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The Effect of Ceramic Waste Broken Tiles as Coarse Aggregate on Strength Properties of Concrete

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ABSTRACT:

Due to day to day innovations and development in construction field, use of sand is increased tremendously, The solid waste generated by construction demolition is also extremely considerable. Because of these factors, Demolished constructional waste such as ceramic tile and granite powder has become popular as a way to reduce solid waste for concrete production. Ceramic tile waste is produced not only during building demolition, but also during the manufacturing process. According to surveys, approximately 20-30% of the material prepared in tile manufacturing companies is discarded. This waste material should be repurposed to deal with the limited availability of natural aggregate and to reduce construction waste. Crushed waste used as coarse and fine aggregate substitutes. Ceramic waste broken tiles were used to replace 10%, 20%, 30%, 40%, and 50% of the coarse aggregates, respectively. Fine aggregate was substituted by 10% with G.P. and C.T.P., as well as ceramic coarse tiles. The concrete grade M25 was prepared. In this mixed design for various types of mixes, C.T. and G.P. were employed to substitute coarse and fine aggregates in varied percentages. Workability, strengthening tests for different concrete mixes with varied percentages of waste crushed and granite powder after 7th, 14th, and 28th days curing period have been carried out. It has been discovered that when G.P. and smashed tiles replaced increases, the workability improves. The strengthening of concrete is increased by up to 30% when using ceramic coarse tile aggregate.

Keywords: Crushed tiles, Compressive strengthening, Flexural strengthening, G.P., Split Tensile strengthening.

1.1 CONCRETE

Its a composite material that primarily consists of water, aggregate, and cement. By adding additives and reinforcements to the concrete mix, the appropriate physical qualities for the completed product can be achieved. By combining these elements in specific quantities, a solid mass that can be easily shaped into the appropriate shape can be created. Over time, a hard matrix generated by cement binds the remaining materials together to form a single hard (rigid) durable material with many applications, including buildings and pavements. The ancient Romans were among the first to employ concrete technology on a broad scale, and the Roman Empire made extensive use of concrete technology. The colosseum in Rome was entirely constructed of concrete, and pantheon's dome is the world's biggest unreinforced concrete building. In the mid-eighteenth century, the technology was re-pioneered as concrete usage declined. Its frequently utilised man-made material nowadays in terms of tonnage.

1.2 HISTORICAL BACKGROUND

Although high strengthening concrete is considered as relatively a new material, its development has been gradually increasing over years. Its having strengthening of 34 MPa was deemed high strength in the 1950s in the United States. Concrete having compressive strengthening of 41 to 52 MPa was used commercially in 1960s. With the current state of affairs, however, concrete of extremely high strengthening has entered the construction industry of high-rise structures and long-span bridges in the last fifteen years. IS 456-2000 considers. Strengthening higher than 110 MPa for use in pre-stressed concrete members and cast-in-place structures. Recently reacted concrete,may be the one with a compressive strengthening of about 250 MPa. Pozzolanic materials provide complete support. The first distinction between high-strength and nominal-strength concrete is the relationship between the concrete sample's compressive strength and its maximum resistance to any form of load. Although there is no definitive distinction between high-strength and normal-strength concrete.

1.3 PROPERTIES OF CONCRETE

Concrete is often a material with a higher compressive strength than tensile strength. Because the tensile stress is reduced, it is usually reinforced using materials that are strong in tension, such as steel. Concrete's elastic behaviour is essentially stable at low stress levels, but when matrix cracking develops, it begins to decreasing. Concrete has a lower thermal coefficient, which causes shrinkage as it ages. All concrete constructions cracking as a result of shrinkage and strain. When concrete is subjected to long-duration forces, it is prone to creep. Various tests will be undertaken for the applications to guarantee that the concrete qualities match the specifications. Varied combinations of concrete materials achieve different concrete strengths, which are measured in psi or Mpa. Concrete of varying strengths is used in a variety of construction projects. If the concrete must be light, a very low-strength concrete can be used. The Lightweight concrete is achieved by the addition of lightweight aggregates, air or foam, the side effect is that the strength of concrete will get reduced. The concrete with 3000-psi to 4000-psi is oftenly used for routine works. Although 5000-psi concrete is more expensive, it is commercially accessible as a more durable option. Concrete with a 5000-psi strengthening is frequently used for large projects and for structural parts. To keep the column sizes small in high-rise concrete buildings with lower floor columns, for example, 12,000 psi or more strengthening concrete may be used.

To reduce no. of spans necessary, bridges can employ concrete with a strength of 10,000 psi in longer beams. Other structural requirements may necessitate the use of high-strengthening concrete on occasion. If the structure must be exceedingly rigid, even stronger than required to carry the service loads, high-strength concrete may be selected. For these commercial reasons the concrete of strength as high as 19000-psi has been used.

1.4 LIGHT WEIGHT CONCRETE

Concrete's having significant self-wt. is one of its drawbacks. The density of ordinary concrete will be between 2200 and 2600 kg/m3. Because of its enormous self-weight, concrete will become an uneconomical structural material. Attempts to reducing self wt. of concrete in order to increase its structural efficiency. The density of light weight concrete varies from 300 to 1850 kg/m3 depending on the components used. There is just one method for generating lightweight concrete, which is to incorporate air into the mix. This is accomplished in three different ways in practise.

(i) By replacing typical mineral aggregate with cellular porous or lightweight aggregate.

(ii) Gas or air bubbles are introduced into mortar to create aerated concrete.

(iii) Omitting the sand from the aggregates, called as No-fines concrete.

Lightweight concrete has growing popularily and offers more benefits than traditional concrete.

2. LITERATURE REVIEW:

A.K. Al-Tamimi and M. Sonebi When immersed in acidic liquids, SCC were investigated. Workability was obtained using slump cone test, L-box and orimet for SCC mix. Cylindrical specimens of diameter 45mm and length 90mm were casted and cured for 28 days in water after they were immersed in 1% HCl and 1% H2So4 solutions by maintaining a pH of 5 regularly. They found that when subjected to 1% SA and HCL, self-compacting concrete performed better than control concrete. They discovered that it took 18 weeks for SCC to lose 10% of its bulk and 6 weeks for CC.

A.Mohd Mustafa et al. (2008) Ceramic waste, such as flower pots, tiles, and clay bricks, were researched. Water cement ratios of 0.4, 0.5, and 0.7 were used with concrete with a typical strengthening of 20 MPa. Flower pots had the best compressive strength values, which was roughly 2.50 percent lower than standard concrete.

Adewuyi and ola (2005) - conducted research on binary O.P.C blends with various pozzolanic materials in cement production composites. Supplementary cementious materials have been shown to meet the majority of the requirements for concrete durability.

Ahmadi et al. (2007) studied the compressive strengthof SSC mix containing RHA in comparison to normal mix.Six arrangement of self compacting concrete with normal cement Table 3.13 Mix Design of various SCC mixes.

Aruna D (2015): For tile waste-based concrete, C.A.were substituted with 20mm downsize, tile wastes with 0%, 5%, 10%, 15%, 20%, and 25%, and cement was partially replaced with fly-ash. At a 25% replacement rate, average max. strengthening of roof T.A. is achieved. At 25% roof tile aggregate replacement, a 10-15% drop in strength is found when compared to standard concrete. Roof tile waste concrete has a medium workability. For modest structures, the replacement of tiles with concrete is satisfactory.

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Asma Abd Elhameed Hussein et al., "Compressive Strengthening and Microstructure of Ash Concrete" was the subject of his research.This report presents the findings of an experimental investigation on the efficacy of SCBA as a cement substitute material in concrete manufacturing. When OPC was replaced with 0, 5, 10, 15, 20, 25, and 30%, respectively, bagasse ash, the impact on workability, compressive strength, and microstructure of the Interfacial Transition Zone of concrete was examined. The results showed that adding up to 20% Ash to concrete boosted the concrete's compressive strength at all ages, with higher strengthening reached at a SCBA replacement level of 5%. The thickness of the ITZ was drastically lowered.

B. TOPÇU AND M. CANBAZ (2010): The amount of tile waste generated is sufficient to substitute C.A. in concrete. C.T.W. benefits the environment. Concrete self wt. is lowered by around 4% when tile aggregate is used, making the building more cost effective. When it comes to concrete strength, T.A. substitution has detrimental impact on both compressive and split tensile strength. But this paper studied maximum replacements of tile waste which can be further divided into smaller percentages and can be utilized in concrete with desirable properties.

B.Madhusudhana Reddy et al., The effects of HCl on blended cement (fly ash) and silica fume blended cement,concretes, were investigated. For comparison, concrete cubes were cast in deionised water with a range of dosages (100, 150, 300, 500, and 900 mg/l) implanted in water and only deionised water. The compressive strengths of silica fume blended concrete were reduced by 2 to 19 percent at 28^{th} and 90^{th} days, according to the results of the tests.

Batriti Monhun R. Marwein (2016): Broken tiles were used as the ceramic waste. 0 percent, 15 percent, 20 percent, 25 percent, and 30 percent CWC manufactured with these tiles. All concrete mixes are made with M20 grade concrete and a constant water cement ratio of 0.48. At 3, 7, and 28 days, concrete qualities such as workability for fresh concrete, and Strengthening, are measured. The report proposes that waste tile aggregate should be replaced at a rate of 5-30%, and that it is suitable for typical mixes such as M15 and M20.

Beulah M. Asst Professor, Prahallada M. C. Professor The effect of replacing cement with metakaolin in high-performance concrete subjected to HCl attack was investigated. Cubes were casted with different water cement ratios (0.3, 0.35, 0.4 and 0.45), compressive strength was evaluated for 150×150×150 mm cubes and For 100×100×100 mm cubes, the % wt. loss was calculated. These cubes were cured in 5% hydrochloric acid for 30, 60, and 90 days. After 30^{th} , 60^{th} , and 90^{th} days of immersion, they discovered that the residual compressive strength decreases as the water binder ratio increases. which they attribute to transition zone that leads to the development of ettringite at higher water levels.

C. Medina et al. (2012) The use of trash as recycled coarse aggregate in the construction of structural concrete in partial substitutions of 15%, 20%, and 25% was examined. At 7, 28, and 90 days, compressive strength is determined. Strength increases as percentage replacement increases; the best outcomes are seen at 25% replacement, with increases of 21.12 percent, 11.04 percent, and 6.70 percent at 7, 28, and 90 days, respectively.

D. Tavakoli (2012) The use of ceramic waste in concrete manufacturing has no discernible detrimental impact on the concrete's qualities. The optimum scenario for using tile waste as sand is in 25% to 50%; also, the best case for using it as C.A. is in amounts of 10% to 20%. These measurements show a rise in compressive strength, as well as decreasing unit wt. and no significant detrimental effect on water absorption.

D. Tavakoli et al. (2013) The potential of utilising ceramic tile in concrete was studied. 0-40 percent, coarse aggregate is substituted. With 10% substitution, compressive strength increases by 5.13 percent while slump, water absorption, and unit weight drop by 10%, 0.1 percent, and 2.29 percent, respectively.

Dr. P. Srinivasa Rao et al., The durability characteristics of metakaolin blended concrete were investigated using M20 concrete grade. H2So4 and HCl were used to make an attempt. Steel fibres with a 60 aspect ratio are employed at 0%, 0.50%, 1.00%, and 1.50% of the volume of concrete, respectively. They concluded that when fibre reinforced concrete and concrete containing 10% metakaolin substituted by wt. were compared to concrete, the % wt. loss was reduced and compressive strength was raised.

Ghassan Abood Habeeb, Hilmi Bin Mahmud (2009), Habeeb and Fayyadh (2009)-have investigated the influence of RHA average particle size on properties of concrete They discovered that the strength was equivalent at young ages, but that at the age of 28 days, the sample with finer RHA had better strength than the sample with coarser RHA.

Ghassan Abood Habeeb, Hilmi Bin Mahmud (2010) RHA produced in a Ferrocement furnace were examined. The impact of grinding on particle size and surface area was studied first, followed by an XRD study to confirm the existence of amorphous silica in the ash. When compared with OPC mixtures, increasing RHA fineness increased the strengthening of concrete.

Gritsada Sua-iam, Natt Makul (2013) The characteristics of SCC mixtures including ternary combinations of Type 1 Portland cement (OPC), untreated rice husk ash (RHA), and pulverised fuel ash were examined (FA). The SCC mixes were made using a controlled slump flow with a diameter of 67.5 to 72.5 cm. Physical qualities of self-compacting concrete mixes formed with ternary blends were significantly better than those of SCC combinations comprising simply RHA or FA.

J.Swathi et al. (2015) Fine aggregate was partially replaced with copper slag (20%, 40%, and 60%) and coarse aggregate was partially replaced with C.T. (10%, 20%, and 30%). The concrete grade utilised was M40. When 40 percent copper slag was combined with 10% C.T., compressive strength improved by 7.59N/mm 2 and flexure upto 4.07 percent.

Julia García-González, Desirée Rodríguez-Robles, Andrés Juan-Valdés, Julia Ma Morán-del Pozo and M. Ignacio Guerra-Romero (2014): The study focuses on ceramic waste from Spanish industry. The recycled C.A. met all of the technical standards imposed by current Spanish regulations, and the concrete was designed according to the Spanish concrete code. Ceramic aggregates substitute as C.A. up to 100 percent. The mechanical properties of the concrete were compared to regular concrete using appropriate tests. The ceramic ware aggregate concrete was exhibited a feasible concrete properties as like the normal gravel concrete.

Kartini, K., Nurul Nazierah According to the study, a 10% half substitution of cement with RHA be most effective in achieving the desired strength; however, for durability index performance, a higher substitution up to 50% obtained, resulting in lower charge passed and lower water absorption, improving the concrete's durability. This demonstrates that the large amount of silica in RHA has an impact on the HSC's strength and durability.

Khaloo (1995) C.T. used as C.A.source in concrete was examined. When compared to real crushed stones, C.T. had lower density and far higher water absorption value. The concrete that resulted from using 100 percent C.T. in place of C.A. had least density and higher compressive (+2%), tensile (+70%), and flexural (+29%) strengths.

Lee et al (2005)-in their study concluded that some of the waste product like rice husk which having Fly ash, silica fume, volcanic ash, and maize cob ashence have pozzolanic qualities and are used in blended cement to provide good strength properties to concrete.

Lourdes M. S. Souza et al., They researched the reactions between calcium hydroxide and ash in "Hydration of Various Initial C/S Ratio" (SCBA). Pastes with varying starting CaO/SiO2 (C/S) molar ratios were made for this purpose. Thermal studies, X-ray diffraction, scanning electron microscopy, and an energy dispersive spectrometer were used to examine the generated products. It shows main product was found to be C-S-H of not specific morphology and that could not be related to the known products C-S-H (I)/C-S-H (II).

M.Roobini et al. (2015) The developing strengthening of concrete using CT as C.A. was determined. The concrete has a typical strengthening of 20 MPa and a water cement ratio of 0.5. At 20% replacement, strengthening increased by 4.84 percent and 13.30 percent, respectively. Flexure strength is optimum at 10% replacement, which is 4.84 percent more than standard concrete.

M.Vijaya Sekhar Reddy, I.V.Ramana Reddy, In 2012, researchers looked into the behaviour of High Performance Concrete (HPC), the most extensively utilised type of concrete in the construction industry. Supplementary cementing materials (SCM) and metakaolin were used instead of cement. The M60 mix design was used, and the cubes were cast and cured for 90 days in a mixture of 5% HCl (PH=2), NaOH, MgSo4, and Na2So4.They came to the conclusion that utilising supplemental cementing ingredients in concrete increased the service life of concrete structures and reduced the heat of hydration. They discovered that when concrete was substituted with fly ash, the maximum and smallest percentages of strength reduction were 12.64 percent and 1.92 percent, respectively.

Maurice E. Ephraim RHA Sp. gravity was 1.55, while RHA density was found to be 2.043, 1.912, and 1.932 kg/m3 at 10%, 20%, and 25% replacement percentages, respectively. With a slump value 100mm, RHA will be workable. The addition of RHA to concrete increased water demand while also improving strength. At same substitution % as above, the compressive strengthening at 28th days were determined to be 38.4, 36.5, and 33N/mm2.

Md Daniyal and Shakeel Ahmad(2015): C.W.C.T. were employed as substitution as C.A. in concrete at 10%, 20%, 30%, 40%, and 50% substitution rates. According to the study, using C.T.A. improves its qualities, with an improvement in both compression and flexural strength.

Mehta and Pirth(2000) - R.H.A used to lower temperature in higher strengthening mass concrete was researched, and it was discovered that R.H.A is particularly effective in reducing temperature in mass concrete when compared to OPC concrete. R.H.A is made by burning rice husk at very higher temperature.

Mr. G. Siva Kumar et al., (2013) "Preparation of Bio-cement utilising Ash and Its Hydration Behavior" was the subject of his research. They employed 10% weight of OPC as half substitution in this study. The sample was tested for compressive strength, and it was discovered that the cementious substance is responsible for early hydration. Bagasse ash's pozzolanic action results in formation of more amount of C-S-H gel which results in enhances the strength, and hence bagasse ash is a potential replacement material for cement.

Mr. H.S. Otuoze et al., SCBA is obtained by burning Sugar Cane Bagasse at between 600-700 degrees Celsius, because the sum of Sio2, Al2o3, and Fe2o3 is 74.44 percent, A 1:2:4 mix ratio was employed for strength tests, with OPC being partially replaced by 0 percent, 5 percent, 10 percent, 15 percent, 20 percent, 25 percent, 30 percent, 35 percent, and 40 percent by weight in concrete. At 7th ,14th ,21th ,28th days strengthening of hardened concrete was measured. According to the results of the experiments, SCBA is a suitable pozzolana for concrete cementation, OPC may provide strengthening development in concrete. A maximum of 10% SCBA mixes with OPC may be used in reinforced concrete with thick aggregate. For plane or mass concrete, higher SCBA/OPC blends of 15 percent to 35 percent are acceptable.

Mr. Lavanya M.R et al., "A Experimental Study on the Compressive Strength of Concrete by Partial Replacement of Cement with Sugar Cane Bagasse Ash" was the subject of his research. It being investigated whether sugar cane bagasse ash, a finely ground waste product from the sugarcane industry, can be used as half substitution for cement in traditional concrete.

3.1 MATERIALS USED

In this investigation, the following materials were used:

1. Ordinary Portland Cement

2. Fine aggregate

3. Coarse aggregate

4. Water

5. Ceramic tiles

3.1.1 CEMENT

Ordinary Portland cement is the most popular type of cement used as a basic ingredient in concrete, mortar, stucco, and most nonspecialty grouts around the world. In the mid-nineteenth century, it evolved from other types of hydraulic lime in England, and it mainly comes from limestone. It's a fine powder made from clinker, which is formed by heating materials. We'll add little amounts of the remaining ingredients after grinding the clinker. There are many different types of cements on the market. When comparing different grades of cement, the 53 Grade OPC Cement consistently gives stronger strength than others. The grade number of a cement, according to the Bureau of Indian Standards (BIS), indicates the minimum compressive strength that the cement is projected to achieve within 28 days. The minimum compressive strength achieved by the cement at the conclusion of the 28th day for 53 Grade OPC Cement shall not be less than 53MPa or 530 kg/cm2. OPC is grey in colour, and we can achieve white cement by removing ferrous oxide during the cement producing process. The experiment was conducted using ordinary Portland Cement of 53 Grade from the Ultra Tech Company brand, which is widely available in the local market. To avoid being affected by atmospheric conditions, care was taken to ensure that the procurement was made from single batching in airtight containers. Physical requirements were met by testing the cement in accordance with IS: 169-1989, and chemical requirements were met by testing it in accordance with IS: 4032-1988. Table - 1 lists the cement's physical characteristics.

Table-1 Properties of cement

S.No.	Properties	Test results	IS:169-1989
1.	Normal consistency	0.32	
2.	Initial Setting time	50 min	Max. of 30 min
3.	Final setting time	320 min	Max. of 600 min
4.	Specific gravity	3.14	
5.	Compressive strength		
	3 days	29.2 Mpa	Minimum of 27 Mpa
	7 days	44.6 Mpa	Minimum of 40 Mpa
	28 days	56.6 Mpa	Minimum of 53 Mpa

3.1.2 FINE AGGREGATES

Sand is a finely divided rocky material and mineral particles that make up a natural granular material. The most frequent ingredient of sand is silica (silicon dioxide, or SiO2), which is usually in the form of quartz and is the most common weathering resistant mineral due to its chemical inertness and substantial hardness. As a result, it's commonly employed as a fine aggregate in concrete. In the investigation, river sand that was readily available on the market was used. In compliance with IS: 2386-1963, the aggregate was evaluated for physical specifications such as gradation, fineness modulus, and specific gravity. Before using the sand, it was thoroughly dried on the surface.

Table 2: Properties of Fine Aggregate

S.No.	Description test	Result
1.	Sand zone	Zone-III
2.	Specific gravity	2.59
3.	Free moisture	1%
4.	Bulk density of fine aggregate (poured density) Bulk density of fine aggregate (tapped density)	1385.16 kg/m3 1606.23kg/m3

3.1.3 COARSE AGGREGATES

Crushed aggregates with a size of less than 12.5mm were obtained from local crushing plants. The aggregate that only passes through a 12.5mm sieve and is retained on a 10mm sieve is chosen. In line with IS: 2386-1963, the aggregates were tested for physical parameters such as gradation, fineness modulus, specific gravity, and bulk density. To achieve the appropriate combined grading, the separate aggregates were blended. The mixture's specific gravity and water absorption are listed in the table.

Table 3: Properties of Coarse Aggregate

S.No.	**Description**	**Test results**
1.	Nominal size used	20 mm
2.	Specific gravity	2.9
3.	Impact value	10.5
4.	Water absorption	0.15%
5.	Sieve analysis	20mm
6.	Aggregate crushing value	20.19%
7.	Bulk density of coarse aggregate(poured density) Bulk density of coarse aggregate (tapped density)	1687.31 kg/m3 1935.3 kg/m3

3.1.4 WATER

Concrete's strength is dependent on the presence of water. It requires around 3/10th of its weight in water to be completely hydrated. For standard concrete, a minimum water-cement ratio of 0.35 has been demonstrated. Water contributes in a chemical reaction with cement, resulting in cement paste that binds coarse and fine particles. If additional water is used, segregation and bleeding occur, causing the concrete to weaken, although the fibres absorb the majority of the water. As a result, it may help to prevent bleeding. It is possible that if the water content exceeds the acceptable limits, bleeding will occur. The requisite workability is not reached if less water is utilised. Water that is fit for drinking must be used in the concrete, and the pH value should be between 6 and 9.

3.1.5 CERAMIC TILE AGGREGATE

Broken tiles were recovered from a ceramic manufacturing unit's solid refuse and a demolished structure. The waste tiles were manually and with the use of a crusher smashed into little pieces. Crushed tile aggregate of the requisite size was separated and used as a partial replacement for natural coarse aggregate. The tile waste with a size of less than 4.75 mm was overlooked. Crushed tile aggregate that has passed through a 16.5mm sieve but has been retained on a 12mm sieve is employed. Crushed tiles were used in place of coarse aggregate in percentages of 10%, 20%, 30%, 40%, and 50%, respectively, as well as fine aggregate being replaced with granite powder.

Figure 1: Ceramic Tile Aggregate Sample

3.1.6 CERAMIC TILE-FINE AGGREGATE

After crushing the tile aggregate, some of the material is finer in size. Because it is also a waste and similar to sand, this material is used in concrete as a fine aggregate replacement. In combination with the coarse aggregate replacement, the aggregate that passes through the 4.75mm sieve is employed as a partial replacement for fine aggregate of 10%.

Table 4: Properties of Ceramic tile aggregate

S.No.	Description	Test results
1.	Origin rock	Feldspar
2.	Impact value of crushed tiles	12.5%
3.	Specific gravity of crushed tiles	2.6
4.	Specific gravity of tile powder	2.5
5.	Water absorption of crushed tiles	0.19%
6.	Water absorption of tile powder	0.13%

3.1.7 GRANITE POWDER

The chemical and mineral makeup of granite powder is comparable to that of cement and natural aggregates because it is obtained by crushing granite rocks. It was chosen to evaluate the behaviour of concrete and ceramic tile waste in combination.

Table 5: Properties of Granite Powder

S.No	Description	Test Results
1.	Specific gravity of granite powder	2.4
2.	Water absorption of granite powder	0.10%

Granite powder will be collected from industry; 4.75 mm passed materials will be separated and used as a partial replacement for fine aggregate. Granite powder was used in place of fine aggregate at a percentage of ten percent of the time, and coarse aggregate was replaced with crushed tiles as well.

CONCRETE MIX DESIGN (AS PER IS: 10262-2009)

MIX DESIGN FOR M25 GRADE CONCRETE:

Characteristic compressive strength required in the field at 28 days: 20 Mpa

a) The mean strength , $f'ck = fck + ks$

=25 + (1.65x4)

= 31.6 Mpa

b) For OPC, adopting a water-cement ratio of 0.44

c) Form table 2 of IS: 10262-2009, maximum water content for 20 mm aggregates is 186 liters.

Adopting a water content of 170 liters

d) Water-cement ratio=0.44

Cement Content, C=170/0.44

=380 kg/m3

From IS: 456-2000, the minimum cement content is 300 kg/m3 for severe exposure.

Hence O.K.

e) From table 3 of IS:10262-2009, volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone III) for water-cement ratio of 0.50 =0.64 %

In the present case water-cement ratio is 0.44. Therefore, volume of coarse aggregate is required to be increased to decrease the fine aggregate content. Thus, corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.44 = 0.652.

Volume of Fine Aggregates = 1- volume of C.A. = 1- 0.652 = 0.348%

f) Volume of cement = 380/3.14×1/1000 = 0.121% Volume of water = 170/1×1/1000 = 0.17%

Volume of all in aggregates = 1- volume of (cement + water) = 1- (0.121+0.17) = 0.71 %

Mass of Coarse aggregate (C.A.) =e x Vol. of C.A. x Sp. gravity of C.A. x 1000 = 0.71*0.652*2.9*1000 = 1340.57 kg/m3

Mass of Fine aggregate (F.A.) =e x Vol. of F.A. x Sp. gravity of F.A. x 1000

= 0.71*0.348*2.59*1000 = 640 kg/m3

g) Mix proportions: C : FA : CA : WATER 380 : 640 : 1340.57 : 170

h) Site Corrections:

Water Absorption of C.A. = 1340.57 ×0.15/100 = 2 kg/m3

Moisture content of F.A. = 640 ×1/100 = 6.4 kg

Weight of C.A. = 1340.57-2 = 1338.57 kg/m3

Weight of F.A. = 640+6.4 = 633.6 kg/m3

Adjusted water content = 170-2+6.4 = 174.4 liters

i) Final quantities of materials after corrections/adjustments according to the site:

Cement = 380 kg/m3

Fine aggregates = 634 kg/m3

Coarse aggregates = 1339 kg/m3

Water = 175 kg/m3

3.2 WORKABILITY

The amount of usable internal effort required to fully compact the concrete without bleeding or segregation in the final product, as indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation in the finished product. Workability is one of the physical properties of concrete that influences its strength and durability, as well as the labour cost and final look. When concrete is simply put and compacted uniformly, without bleeding or segregation, it is considered to be workable. Unworkable concrete requires more effort to compact in place, and honeycombs and/or pockets may appear in completed concrete.

SUMMARY:

The prime object of this study is to prepare a concrete much more stable and durable than the conventional by replacing aggregates both coarse and fine. Mix designs for all material replacements have been completed, and a total of 90 specimens (42 cubes, 42 cylinders, and 6 beams) have been made and tested in terms of strength calculations and comparisons.

FUTURE SCOPE OF WORK

There is a vast scope of research in the recycled aggregate usage in concrete especially ceramic tile wastes in the future. The following are some of the probable research investigations:

1. Marble floor tiles can be investigated because they are similar to tile waste generation and are also quite hard when compared to natural crushed stones used in typical concrete.

2. The use of granite powder as an additive in concrete to increase workability and strength parameters can be investigated at various percentages.

3. The impact of different tile combinations in varying amounts in concrete on concrete qualities such as strength, workability, and so on can be determined.

4. The physical features of ceramic tile aggregate in concrete, such as durability and permeability, are improved. It can be analyzed to prepare a concrete with more advantageous than conventional concrete.

5. A study of the qualities of concrete created using a mix of recycled aggregate and tile aggregate in various proportions might be conducted to improve the concrete's properties while simultaneously reducing pollution and waste generated by the construction sector.

6. A further investigation on the use of granite powder alone as a replacement to fine aggregate can be carried out the possibility of using such waste generation from industries.

7. The mechanical properties of concrete with marble aggregate (waste) either from manufacturing units or from construction demolition can be investigated to improve the properties like permeability; resistance to sound can also be studied.

8. Ceramic tile aggregate in high strength concrete can be studied further to check the possibility of its use in high rise buildings.

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