed that, when fly ash is added to recycled-aggregate concrete:

1. the pore structure is improved, and particularly the macrospore volume is reduced causing benefits in terms of mechanical performance, such as compressive, tensile and bond strength [Corinaldesi & Moriconi 2002, Marconi 2003]. With respect to ordinary concrete prepared with natural aggregate, the only difference is a somewhat reduced stiffness of recycled aggregate concrete containing fly ash, which should be taken into account during structural design [Moriconi 2003];
2. the drying shrinkage of recycled-aggregate concrete, from a serviceability point of view, does not appear to be a problem since, due to the reduced stiffness of this concrete, the same risk of crack formation results as for ordinary concrete under restrained conditions [Moriconi 2003];
3. testing of concrete resistance against freezing and thawing cycles showed no difference between natural-aggregate concrete and high volume fly ash recycled-aggregate concretes [Corinaldesi & Moriconi 2002];
4. the addition of fly ash is very effective in reducing carbonation and chloride ion penetration depths in concrete because of pore refinement of the cement matrix due to a filler effect and pozzolanic activity of fly ash. Moreover, the strong beneficial effect of the presence of fly ash on chloride penetration depth is quite evident since the chloride ion diffusion coefficient in high volume fly ash concrete is one order of magnitude less than that into concrete without a fly ash addition [Corinaldesi & Moriconi 2002, Corinaldesi et al. 2002];

LITERATURE REVIEW

Due to rapid development of industries and urban areas waste generation is also increases, which is unfavorably carrying out the environment. At present, in India 27.8% of the total population living in cities, which is 13.8% more than the year of 1947. There is a shortage of about 55,000 million m 3 due to the construction of new infrastructure which shows that the demand of the aggregates in future increases. 750 million m 3 additional aggregate is required to fulfill the demand of the road sector. There is a huge gap between the demand and the supply of the aggregates because giant amount of aggregates is required in the housing and transportation nowadays. During construction waste generated is about 40 kg per m 2 to 60 kg per m 2 . Similarly, during renovation, repair and maintenance work 40 kg/m 2 to 50 kg/m 2 waste is generated. The waste generated due to demolition of the building is highest among all the wastes. If we demolish permanent building about 300kg/m 2 waste is generated and in case of demolition of semi-permanent building 500kg/m2 waste is generated. Environment must be protected for the survival of the human beings and other lives on earth.

So environment consciousness, sustainable development and preservation of natural resources should be kept in mind during the construction work and industrialization. At present, demolished material are dumped on land or treated as waste, which means they cannot be utilized for any purpose. If we put the demolished waste on land then the fertility of the soil get decreases. 23.75 million tons of waste is generated annually in India in the year of 2007 according to Hindu Online. According to CPCB (Central Pollution Control Board) Delhi, 14.5 million tons out of 48 millionwaste is generated from the construction waste from which only 3% is utilized in the construction of the embankment. In 100 parts of the construction waste 40 parts are of concrete, 30parts of ceramics, 5 parts of plastics, 10parts of wood, 5 parts of metal and 10 parts of some other mixed compounds. There is a huge demand of construction aggregate which is more than 26.8 billion in all over the world. There is a quiet increment in the utilization and demand of the natural aggregates in India due to housing, road, construction and infrastructure development.

During the time of Second World War the use of demolished concrete waste was started, it was utilized in the construction of the pavements. According to Union Environment Ministry 12 million tons of the construction and demolition waste is generated in the year of 2013 but the current method adopted for the management of this waste are landfill mainly which causes a giant amount of the construction and demolished waste deposition and such huge amount affects the environment adversely. In India concrete, bricks, sand, mortar and tile residues are the main materials found in the demolished waste of buildings. This waste can be recycled or process in to the recycled demolished aggregates which can be utilized in the concrete mixes. Demolished concrete aggregate (DCA) is generally produced by the crushing of concrete rubble, then screening and removal of contaminants such as plaster, paper, reinforcements, wood, plastics. Concrete made with this type of recycled demolished concrete aggregate is called Demolished aggregate concrete (DAC).

The main purpose of SSRG International Journal of Civil Engineering (SSRG-IJCE) – volume 3 Issue 5 – May 2016 ISSN: 2348 – 8352 www.internationaljournalssrg.org Page 118 this work is to determine the basic properties of DAC made of coarse recycled demolished concrete aggregate then to compare them with the properties of concrete made with natural aggregates concrete. Fine recycled aggregate cannot be applied in the concrete which is used for structures so we can ignore its amount 70-75% aggregates are required for the production of concrete. Out of this 60-67% is of coarse aggregate & 33-40% is of fine aggregate. India is in the top 10 users of the concrete due to rapid growth of infrastructure. For the production of 1 ton of natural aggregate 0.0046 million ton of carbon is emitted which is harmful for the environment. So generation of the carbon is also getting reduced if we use demolished aggregates.

As the demolished aggregate is lighter than the natural aggregate so the concrete made from such aggregate possesses low density but the water absorption of the demolished aggregate is higher than the natural aggregate and the strength of the demolished aggregates is somehow lesser than the natural aggregates. So concrete made from these demolished aggregate can be utilized where more strength is not required e.g. in low rising buildings, in reinforced concrete pavements etc.

EXPERIMENTAL INVESTIGATIONS

In this investigation an attempt has been made to study the effect of demolished concretion physical properties of concrete as replacement of coarse aggregate. The property of concrete used, the procedure used for mixing and tests conducted are represented in this module.

The mixing has been done in the laboratory. The properties considered in this study are strength and workability. The experimental program is broadly divided into following categories, viz.

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Workability characteristics
a)Slump
b)Compaction factor test

Strength characteristics
a)Compression test

MATERIALS USED
CEMENT
Cement can be defined as the bonding material having cohesive & adhesive properties which makes it capable to unite the different construction materials and form the compacted assembly.

Ordinary Portland Cement (O.P.C)
It is hydraulic cement. It is used in the making of concrete with property of setting and hardening, of which when the chemical properties react with water, O.P.C does not disintegrate in water as it sets and hardens in water.

Ideal applications
1. Gives more flexibility to architects and engineers to design sleeker and economical sections
2. On being mixed with other aggregates, O.P.C begins to serve a dual purpose. One, it provides for the concrete products to be workable when wet and two, it provides them to be durable when dry.
3. It is extensively used by retaining walls and the precast concrete block walls as a major component to build a strong foundation of concrete.
4. Almost negligible chloride content results in restraining corrosion of concrete structure in the hostile environment
5. Produces highly durable and sound concrete due to very low percentage of alkalis, chlorides, magnesia and free lime in its composition.
6. It is also brought into usage in mortars, plasters, screeds and grouts as a material which can be squeezed into gaps to consolidate the structures.

Advantages
- Roadways, runways, flyovers and bridges
- For heavy defense structures like Bunkers
- Pre-stressed concrete structures
- Residential and commercial buildings
- Pre-casted cubes

TESTS ON CEMENT
(a) Field Test
It is sufficient to subject the cement to field tests when it is used for minor works. The following are the field tests.
1. Have a good look at the cement. The lumps must not be present. The color of cement should be greenish grey.
2. Drill your hand into the cement bag, you should feel cool.
3. Take a pinch of cement in between your fingers, it should give you smooth and gritty feeling.
4. Take a handful of cement and throw it in a bucket full of water, the particles should float for some time before they sink.

(b) Laboratory Testing
- Fineness test
- Setting time test
- Strength test
- Soundness test
- Heat of hydration test
- Chemical composition test

The following tests were conducted to determine the properties of cement.

SETTING TIME TESTS
(A) NORMAL CONSISTENCY
The objective of conducting the test is to find out the amount of water to be added to the cement to get a paste of normal consistency i.e.…, the paste of certain solidity which is used to fix the quantity of water to be mixed to the cement for the test for tensile strength, compression strength, setting time and soundness of cement as standard for comparing various cements as it is the water cement ratio that decides the characteristics of cement water paste.

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Standard consistency test of cement paste is defined as the amount of water expressed as the percentage by weight of cement which will permit the vicat plunger to penetrate to a depth of 5mm to 7mm from the bottom of vicat mould.

Plunger is the needle used for determining the normal consistency of cement

Apparatus

- Vicat apparatus with plunger & needles
- Stop watch

Test Procedure

- The test will be generally conducted at a temperature of 27+20°C
- Prepare a paste of weighed quantity of cement (300gms) with weighed quantity of potable or distilled water, taking care that the time of gauging is not less than 3 minutes or more than 5minutes and the gauging is completed before any sign of setting occurs.
- The gauging is counted from the time of adding water to the dry cement until commencing to fill the mould.
- Fill the vicat mould with this paste resting upon a non-porous plate.
- Smoothen the surface of the paste, making it level with the top of the mould.
- Slightly shake the mould to expel the air.
- In filling the mould operator's hands and the blade of the gauging trowel shall only be used.
- Immediately place the test block with the non-porous resting plate, under the rod bearing the plunger.
- Lower the plunger gently to touch the surface of the test block and quickly release, allowing it sink into the paste.
- Record the depth of penetration
- Prepare trial pastes with varying percentages of water and test as described above until the plunger is 5mm to 7mm from the bottom of the vicat mould.

(B) INITIAL SETTING

Initial setting time regarded as the time elapsed between the movements that the water is added to the cement, to the time that the paste starts losing its plasticity. Initial needle is used for determining initial setting time.

(C) FINAL SETTING TIME

Once the concrete is placed in the final position, compacted and finished, it should lose its plasticity in the earliest possible time so that it is least vulnerable to damages from external destructive agencies. This time should not be more than 10 hours which is often referred to as final setting time. Final needle is used for determining final setting time.

Fig 3.1 VICAT APPARATUS

Table: 3.1 Shows The Properties of Cement

s. no:	Characteristics	Values obtained	Standard values
1	Normal consistency	33mm	33 to 35 mm
2	Initial setting time	40 min	Not be less than 30 mins
3	Final setting time	300 min	Not be greater than 600 mins.

AGGREGATES

Construction aggregate, or simply "aggregate", is a broad category of coarse particulate material used in construction, including sand, gravel, crushed d stone, slag, recycled concrete and geo-synthetic aggregates.

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Aggregates are the most mined materials in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material.

Fine Aggregate

The aggregate which passes through 4.75mm IS Sieve are termed as Fine Aggregate. They play a role of filling the voids in the concrete mix. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape.

Coarse Aggregate

Coarse aggregate is a material that will pass the 80mm sieve and will be retained on the 4.75mm sieve. As with fine aggregate, for increased workability and economy as reflected by the use of less cement, the coarse aggregate should have a rounded shape. Larger pieces offer less surface area of the particles than an equivalent volume of small pieces. Use of the largest permissible maximum size of coarse aggregate permits a reduction in cement and water requirements.

WATER

Water is one of the most important elements in construction but people still ignore quality aspect of the element. The water is required for preparation of motor, mixing of cement and concrete and for curing work etc... During construction the quality and quantity of water has much effect on the strength of mortar and cement concrete in construction work. The required quantity of water is used to prepare mortar or concrete, but in practice it is seen that more water is mixed to make the mix workable. This is a bad practice and additional water weakens the strength of cement paste. Extra water also weakens adhesive quality.

Quality of Water

The water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth and other substances that may be deleterious to bricks, stone, concrete or steel. Potable water is generally considered satisfactory for mixing. The pH value of water should be not less than 6. A popular yard sticks to the suitability of water for mixing concrete is that, if water is fit for drinking it is fit for making concrete. This does not appear to be a true statement for all conditions. Mixing and curing with sea water shall not be permitted.

(a). To neutralize 200 ml sample of water. Using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NAOH.

(b) To neutralize 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 normal HCL

SAND

Sand is an inorganic material. It consists of small angular or rounded or sharp grains of Silica. Sand is formed by decomposition of sand stone under the effect of weathering agencies. Various sizes or grades of sand are formed depending on the amount of wearing.

Characteristics of Good Sand

- Should consist of coarse, angular, sharp and hard grains.
- Should not contain any organic matter.
- Should be chemically inert.
- Must be strong and durable.
- Size of grains should be such that, next line they pass through 4.75 mm I.S. sieve and are entirely retained on 75µ I.S sieve.

The following tests were conducted to determine the properties of sand

Natural Sand

- This sand contains impurities like silt, silica etc.
- Natural Sand is made from different type of stones so; binding strength varies.

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- Natural Sand which is available today, don't have fines below 600 microns in proper gradation. So, voids in the concrete are not filled properly & also increases cement consumption.
- Natural and gives low compressive strength as compare to Artificial Sand.
- As the voids are not filled properly, strength of the concrete is not achieved.
- As every truck of Natural Sand has different fineness modules, every time concrete mix design have to be changed.
- Natural Sand is available in less quantity so; it is costlier.
- Because of sand dragging, riverbeds had become deep. It is harmful to thenature.
- Natural Sand contains pieces of bones, woods etc. So it is not suitable as per Vastushastra.

TESTS CONDUCTED ON SAND

SIEVE ANALYSIS

The portion of sand retained on 4.75mm sieve for the analysis. The quantity of sample to be taken shell depends upon the maximum particle size contained in the sand.

Separate the sample into various fractions by sieving through the 4.75mm, 2.36 mm, 1.18mm, 600µm, 300µm, 150µm and pan. While sieving through each sieve agitate the sieve so that the sample rolls in irregular motion over the sieve. Any particle may be tested to see if they will fall through but they shall not be pushed through. If the soil appears to contain over 5% moisture, determine the water content of the material.

When the soil sample contains less than 5% of moisture it is not necessary to determine the moisture content for dry weight computation and make all determinations on the basis of wet weight only. If the soil contains more than 20% of gravel particles and the fines are very cohesive with considerable amounts adhering to the gravel after separately wash the gravel on 4.75mm sieve using sodium hexametaphosphate if necessary.

Fig 3.2 Sieve shaker

Table 3.2 Sieve Analysis For Fine Aggregate

S. NO.	SIEVE NO.	MASS RETAINED (gms)	%RETAINED	% PASSING	CUMULATIVE % RETAINED
1	4.75	95	9.5	90.5	9.5
2	2.36	112.5	11.25	79.25	20.75
3	1.18	118.5	11.85	67.4	32.6
4	600µm	105.5	10.55	56.85	43.15
5	300µm	313	31.3	25.55	74.45
6	150µm	251	25.1	0.45	99.55
7	Pan	4.5		_	
				ΣF =	280

Modulus of fine aggregate = ΣF/100=2.8

BULKING OF SAND

The absorbed moisture content in the fine aggregate results in the bulking of volume. Moisture forms a thin film around each particle and is known as adsorbed moisture. This film of moisture exerts surface tension which keeps the neighboring particles away from it. This causes the bulking of the volume. The bulking will depend upon the percentage of moisture content up to certain limit and beyond that the further increases in the moisture content results in the decrease in the

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volume. When the film of water around the particles becomes thicker, the particle cannot hold it and it becomes absorbed water and force of repulsion between the particles decreases and finally becomes zero. It can be noted that fine sand bulks more and coarse sand bulks less.

Due to the bulking, fine aggregate shows completely unrealistic volume. Therefore it is absolutely necessary that consideration must be given to the effect of bulking in proportioning the concrete by volume

Apparatus

- Cylindrical beaker
- Tray

Test Procedure

- Take 300 ml sand say v1 and put it in a container.
- Empty the container on to a clean metal tray without any loss of sand.
- Add 1% of water by weight of sand and mix it thoroughly by hand.
- Put back the loose sand into the container without tamping it.
- Smooth and level the top surface of moist sand and its depth v2.
- Repeat the above procedure with 2%,3%......5%.

Fig 3.3 BULKING OF SAND APPARATUS

SPECIFIC GRAVITY AND WATER ABSORPTION

Specific gravity of aggregate is defined as the ratio of weight of aggregate to the weight of an equivalent volume of water 270C water absorption is the weight of the water absorbed in terms of oven dried weight of aggregate.

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material having low specific gravity are having generally weaker then the those with higher specific gravity values.

Water absorption of aggregates gives strength of rock, stone having more absorption are generally unsuitable unless they are found to be acceptable based on strength and hardness test.

Apparatus:

- Pycnometer
- Weighing machine

Test Procedure

- Take 500 g of fine aggregate (the quantity shall be in such a way that it should fill the pycnometer up to two thirds of its volume) and cleaned it thoroughly by washing it -through 75µ sieve till the fine dust is fully removed and the sand was free from all the physical impurities.
- Fill the sand in pycnometer and pour distilled water till the sand is inundated. Clean the pycnometer on its outside surface and find its weight after fully saturation and let the weight be ‘A’.
- Empty the pycnometer and fill it with distilled water only and let the weight be ‘B’.
- The wet aggregates were cleaned with soft clothes until the aggregate becomes saturated surface dried and let the weight be ‘C’.
- The aggregates were kept in oven and dried it at a temperature of 100 to 110 degrees

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- The aggregates from the oven were removed and cool to room temperature in the air tight desiccators and let the weight be 'D'.

$$\text{Specific gravity} = \frac{D}{C-(A-B)}$$

$$= \frac{499}{500-(1826-1514)}$$

$$=2.65$$

Fig 3.4 Pycnometer

FINENESS MODULUS (F.M)

Fineness modulus is an empirical factor obtained by adding the cumulative percentages retained on each of the standard sieves and dividing it by arbitrary number 100.

Fineness modulus of sands varies as below

Fine sand	:	F.M	:	2.2-2.6
Medium sand	:	F.M	:	2.6-2.9
Coarse sand	:	F.M	:	2.9-3.2

Sand having fineness modulus more than 3.2 will be unsuitable for making satisfactory concrete

Table 3.3: Shows The Characteristics of Sand

S.NO	CHARACTERISTICS	VALUE
1.	Bulking	12.8%
2.	Specific gravity	2.65
3.	Water absorption	12.8%
4.	Fineness modulus	2.8

TESTS CONDUCTED FOR CONCRETE MIX

Workability

Workability is the property of concrete which determines the amount of useful internal work necessary to produce full compaction. (or) the "ease with which concrete can be compacted hundred percent having regard to mode of compaction and place of deposition.

A concrete mix is said to be workable when it satisfies the following five properties.

1) Easy to mix
2) Easy to transport
3) Easy to place
4) Easy to compact
5) Easy to finish

The workability is one of the physical parameters of concrete which affects the strength and durability and the appearance of the finished surface. The workability of concrete depends on the water cement ratio and the water absorption capacity if the aggregates. If the water added is more which will lead to bleeding or segregation of aggregates. The test for the workability of concrete is given by the Indian Standard IS 1199-1959 which gives the test procedure using various equipment's. In our case we have used slump cone test and compaction factor test for measuring the

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workability of concrete. We have measured the height of the fall of the cone of concrete for various water-cement ratios and recorded the values for ordinary concrete.

- Slump cone test
- Compacting factor test

Slump Cone Test

The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. This test is performed to check the consistency of freshly made concrete. Consistency is a term very closely related to workability. It is a term which describes the state of fresh concrete. It refers to the ease with which the concrete flows. Workability of concrete is mainly affected by consistency i.e., wetter mixes will be more workable than drier mixes, but concrete of the same consistency may vary in workability. It is also used to determine consistency between individual batches. The test is popular due to the simplicity of apparatus used and simple procedure.

The apparatus for conducting the slump test essentially consists of metallic mould in the form of a frustum of a cone having the internal dimensions as under.

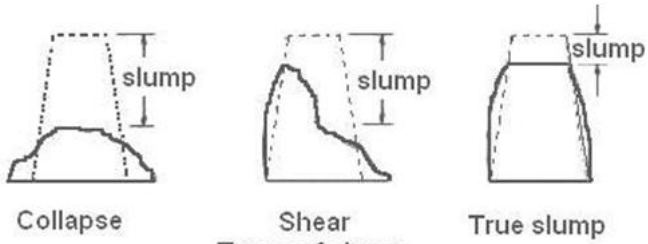
Bottom Diameter	:	20 cm
Top Diameter	:	10 cm
Height	:	30 cm

Fig 3.9 Slump Cone Apparatus

Test Procedure

In slump cone the container is filled with concrete in three layers. Each layer is tamped 25 times with a standard 16mm diameter steel rod and 600mm height. The top surface is struck off by means of a screening and rolling motion of the tamping rod.

Immediately after filling, the cone is slowly lifted and the unsupported concrete will now slump. The decrease in the height of the center of the slumped concrete is called “Slump”. Instead of slumping evenly all round as in a “True Slump”. One half of the cone slides down an inclined plane is a “Shear Slump”. Mixes of stiff consistence have a “Zero Slump”. If any specimen shears off laterally or collapses, the test should be repeated.



Types of slump

S.NO	SLUMP VALUES(mm)			AVERAGES(mm)
	SAMPLE 1	SAMPLE 2	SAMPLE 3	
1	50	52	48	50

COMPACTION FACTOR TEST

The compacting factor test is designed primary for use in the laboratory but it can also be used in the field. It is more precise and sensitive than the slump test and is particularly useful for concrete mixes of very low workability. Such dry concrete are insensitive to slump test. The diagram of the apparatus is shown in figure3.10.

The compacting factor test has been developed at the road research laboratory U. K. And it is claimed that is one of the most efficient tests for measuring the workability of concrete. This test works on the principle of determining the degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height.

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The degree of compaction called the compacting factor is measured by the density actually achieved in the test to density of same concrete fully compacted.

Test Procedure

- The sample of concrete to be tested is placed in the upper hopper up to the brim.
- The trap-door is opened so that the concrete falls in to the lower hopper.
- Then the trap-door of the lower hopper is opened and the concrete is allowed to fall in to the cylinder.
- The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane scale.
- The concrete is filled up exactly up to the top level of the cylinder.
- It is weighed to the nearest 10gms. This weight is known as “weight of partially compacted concrete”.
- The cylinder is emptied and then refilled with the concrete from the same sample in layers approximately 5cm deep.
- The layers are heavily rammed or preferably vibrated so as to obtain full compaction.

The top surface of the fully compacted concrete is then carefully struck of level with the top of the cylinder and weighed to nearest 10gms. The weight is known as “weight of fully compacted concrete”.

$$\text{compaction factor} = \frac{\text{weight of partially compacted concrete}}{\text{weight of fully compacted concrete}}$$

It can be realized that compacting factor test measures the inherent characteristics of the concrete which relates very close to the workability requirements of the concrete and as such it is one of the good tests to depict the workability of concrete.

The compacting factor equipment has been shown below in fig3.10

Fig 3.10 Compaction Test Apparatus

COMPRESSIVE STRENGTH TEST

Concrete has relatively higher compressive strength, but very poor in tensile strength. The different mix of concrete gives various strength, according to the IS 10262: 1982 gives the characteristic and design strength values for various grades of concrete. The strength attained by the mix must be tested by its compressive strength of the samples which are made in the standard mould of size 150mm X 150mm X 150mm and then the cubes are kept for curing and the compressive strength test was done according to IS 516: 1959 for 7days, 14days and 28days for ordinary mix and for the partial replaced samples.

Fig 3.11 Universal Testing Machine

MIX DESIGN (ACI committee 211.1-91 method)

Design of concrete mix needs not only the knowledge of material properties and properties of concrete in plastic condition; it also needs wider knowledge and

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experience of concreting. Even then the proportion of the materials of concrete found out at the laboratory requires modification and readjustments to suit the field conditions.

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. The purpose of designing as can be seen from the above definitions in two-fold. The first object is to achieve the stipulated minimum strength and durability. The second object is to make the concrete in the most economical manner.

DESIGN STIPULATIONS FOR PROPORTIONING (Conventional Sand)

- Grade designation = M25.
- Type of cement = OPC 53 grade.
- Maximum nominal size of aggregate = 20 mm.
- Maximum water cement ratio = 0.47
- Slump = 50mm(Workability).
- Degree of supervision = good.
- Type of aggregate = crushed angular aggregate.
- Chemical admixtures = not recommended.
- Strength of concrete at 28 days = 20N/mm2.
- Fineness modulus = 2.8.
- Specific gravity of fine and coarse aggregate = 2.65 and 2.7.

Step1:- Calculation for mean strength.

Mean strength $F'_{ck} = F_{ck} + TS$ (where T=tolerance factor, S=standard deviation)

= 20+1.64 × (4).

= 26.56 N/mm².

Step2:- Selection of water cement ratio.

Since OPC is used, according to IS456:2000,

w/c ratio = 0.47.

Step3:- Calculation for cement content.

Cement content = water content/water cement ratio.

Water content = 186 according to code.

Cement content = 186/0.4 = 395Kg/m³.

Step4:-Calculation of mix propositions:

Volume of concrete = 1m^3

Absolute volume of cement =395/(3.15×1000)

= 0.125m^3

Volume of water = 186/1000

= 0.186 m^3

Total aggregate = 0.125+0.186

= 0.31 m^3

Absolute volume of total aggregate = 1 – 0.31

= 0.69 m^3

Step5:- Proportioning of volume of coarse aggregate.

Since 20mm coarse aggregate is used, for fineness modulus of 2.80, the dry rounded bulk volume of coarse aggregate is o.62 per unit volume of concrete. But it is highly workable, so it should reduce by 10%.

0.62 × (10÷100) = 0.062.

Therefore,

Volume of coarse aggregate = 0.62-0.062.

= 0.558.

Therefore,

Weight of coarse aggregate = 0.62×0.62×2.7×1000

= 1037 kg/m^3

Weight of fine aggregate = 0.62×0.42×2.65×1000

= 690 kg/m^3

Step6:-Site correction

Fine aggregate = (1/100) × 690 = 6.9 lit

Coarse aggregate = (0.5/100) ×1037 = 5.18 lit

Total aggregate required water = 6.9 + 5.18 = 12.08 lit

Total required water = 186 + 12.08 = 198 lit

Actual weight of fine aggregate = 690 – 6.9 = 683.1kg/m^3

Actual weight of coarse aggregate = 1037 – 5.18 = 1031.82kg/m^3

Step 7 :- Weight of all ingredients.

Weight of cement = 395Kg/m³.

Weight of water = 198 Kg/m³.

Weight of C.A = 1031.82Kg/m³.

Weight of F.A = 690 Kg/m³.

Proportions:

Cement:	F.A:	C.A:	water.
395:	690:	1031.82:	198.
1:	1.72:	2.62:	0.50.

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Results

The following are the results of compressive strengths of all concrete mixes prepared by replacing CA by Demolished concrete with various percentages. The strengths of all concrete mixes are determined a 7, 14, 28 days of curing in water. The following are the tables showing all the results.

Table 7.1: Variation of Compressive strength with days of curing for sample 1

SAMPLE 1 : CONVENTIONAL CONCRETE MIX OF 1:1:2				
S. No	NUMBER OF DAYS OF CURING	COMPRESSIVE STRENGTH(N/mm²)		AVERAGE COMPRESSIVE STRENGTH (N/mm²)
		Sample 1	Sample 2	
1	7	16.5	15.9	16.2
2	14	21.4	20.8	21.1
3	28	26.3	26.9	26.6

Table 7.2: Variation of Compressive Strength with Days of Curing For Sample 2

SAMPLE 2 : 20% REPLACEMENT OF DEMOLISHED CONCRETEIN CA				
S. No	NUMBER OF DAYS OF CURING	COMPRESSIVE STRENGTH(N/mm²)		AVERAGE COMPRESSIVE STRENGTH (N/mm²)
		Sample 1	Sample 2	
1	7	16	15.8	15.9
2	14	21	21.6	21.3
3	28	25.8	26.4	26.1

Table7.3: Variation of Compressive Strength with Days of Curing For Sample 3

SAMPLE 3 : 40% REPLACEMENT OFDEMOLISHED CONCRETE IN CA				
S. No	NUMBER OF DAYS OF CURING	COMPRESSIVE STRENGTH(N/mm²)		AVERAGE COMPRESSIVE STRENGTH (N/mm²)
		Sample 1	Sample 2	
1	7	16.5	16.4	16.45
2	14	21.8	22	21.9
3	28	26.8	27.5	27.15

Table 7.4: Variation of Compressive Strength with Days of Curing for Sample 4

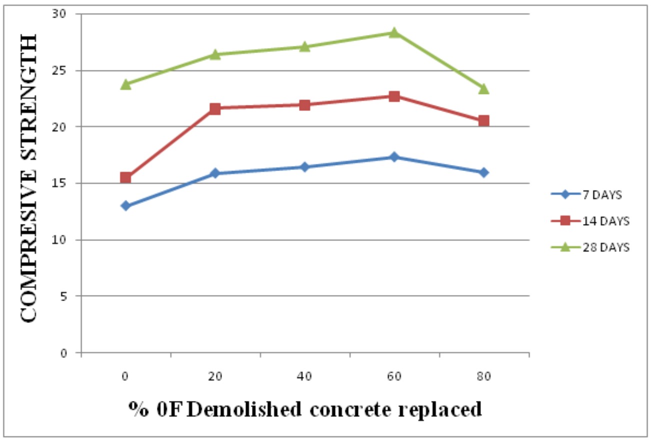
SAMPLE 4 : 60% REPLACEMENT OF DEMOLISHED CONCRETE IN CA				
S. No	NUMBER OF DAYS OF CURING	COMPRESSIVE STRENGTH(N/mm²)		AVERAGE COMPRESSIVE STRENGTH (N/mm²)
		Sample 1	Sample 2	
1	7	17.5	17.2	17.35
2	14	22.6	22.8	22.7
3	28	27.8	28.9	28.35

Table 7.5: Variation of Compressive Strength with Days of Curing for Sample 5

SAMPLE 5 : 80% REPLACEMENT OF DEMOLISHED CONCRETEIN CA				
S. No	NUMBER OF DAYS OF CURING	COMPRESSIVE STRENGTH(N/mm²)		AVERAGE COMPRESSIVE STRENGTH (N/mm²)
		Sample 1	Sample 2	
1	7	16.5	15.8	15.95
2	14	20.45	20.62	20.53
3	28	26.4	25.9	26.15

Table7.6: Compressive Strength for All Samples

8SAMPLE NO.	% OF DEMOLISHED CONCRETE	COMPRESSIVE STRENGTH (N/mm²)		
		7 days	14 days	28 days
Sample 1	0	16.2	21.1	26.15
Sample 2	20	15.9	21.6	26.4
Sample 3	40	16.45	21.9	27.1
Sample 4	60	17.35	22.7	28.35
Sample 5	80	15.95	20.53	23.35



Graph 7.1 showing compressive strength at various days of curing vs % of Demolished concrete

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Discussion on Compression Value

The compressive strength for the concrete mix gradually increased with the increase in % of Demolished concrete added up to 60% of CA replaced by Demolished concrete and then decreased with increase in % of Demolished concrete.

As the table and graphs shows the concrete mix prepared by replacing the 60% of CA by the Demolished concrete is having the more compressive strength. If there is a need of concrete with high compressive strengths in same grade of concrete the mix with 60% Demolished concrete can be adopted.

But through graphs we cannot judge the exact % at which the compressive strength is highest. Through the graph it can be said that the high compressive strength mix can be get at the percentage between 50 and 70. But through our experiment we adopt that high compressive strength mix can be obtained by replacing 60% of coarse aggregate by Demolished concrete.

High compressive strength can be seen in the concretes with 60% of Demolished concrete replaced in the place of CA

CONCLUSION

Replacement of natural coarse aggregate by 60% artificial aggregate gives the maximum compressive strength.

The concrete mix is more workable when 60% of CA is replaced by Demolished concrete as the slump values and compacting factor values are high when compared to conventional mix.

Finally the concrete mix with 60% of aggregate replaced by Demolished concrete gives the best mix with high compressive strength with high workability.

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