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Experimental on partially replacement of cement, fine aggregate, coarse aggregate using municipal waste ash, sea sand, lightweight aggregate

G. pradeep head of the department civil , M. abimanyu , I. Joshva , G. Nisanth , B. Suriyapriyan

Department of civil engineering, mookambigai college of engineering, tamilnadu, india

ABSTRACT

Concrete ingredients is different material like binding materials cement + fly ash , fine aggregate, coarse aggregate and water. Today construction cost is very high with using conventional materials due to unavailability of natural materials. The municipal waste dumping to the nearest site which spoils the land and atmosphere as well as it also effects of urban environment so use of this concrete is cost effective as well as environment friendly way to disposal of waste. As the river sand is widely used in development industry , the interest for final total is expanding quickly. As the results, there was an immediate requirement for alternatives to river sand such as alternative material. An experimental study is made on the strength aspects of cement concrete by partially replacing sea sand with as fine aggregate. As aggregate material typically comprises 65 - 75% of concrete volume and has significant effect on its mechanical properties aggregate type considerably affects concrete behaviour at high temperature. As the highest compressive strength was 19.8 N/mm^2 and 19.6 N/mm^2 at 28days for 20%. As the highest tensile strength was 4.9 N/mm^2 at 28days for 20% of replaced materials. As the highest flexural strength was 4.87 N/mm^2 at 28 days for 20% of replaced materials.

1. INTRODUCTION

Cement plays the role of a binder , a substance that sets and hardens and might bind alternative material along. Concrete is used more than any other man made material on this planet. It can be used for the construction of any type of structure. Because cement remains the most expensive ingredient in making of concrete. Cement is a fine, soft powder used as a binder because it hardens after contact with water. Cement plays vital role in building economic development of any country. Since ancient Greece and Rome, humankind has used cement for construction. However, the process for making this quick drying gray paste has changed significantly since those times. The rudimentary methods of yesteryear are no longer used to work with limestone instead, special machinery is used to generate very fine powder in quantities never before soon. Cement is an essential building material; in fact, it is the one most widely used in the world. Most structures use it in at least one of their stages: foundations, floors, lintels, interior or exterior walls, or ceilings. he main benefit of cement is that it is a resistant, durable material that's low-cost and has a wide variety of applications. This makes it a favourite among architects and construction companies around the world. Concrete and the price of cement is increasing day by day. The word "cement" comes from Romans, UN agency used the term masonry fashionable concrete that was made up of rock with calcined lime as binder. Cement is widely used by human beings and it is second material after water used by human beings .India is second largest country after china based on uses of cement. During production of cement and hydration process of cement carbon dioxide is produced based on experimental investigation it has been proved that 1 tons of clinker produces around 1tons of CO2. Cement which is not possible right now for unavailability of such a binding material and another way is way-2 partial replacement of cement by appropriate material. As per this code if we are designing concrete grade of M20. If we find suitable material as a partial replacement of cement then we can save cement and environment also. Based on recent survey total amount of cement is used during the financial year of 2012 247MT and it increase up to 550MT for financial year 2020. Municipal Solid Waste (MSW) more commonly known as trash or garbage consists of everyday items we use and then throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. The municipal waste (MW) consists of domestic, garden, commercial, and small-scale industrial waste. Furthermore, municipal solid waste (MSW) is divided into organic and nonorganic waste. It is projected that globally, 4.3 billion municipal populations will be accountable for generation of 1.42 kg/capita/day of MSW by 2025. Numerous processes are implemented for management of MSW, such as aerobic composting, landfill, organic waste recycling, vermicomposting, and thermal treatment, producing considerable energy for local usage. Additionally, MW can also be utilized to produce PHA, where microorganisms utilize MW as a carbon source for accumulating PHA. In MW hydrolysis, the foremost obstacle is the segregation of organic parts from other domestic wastes like plastic, metal, and glass, thereby making the whole process complicated (Bind et al., 2018). However, microaerobic fermentation is more effective for MW hydrolysis since anerobes and aerobes work simultaneously for enhanced feedstock degradation. During fermentation, media pH also plays a significant role by averting the metabolic route toward many volatile fatty acids; for instance, butyric acid is the primary product at pH 6, whereas acetic acid is produced at pH . This sand is acquired from banks or beds of streams the world over. Because of common steady loes under the activity of streaming water the River sand comprises of fine adjusted grains. The shade of waterway sand is relatively white. The current boom in the construction industry worldwide and in India and also the fact that river sand is a vital component in construction, compels is to know sand a few things regarding river. The river sand still remains the main source of sand for construction industry. The demand for sand has been ever increasing with the development of building industry. One of the main objectives of the study is the identification of potential sources of river sand alternatives. The sea sand is now being recognized as the major alternatives of river sand in this study. Sea sand is some of the alternative that can be used to replace with river sand in the preparation of concrete. As major natural resource Sea sand can be obtained from the sea shores abundantly at free of cost. Now-a-days, the use of river sand for concrete production has increased rapidly due to increase in number of construction industries, The increase in rate of production of concrete leads to increase in demand for raw materials which in turn leads to price hike of raw materials. Also this demand may be due to scarcity in availability of raw materials mostly the river sand. This problem of importing river sand from other places at a higher price has brought the idea of using the locally available natural material in the place of this river sand. So, by using the sea sand which is abundantly available at the sea shores for the low volume road construction, much of the economy of construction could be saved. So, by using sea sand from the sea shores as a fine aggregate replacement in preparation of concrete will save our earth for a sustainable environment. It also helps to save much of our river sand from being deployed for construction. The continuous grabbing of sand from the beds also leds to scarcity. The history of using sea sand in our country is very short. When sea sand is mixed with concrete in place of normal river sand to make concrete for buildings, the high content of chloride in sea sand leads to defects in concrete structure. Sea Sand suitable for construction purpose by reducing the salt content to equalize its properties similar to the River Sand. The removal of salt content present in the Sea Sand is mandatory because, it affects the durability and workability. Lightweight aggregate are defined as construction materials that have a bulk density lower than that of common construction aggregates. The scope of the projects is to utilize Sea Sand for the replacement of demand of River sand and to improve the high strength for the concrete. Thus, this study mainly

focused on study the strength variations in concrete before and after the removal of salt content from the Sea Sand with respect to compression and compare the

different test results on water to determine the hardness. Sand is a unique uncooked material for the development enterprise at gift, however contractors should spend greater allocations for obtaining bulk for sand for hits or her construction work. River sand are random due to upward push in river water table. Also governments have banned using river sand. According to the industry as sets, the charge level of the river sand has grown to be sky rocketed. Lightweight aggregate concrete is made with lightweight aggregates, either natural or manufactured, comprising gravel or crushed stone. Therefore it has substantially lower bulk density than concrete. Further as many types of aggregates can be used, one can design concretes of required densities and strengths. Lightweight aggregates is a popular choice in construction due to its many advantages including reduced weight, improved insulation, and increased fire resistance. Lightweight concrete is a special type of concrete which weighs lighter than conventional or normal concrete. Density of light weight concrete is conventionally low. Generally 300 kg/m³ to 1900 kg/m³ and thus normal concrete has density between 2300 kg/m³ to 2600 kg/m³.The lightweight aggregate used in concrete may have any form, including cubical, rounded, angular, and other shapes. Its workability is directly influenced by its form and texture. These aggregates are known for absorbing little water and maintaining their low density. A high saturation level makes it an attractive option. LWA can reduce the dead loads on the structure and make it more economical. LWA can reduce the dead loads on the structure and make it more economical. Has relatively low thermal conductivity and is preferred for roof insulations. Lightweight concrete is a versatile building material. Since it is generally 20% to 40% lighter than normal weight concrete, a structure's dead load can be reduced, its foundation costs lowered, and its concrete and rebar needs lessened. Structural lightweight concrete also resists fire better than normal weight concrete because of its lower thermal conductivity and its lower coefficient of thermal expansion. In many structures, these benefits justify the use of lightweight aggregate concrete, which generally costs more than normal weight concrete. By definition, structural lightweight concrete contains aggregates that are either all lightweight or a combination of lightweight and normal weight aggregate. Lightweight aggregates suitable for structural concrete may be natural materials such as pumice or scoria, or they may be processed aggregates such as expanded shales, clays, slates, and slags. More porous than normal weight particles, lightweight aggregates that are not presaturated will absorb the water in the concrete mix. To control the slump, the lightweight aggregates should be prewetted before being used in a mix. There are three ways to prewet them: thorough sprinkling, thermal quenching, and vacuum saturation. If the aggregate particles in lightweight concrete are properly prewetted, then the concrete should behave much like normal weight concrete. Natural lightweight aggregate materials prepared by crushing and sizing natural rock materials such as pumice, scoria, tuff, breccia, and volcanic cinders. Manufactured structural lightweight aggregates—prepared by pyro processing shale, clay, or slate in rotary kilns or on traveling grate sintering machines. By-product lightweight aggregates—prepared by crushing and sizing foamed and granulated slag, organic cinders, and coke breeze. Other by-product lightweight aggregates in use include coal combustion by-products (fly ash and bottom ash), flue gas desulfurization by-products resulting from manufacturing processes, or other waste products. This group, with the exception of slag, has continued to decline in popularity and is not discussed here. Microstructure development and its relation to the durability properties of LWAC generally are not highlighted in the literature. The development of bonds, the microstructure with different binder systems, and different types of lightweight aggregates are explained. They show how lightweight aggregate concrete differs from normal weight concrete. The chapters on chloride ingress and freeze-thaw resistance are detailed because of the use of LWAC in offshore construction. The economical aspects of using LWAC are also reviewed. Emphasis is placed on the fact that although the cost of LWAC is high, the total cost of construction has to be considered, including the cost of transport, reinforcement, etc. When these are considered then LWAC becomes cheaper and attractive. The life cycle cost of the concrete is another consideration for calculating long-term savings on maintenance costs.

2. METHODS AND MATERIAL

GENERAL

The following flow chart represents the steps carried out the under various condition.

MATERIALS USED

The following materials are used

- Cement
- Fine Aggregate
- Coarse Aggregate
- Municipal Waste Ash
- Sea Sand
- Lightweight Aggregate

CEMENT

Cement is a material that has a cohesive and adhesion properties that enable binding chunks of rock into one cohesive body. In this project we are used Op (Ordinary Portland Cement) for high strength and durability. Cement is a hydraulic binder, primarily composed of calcium silicates and aluminates produced by heating a mixture of limestone and clay to high temperatures (14500C) in a kiln, then finely grinding the resulting clinker. When mixed with water it undergoes a chemical reaction called hydration, forming a gel-like matrix that binds aggregates, such as sand and gravel, together. This hydration process gives concrete its strength and durability.

TESTING OF CEMENT

SI.NO	TESTS	RESULTS
01	Consistency	36%
02	Specific gravity	3.2
03	Initial settling time	35 mins
04	Final setting time	10 hours

FINE AGGREGATE

River sand is a naturally occurring granular material composed of finely divided rock and mineral particles. Its collected form river beds and banks and its typically light to golden in color, depending on the location and minerals present. River sand particles have a smooth texture due to the natural weathering process and are typically finer than other types of sand. It provides strength to the construction and is a key ingredient in concrete, mortar, and plasters. River sand is a primary component in the production of concrete, where it acts as a fine aggregates, contributing to the strength and durability of the concrete.

TESTING ON FINE AGGREGATE

SI.NO	TESTS	RESULTS
01	Bulk density	1700 kg/m^3
02	Specific gravity	2.70
03	Finess modulus	2.80
04	Water absorption	0.7

COARSE AGGREGATE

Aggregates are inert granular materials such as sand, grave, or crushed stone that, along with water and Portland Cement, are an essential ingredient in concrete construction aggregate, or simply "aggregate" is a broad category of coarse to medium grained particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete aggregates. Aggregates are the most mined materials in the Coarse aggregate is one of the essential ingredients apart of water and cement in concrete production. It consists about 60 to 70 percent of total concrete production Coarse aggregate comes from particles greater than 4.75mm but commonly in a range between 9.5mm to 37.5mm.

TESTING ON COARSE AGGREGATE

SI.NO	TESTS	RESULTS
01	Bulk density	1600 $kglm^3$
02	Specific gravity	2.69
03	Finess modulus	7.56
04	Water absorption	1.4%

MUNICIPAL WASTE ASH

Fly ash is gray or dark gray with an irregular structure**.** The particle size of fly ash is larger than that of cement, and its density is about 1.5-2.4g/cm. The particle size distribution is uneven, which means it can form a good structure. Municipal solid waste ash has a high porosity and absorption, and some volatile heavy metals are absorbed on the surface of municipal ash.

TESTING ON MUNICIPAL WASTE ASH

SI.NO	TESTS	RESULTS
01	Bulk density	1200 kglm^3
02	Specific gravity	2.1
03	Finess modulus	7.56
04	Water absorption	0.7

SEA SAND

The primary physical properties such as grain, density, shape and size distribution. The most common component of sand is silicon dioxide in the form of quartz. Sand particles composed of quartz having a specific gravity ranging from 2.65 to 2.67. The fine grains of sand and shells help to remove dead skin cells, keeping your skin soft, clean and healthy. A walk along the beach provides a great way to exfoliate dead skin from your feet, so dig your toes into the sand and start rejuvenating your skin, naturally

TESTING OF SEA SAND

SI.NO	TESTS	RESULTS
01	Bulk density	1684 kglm^3
02	Specific gravity	2.66
03	Finess modulus	2.7
04	Water absorption	0.6%

LIGHTWEIGHT AGGREGATE

The specific gravity of lightweight aggregate was found to be in the range from 1.41 to 2.2.The aggregate should have a low number of large external voids. The particles should have a good bond with cement and should not react chemically with it. Lightweight aggregates are not as rigid as normal weight aggregates, and therefore produce concrete with a lower elastic modulus and higher creep and shrinkage. Some very porous aggregates are generally weak and are therefore more suitable for making nonstructural insulating concretes, instead of a structural member.

TESTING ON LIGHTWEIGHT AGGREGATE

SI.NO	TESTS	RESULTS
01	Bulk density	1100 $kglm^3$
02	Specific gravity	2.4
03	Finess modulus	3.26
04	Water absorption	1.4%

3. OBJECTIVES

1. The main objectives of the waste material can be modified in the use of construction work.
2. A M20 grade of concrete is used in the mix design.
3. Lightweight aggregate is a choice in construction due to its reduced weight.
4. To study the material properties of sea sand , river sand and partially replaced sea sand in river sand.
5. Municipal waste ash is a replacement material of concrete.

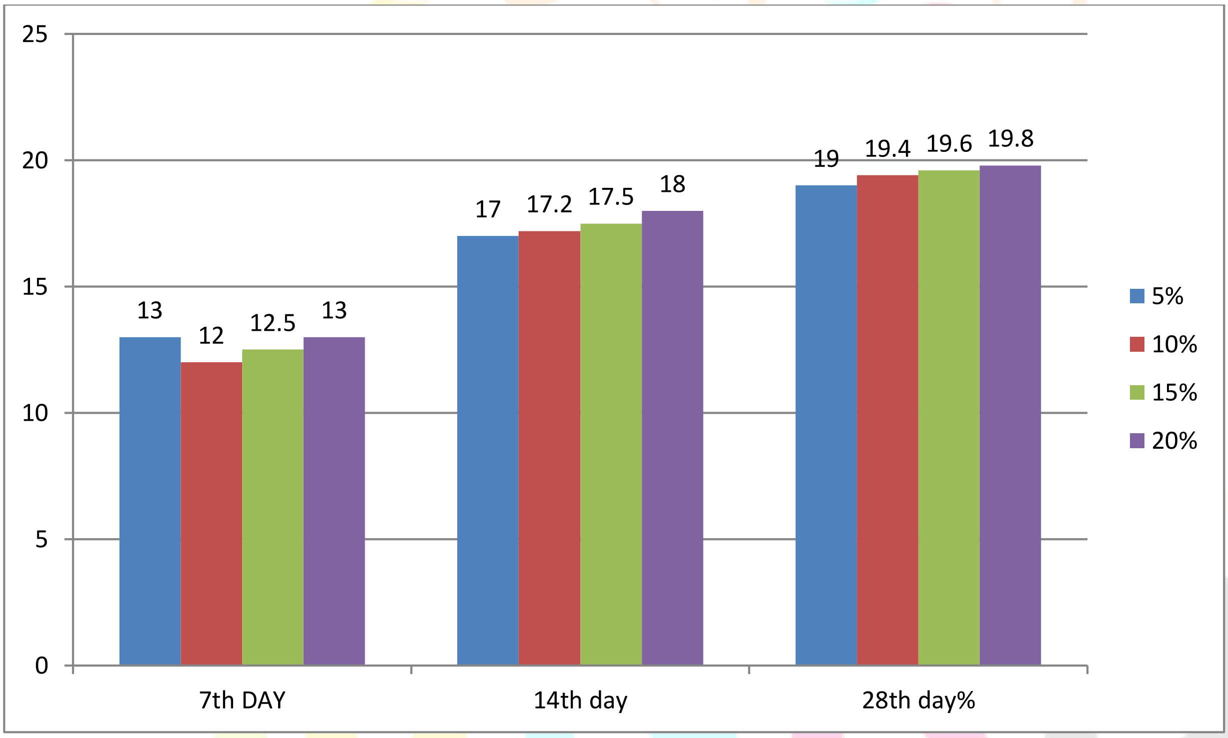
4. RESULT AND DISCUSSION

COMPRESSION STRENGTH TEST

The cubical mould of size 150mm x 150mm x 150mm were cleaned and checked against the joint movement. After finishing the curing period ,it can be ready to test. The specimen should fix in the compression testing machine with correct position , even the machine should be unloading when fix in it. After fix the specimen, the load should be act on it corresponding increased, then note the value occurred in the dial reading when the specimen occurred first crack in the surface. Now, there are three same specimens taken to be tested for accurate reading. And determine the compressive strength by using the formula (load/area) in N/mm^2.

Compressive strength of different curing days

PERCENTAGE	7^{th} DAY (N/mm^2)	14^{th} DAY (N/mm^2)	28^{th} DAY (N/mm^2)
Conventional concrete	12.5	17	19
5%	13	17	19
10%	12	17.2	19.4
15%	12.5	17.5	19.6
20%	13	18	19.8



COMPRESSIVE TEST FOR CUBE

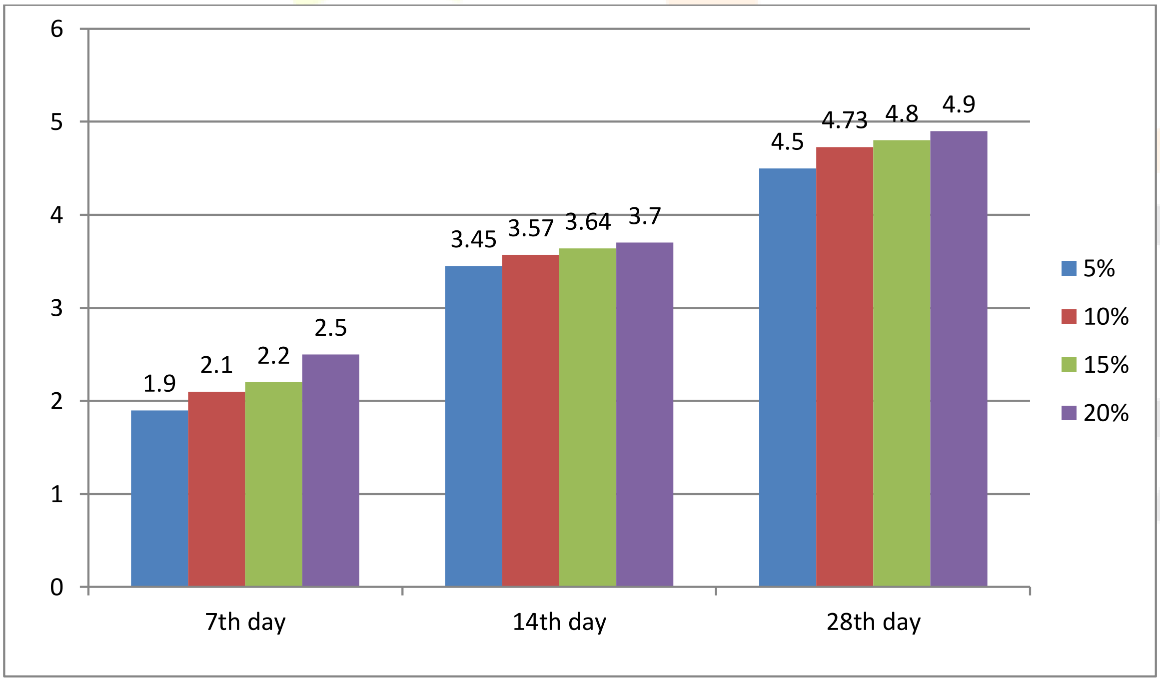
SPLIT TENSILE TEST

The test is carried out by placing cylinder specimen of dimension 150mm diameter and 300mm length, horizontally between the loading surface of compression testing machine and the load is applied until failure of the cylinder along the vertical diameter. The failure load of the specimen is noted. The failure load of tensile strength of cylinder is calculated by using the formula. Split- tensile strength is indirect way of finding the tensile strength of concrete by subjecting the cylinder to a compressive force. Cylinders of size 150mm diameter and 300mm long were cast. After 24 hours the specimen were remoulded and subjected to water curing. After 3, 7, 14 and 28 days of cylinders were taken allowed to dry and tested in compression testing machine by placing the specimen horizontal.

The ultimate load of the specimen horizontal. The ultimate load of the specimen is at which the cylinder failed.

Split tensile test of different curing days

PERCENTAGE	7th DAY (N/mm²)	14th DAY (N/mm²)	28th DAY (N/mm²)
Conventional concrete	1.8	3	4
5%	1.9	3.45	4.5
10%	2.1	3.57	4.73
15%	2.2	3.64	4.8
20%	2.5	3.7	4.9

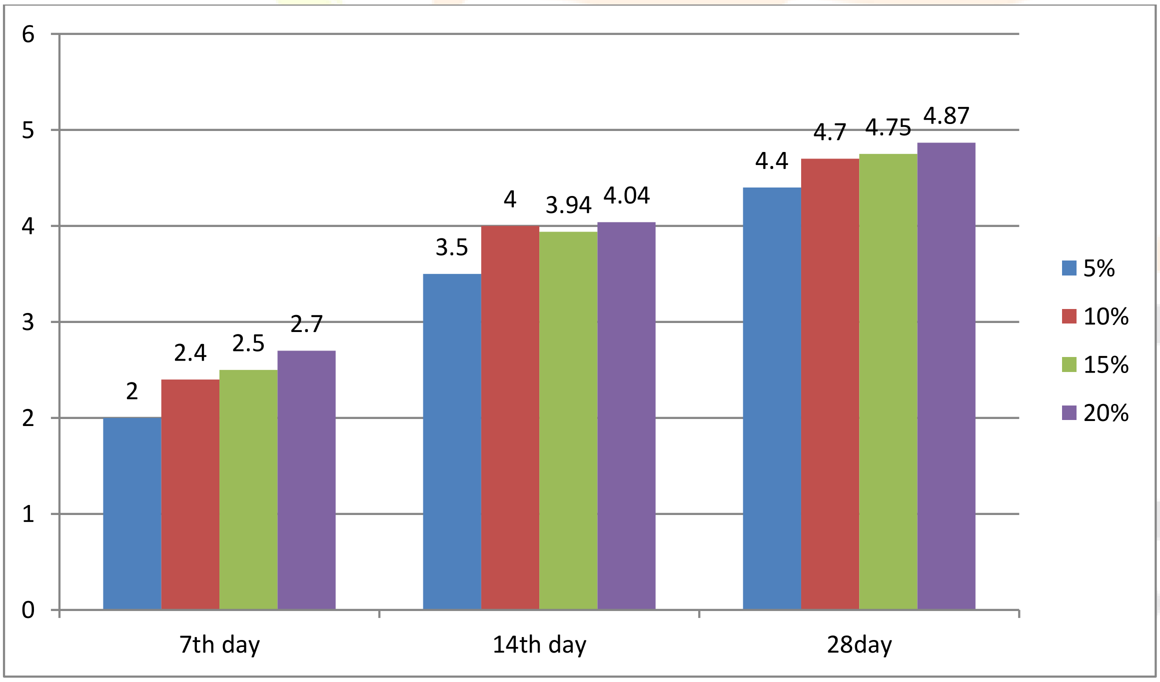


TENSILE TEST FOR CYLINDER

FLEXURAL TEST

This involves casting of concrete beam of size (500 x 100 x 100) for determine this strength for 7th, 14th, 28th days curing. And determine the flexural strength by using the formula (PI/bd^2) in N/mm^2.

PERCENTAGE	7th DAY (N/mm^2)	14th DAY (N/mm^2)	28th DAY (N/mm^2)
Conventional concrete	1.9	4	4.35
5%	2	3.5	4.4
10%	2.4	4	4.7
15%	2.5	3.94	4.75
20%	2.7	4.04	4.87



FLEXURAL TEST FOR BEAM

5. CONCLUSION

1. An experimental study has been done on concrete using partially replaced by municipal waste ash, sea sand and lightweight aggregate.
2. A concrete mix grade of M20 is aimed the design mix proportion obtained by Indian Standard method of mix design.
3. Sea sand is replaced with river sand in proportion of 5%,10%,15%,20%.
4. At the initial ages with the increase in the percentage of replacement of municipal waste ash the strength as well as compressive strength increases.
5. Moreover with the use of municipal waste ash and lightweight aggregate the weight concrete reduces, thus making concrete lighter which can be used as light weight concrete.
6. Be replacing 5%, 10%, 15%, 20% municipal waste ash, sea sand and lightweight aggregate the compressive strength has increased.
7. Be replacing 5%, 10%, 15%, 20% municipal waste ash, sea sand and lightweight aggregate the tensile strength has increased.
8. Be replacing 5%, 10%, 15%, 20% municipal waste ash, sea sand and lightweight aggregate the flexural strength has increased.

APPENDIX

MIX DESIGN FOR M20 GRADE CONCRETE

A) Data:

Characteristics compressive strength, fck = 20N/mm²

Nominal size of aggregate = 16 mm

B) Test data for concrete materials:

Specific gravity of cement = 3.2

Specific gravity of coarse aggregate = 2.69

Specific gravity of fine aggregate = 2.70

Water absorption for coarse aggregate = 1.4%

C) Target mean strength:

Fck = fck + K.S = 20 + (1.65 x 5) = 28.25 N/mm²

D) Selection of water cement ratio:

From IS 456-2000 pg no.20

The water cement ratio for M20 grade concrete as been mentioned 0.45.

Adopt water cement ratio is 0.45

E) Selection of water content:

From IS 10262-2009, Table2- for 20mm aggregates and slum range as 25mm to 50mm, the maximum water content is 186 kg or liters.

Adding 6% of 186 liter of water for 100 mm slump range,

(6/100) x 18611.16 liters

Total water content 186+11.6 = 197 liters.

F) Calculation of cement content:

Water cement ratio adopted 0.45

(water content / Cement content) = 0.45

Cement content = (Water content/0.45)

= 197/0.45

= 437.78 kg/m³

G) Proportion of Volume of C.A and F.A content:

For zone I and for 16mm size aggregate volume of C.A and F.A (zone I) for 0.4 is 0.6 as per (IS 10262-2009, Table 3)

Volume C.A and F.A content = 0.60

H) Mix Proportion:

1) volume of concrete, (a) = 1 m³

2) Volume of cement, (b) = (Mass of cement / Specific gravity of cement) x 1/1000

= (437.78/3.15) x (1/1000) = 0.138 m³

3) Volume of water, (c) = (Mass of water / Specific gravity Of water) x 1/1000 n =(197/1) x (1/1000)

= 0.197 m³

4) Volume of Aggregate, (z) = (a-(b+c))

= 1-(0.138+0.197)

= 0,665 m3

5) Mass of Coarse aggregate = z x Volume of C.A x Specific gravity of ca x 1000

= 0.665 x 0.6 x 2.70 x 1000

= 1077.3 kg

6) Mass of Fine aggregate = z x Volume of F.A x Specific gravity of F.A X 1000

= 0.665 x 0.4 x 2.64 x 1000

= 702.24 kg

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