"MECHANICAL PROPERTIES OF CONCRETE INCORPORATING WASTE CERAMIC TILES AND WASTE FOUNDRY SAND"

A PROJECT

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"To study mechanical properties of concrete incorporating waste foundry sand and waste ceramic tiles"** in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by Vishal Rajpoot(141675), Suyash Sharma(141678), Dashmeet Singh(141688)during a period from July 2016 to June 2017 under the supervision of **Mr. Anirban Dhulia (Assistant Professor),** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: 16-05-2018

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This project gives a detailed description of the study work done on the project topic **"MECHANICAL PROPERTIES OF CONCRETE INCORPORATING WASTE CERAMIC TILES AND WASTE FOUNDRY SAND"** for the partial fulfillment of the requirements for the degree of Bachelor of Technology in Civil Engineering, under the supervision of **MR. ANIRBAN DHULIA**.

We gratefully acknowledge the management and administration of jaypee university of information technology, waknaghat for providing us the opportunity and hence the environment to initiate and complete our project now.

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1.1 General

Concrete is one of the most vital and common materials used in the construction field. Development parts are sending quickly on an expansive scale and furthermore walking to association of new development advancements. The utilization of characteristic assets in development has regular from decades, which is the aftereffect of high cost. To defeat the utilization of common assets and utilization of waste material like foundry sand in cement could be make conceivable to accomplish the minimal effort development. Additionally the utilization of waste foundry sand in development could maintain a strategic distance from the issues identified with condition contamination.

The present area of research in the solid was presenting waste foundry sand (WFS) and waste clay tiles in the conventional cement. Squander foundry sand is the result of metal throwing businesses, which causes ecological issues as a result of its dishonorable transfer.

Development businesses requires colossal measure of clay tiles and other fired for building appearance, the preparations of which are definitely expanded, because of this waste is likewise create amid dealing with and utilization of artistic tiles.

Thusly, its use in building material, advancement and in various fields is essential for diminishing of natural issues. This undertaking is done to convey an eco-accommodating bond. This Project endorses the capable use of waste foundry sand as a fragmented substitution for fine aggregate and WCT as a fractional swap for coarse total in concrete.

The point of this task is to know the conduct and mechanical properties of cement for its eco-accommodating and prudent utilize.

1.2 Literature Review

On perusing different research paper we found that there were a great deal of studies directed among waste material and there use in construction field. Numerous looks into were done on foundry sand and waste ceramic tiles and different tests were done on foundry sand when mixed in concrete. These tests were directed on grades of concrete like M10, M20 and M30 and so forth. Aside from this, foundry sand improves properties of cement. So we look into research papers identified with utilization of foundry sand and waste ceramic tiles in concrete.

A Study on utilization of Waste Foundry Sand: Opportunities for Economical and Sustainable Concrete was directed by Samir S. Shah, Prof. V. V. Shelar.

They utilized foundry sand as the incomplete substitution of fine total and thought about the mass thickness of the sand. They found the fineness modulus increments with increment in level of substitution of foundry sand upto a specific point of confinement and afterward diminishes.

(2013) An examination on utilization of waste foundry sand by Pathaiya Saraswati and Rana Jay krishna was directed. As indicated by them compressive quality increments on increase in level of WFS as contrast with M30 concrete. In the examination, most extreme compressive quality is found at 60% substitution of fine total by WFS. Split elasticity increment on increment in level of waste foundry sand.

Studies were directed on utilization of waste earthenware tiles in concrete.

As per H. A. Sibak Professor (Faculty of Engineering), Cairo University, Giza, Egypt Concluded that the fired squanders can be delegated non– dangerous mechanical waste (NHIW).

Clay squanders were normally utilized as a part of the development business, vitrified sewer channels, building blocks, solid blend, and mixed bond.

1.3 Objectives

- To design a new concrete mix using waste materials (WFS and WCT) and to compare its mechanical properties with conventional M30 concrete.
- To study the physical properties of the mineral admixtures and aggregates.
- To prepare a eco-friendly construction material avoiding the dumping issues.

1.4 Limitations

- Studies were performed on only M30 concrete.
- Maximum replacement of WFS and WCT was kept 40% .

Chapter 2 : Literature Review

General

Today the word green isn't simply restricted to shading, it speaks to the earth , which is around us. Concrete which is produced using concrete wastage that are eco-accommodating are called as "Green Concrete". The other name for green concrete is asset sparing structures with lessened natural effect for e.g. Vitality sparing, CO2 discharges, squander water. "Green concrete" is a progressive subject in the historical backdrop of concrete industry. Concrete wastage like slag, control plant squanders, reused concrete, mining and quarrying wastage, incinerator buildup, red mud, consumed dirt, sawdust, combustor fiery debris and foundry sand. Green Concrete is a term given to a concrete that has had additional means taken in the blend plan and position to guarantee a reasonable structure and a long life cycle with a low upkeep surface. E.g. Vitality sparing, CO emanations, squander water. To empower this, new innovation is produced. There are various option natural necessities with which green concrete structures must consent.

Specialists all through the world have been exploring method for the replacement of total to make development reasonable and practical .Various analysts have examined the utilization of WCT and their subordinate in structural designing development. WCT is a richly accessible Non-dangerous mechanical waste (NHIW) squander from nearby or fundamental steel throwing ventures, so its transfer is a significant issue for neighbourhood condition. Thus, theories squanders can be utilized as substitution material in the development business. This will diminish cost of development materials and take care of the issue of transfer of squanders. WCT is utilized as medium weight total in concrete. The properties of WCT, total concrete is analyzed and the utilization of WCT total in development is tried. WCT have uneven smooth surface which helps in low retention of water content.

2.1 Studies conducted on utilization of foundry sand

- International Journal of Engineering Trends and Technology' (IJETT) – Volume 4 Issue 10 - Oct 2013 Pathaiya Saraswati and Rana Jay krishna

the mechanical properties of concrete are as follows

Compressive strength

Compressive quality increments on increment in level of waste foundry sand as contrast with conventional cement. In the examination, greatest compressive quality is gotten at 60% substitution of fine total by squander foundry sand.

Split tensile strength

Split tensile diminish on increment in level of waste foundry sand.

- A Study on Utilization of Used Foundry Sand: Opportunities for Economical and Sustainable Concrete was led by Samir S. Shah, Prof. V. V. Shelar, Department of Civil Engineering Trinity College of Engineering and Research, Pune, Savitribai Phule Pune University, Pune, India

They used foundry sand as the partial replacement of fine aggregate and compared the bulk density of the sand.

According to them the Fineness modulus for 0% replacement level (Fine aggregate) is 2.60, Fineness modulus for 10% replacement level is 3.334,
Fineness modulus for 20% replacement level is 3.079,
Fineness modulus for 30% replacement level is 3.334,
Fineness modulus for 40%replacement level is 2.398.

Environmental issues from disposal problems of waste can be minimize through this research. **An innovative supplementary Construction Material is formed through this study.**

2.1 Studies conducted on utilization of waste ceramic tiles

According to International Journal of Applied Engineering Research, ISSN 0973–4562, Volume 11, Number 4, (2016), published by H. A. Sibak Professor, Chemical Engineering Department, Sh. K. Amin Assistant Professor, Chemical Engineering S. A. El–Sherbiny Assistant Professor, Chemical Engineering Department, Faculty of Engineering, Cairo University, Giza, Egypt Concluded that the ceramic wastes can be classified as non–hazardous industrial waste (NHIW). Ceramic wastes include, white ceramic, sanitary porcelain ware, roof tiles, electrical insulator residues, cement kiln dust electrical insulator residues, fired clay brick waste , glass waste, ceramic sludge, ceramic broken tiles, and the accumulated ceramic dust.

Ceramic wastes were generally suitable for use in the vitrified sewer pipes, building bricks, construction industry, concrete mix, and blended cement.

REVIEWS

Rahul Sharma (2016)

From the above trial results and strategies embraced the accompanying conclusions are influenced with respect to different properties of concrete consolidating the utilized foundry to sand and waste earthenware tiles:

1. Compressive quality of concrete expanded with increment in sand replacing with various substitution levels of foundry sand. In any case, at every supplanting level of fine total with foundry sand, an expansion in quality was seen with the expansion in age.
2. The compressive quality expanded by 4.1%,5.3%, and 9.7% when contrasted with conventional blend without foundry sand at 28-days.

Prof. Rama Rao & Ch.Anuradha (2016)

Following on above outcomes and system received after conclusion were influenced with respect to properties of concrete consolidating waste foundry to sand and waste artistic tile.

It is discovered that compressive quality of concrete blend is increments with increment in level of waste foundry sand and waste earthenware tiles as contrast with general concrete. It was greatest for 20 % substitution after that it diminishes. It is likewise discovered that split elasticity increments with increment in level of waste foundry sand and waste fired tiles up to 20 % substitution after that it decreases. Workability of concrete blend increments with increment in level of waste foundry sand and waste clay tiles as contrast with consistent concrete. As waste foundry sand is wastage from metal enterprises and waste artistic tiles is squander from development ventures accordingly both waste can be successfully use in concrete blend subsequently an eco-accommodating development material. By utilizing this loss in concrete, issues with respect to securely transfer is decreased.

Shakeel Ahmad & M.D Daniyal (2015)

The way toward substituting 0 to 50 percent waste fired tile as coarse total was concentrated and after that parameters of Slump, compressive quality, unit weight and flexural quality were estimated. At last, the accompanying conclusions can be featured from the yield of this exploration and can be compressed as takes after: 1) The yield comes about uncovered that utilizing coarse waste artistic tile inside the concrete blend prompt an impressive lessening in the workability for every one of the blends. Likewise, it was seen that the workability of concrete slowly diminished with the expansion of amount of waste artistic tile content. 2) As a general result, it was seen that the concrete mass thickness was diminished by the expansion of water bond proportion. Additionally, it was seen that the thickness of concrete bit by bit diminished with the expansion of amount of waste clay tile content. 3) Compressive quality of concrete step by step expanded with the expansion of amount of coarse waste earthenware tile total up as far as possible i.e 20% for w/c proportion of 0.4, 30% for w/c proportion of 0.5 and 40% for w/c proportion of 0.6. The best compressive quality was watched for C5-10 concrete. 4) It was seen that the flexural quality of Optimal Waste Ceramic Concrete was 32.2% higher than flexural quality of

Reference Concrete. In this manner, it can be inferred that the utilization of coarse waste artistic tile content in the concrete improved the flexural quality extensively. 5) Also, it can be seen that utilizing waste artistic tiles in concrete creation causes no surprising negative impact in the properties of concrete. The ideal instance of utilizing waste fired tiles as coarse totals is observed to be 10 to 30 percent. In these measures, an expansion occurs in compressive quality, as well as a decline in unit weight is accounted for. 6) Finally, utilizing waste clay tiles in concrete is a powerful measure as to diminishing the expenses of concrete and keeping the earth clean alongside wastage administration and diminishing the utilization of common crude materials.

Jagannathan Saravanan1, G.Srinivasan2 and B. Palani (2014)

The above outcomes says that exploratory examinations the following conclusions were made

Compressive nature of solid additions in 20% substitution of fine aggregate and coarse aggregate with foundry sand and WCT squander were observed. Split Tensile Strength solid additions in 20% substitution of fine aggregate and coarse aggregate with foundry sand and WCT were observed. Flexural quality solid additions in 20% substitution of fine aggregate and coarse aggregate with foundry sand and WCT were observed. Ceramic waste and foundry sand were mostly used to substitution of standard sums and the substitution of 15% and 30% shows lessen in all quality parameter and 20% substitution exhibits a development in quality parameter.

Parmindar Singh & Rakesh Shukla (2015)

Research on the usage of waste ceramic materials is indispensable due to the material waste is well ordered extending with the development in people and growing of urban change. The reasons that various examinations and examination had been made on imaginative tile add up to are because of tile aggregates are definitely not hard to get and their cost is more affordable than the ordinary sums. For customary sums mining is required yet tile aggregate can slight this technique.

1. Let go tile add up to is a recognized and appropriate solid material for substitution into solid piece in perspective of its properties.

2. Mechanical properties of let go add up to resemble the regular aggregate and its lead is relative however not same. Water digestion, squashing quality and impact regard, are higher than standard coarse aggregate and lower by specific gravity i.e. 2.24 g/cm3.

3. There can be likelihood that in M 20 survey cement to substitute 20% of customary 20 mm sums with dirt tile aggregates without exchanging off its required compressive quality.

4. For all solid blend (M 20, M25, M30) weight nature of solid decreases with increase in the degree of supplanting of normal sums with tile sums which is a direct result of low specific gravity higher porosity of tile adds up to as diverge from trademark sums.

5. In M 30 audit concrete with 5% substitution of tile adds up to its quality decreases from 38.73 to 36.73 n/mm2, which isn't as much as target mean quality. Along these lines, as per comes to fruition substitution should be avoided for this audit of cement. M 20 and M 25 cements are sensible for the substitution of aggregates.

6. Tile add up to concrete is bit more productive as appear differently in relation to customary cement. As a check for making 1 m3 of cement by substituting 20% commonplace 20 mm sums with tile adds up to around 16% money can be spared cash on total entirety of 20 mm aggregates.

7. By extension of WCT squander into concrete, suitable convincing use of masterful tile waste can be proficient.

Muhammad Farooq , Tauqir Ahmed (2014)

In view of test examine work with respect to the compressive quality of non-ferrous RFS concrete, it is watched that compressive quality of concrete increments up to 30% replacement of non-ferrous RFS however ideal value was 10 % of non-ferrous concrete. Consequently it closes from the present investigation that

1. For the creation of good quality concrete nonferrous RFS can be utilized.

2. Compressive quality of concrete increments with the expansion in non-ferrous RFS substance. Utilization of non-ferrous RFS can spare the cost of concrete up to 1.7% at 10% replacement of non-ferrous RFS, at last cost of structure.

3. Environmental impacts from the foundry waste and transfer issue of foundry waste can be lessened through this exploration.

Chapter 3 : Materials And Methodology

3.1 General

To study the suitability of foundry sand and ceramics in concrete, tests will be conducted on M30 grade of concrete. Mix design will be done as per IS: 10262 (2009).

Waste foundry sand and ceramic tiles were added as percentage replacement(10%, 20%, 30%, 40%) of fine aggregate and coarse aggregate respectively in M30 grade concrete. The tests on the properties of the resulting concrete were performed.

3.2 Experimental Program

Following tests were performed in laboratory for this study

Tests for aggregates and cement

(i) SG of OPC
(ii) SG and Water absorption for Coarse Aggregate
(iii) SG and Water absorption for Fine Aggregate
(iv) FM of Fine Aggregate
(v) Nominal size for coarse aggregate

Tests for concrete

(i) Test for Compressive Strength
(ii) Test for Split Tensile
(iii) Workability Test

3.3 Specification of Materials

Checking of materials is a basic piece of structural designing as the life of structure is reliant on the nature of material utilized. IS: 10262 (2009) manages Mixed Design of Concrete and in this manner it rely upon various properties of bond and totals. The properties that the Concrete Mix Design requires are particular gravity, water retention, fineness modulus and workability.

The fundamental goal of this task is to analyze the adjustments in quality properties in plain bond concrete and the solid fusing distinctive rates of WFS and WCT. The most critical property of cement is presumably quality, albeit numerous different attributes like strength might be similarly imperative. Then again, solid quality is a slippery property. Regardless of whether all the numerous components that are known to influence the quality – the properties and inborn inconstancy in the solid making materials, extents, air content, blending, temperature and others – are completely steady, the might be a wide scattering in the numerical estimations of the deliberate quality relying upon how well the fixings are blended.

Figure 3. 1 concrete cube and cylinder with 10% replacement of WFS &WCT

3.4 Material Used

The materials required are ordinary Portland cement, coarse aggregate, fine aggregates, foundry sand and waste concrete tiles. The concrete will be tested in five batches consisting of the following:

1. Plain cement concrete of M30 grade having cement: fine aggregate: coarse aggregate ratio of 1: 1.7: 3.7.

2. OPC incorporating 10% substitution of foundry sand from fine aggregate and waste ceramic tiles from coarse aggregate.

3. OPC incorporating 20% substitution of foundry sand from fine aggregate and waste ceramic tiles from coarse aggregate.

4. OPC incorporating 30% substitution of foundry sand from fine aggregate and waste ceramic tiles from coarse aggregate.

5. OPC incorporating 40% substitution of foundry sand from fine aggregate and waste ceramic tiles from coarse aggregate.

3.4.1 Ordinary Portland Cement

At the point when normal Portland bond is getting blended with water, its substance compound issue will experience through a concoction responses which will make it set. These synthetic responses all include the expansion of water to the fundamental concoction mixes. This substance response with water is called "hydration". Every one of the mixes free unique warmth of hydration and hydrate at various rates. Expansion of every one of these responses gives the information about how Ordinary Portland bond solidifies and picks up quality. Those mixes and their part in solidifying of bond are as under:

i. Tricalcium Silicate (C3S): It hydrates and solidifies rapidly and is in charge of beginning setting and early quality of the solid. OPC (Ordinary Portland concrete) with rates (over 70%) of C3S will bring about higher early quality.

ii. Dicalcium Silicate (C2S): Hydrates and solidifies gradually and is in charge of quality increments, following one week.

iii. Tricalcium Aluminate (C3A): Hydrates and solidifies the snappiest. It discharges extensive amount of warmth promptly and adds to early quality. Gypsum is added to Ordinary Portland concrete to impede C3A hydration. Gypsum controls the hydration of C3A which can cause the snappy setting of concrete.

iv. Tetracalcium Aluminoferrite (C4AF): Hydrates quickly, yet contributes almost no to quality. Shading in normal Portland concrete is because of the nearness of C4AF.

3.4.2 Fine aggregates

Fine aggregate that will be used is natural sand. Natural sand is available abundantly in coastal areas and thus widely used all over India. Advantages of natural sand are that the particles are Cubical or rounded with smooth surface texture. Being cubical and rounded and smooth textured it gives good workability. The fractions which are coming under 4.75 mm to 150 micron are termed as “fine aggregate”.

3.4.3 Coarse aggregate

Course aggregates occupy almost 35 to 70% of the volume of the concrete and are categorized according to various factors like maximum size, particle shape, textures and some other factors such as strength, porosity, hardness etc. It is recommended to use smaller sized aggregates as they act as a key in providing higher strengths. Aggregates whose specific gravity is more than 2.55 and water absorption less than 1.5% are considered to be of good quality aggregates.

3.4.4 Waste Foundry Sand (WFS)

Foundry sand comprises of great silica sand with uniform physical properties. It is a wastage created from metal throwing businesses, where sand is utilized as an embellishment material in view of its warm conductivity.

Indian foundries create around 1.71 million tons of waste foundry sand every year (Metal World, 2006). In the throwing procedure, warm and mechanical scraped spot in the end render the sand and in this manner inadmissible for use in throwing molds, and a bit of the sand is persistently evacuated and supplanted with new one.

This sand is dealt with as waste from throwing industry and in light of high silica content it can't be arranged effectively. Squander foundry sand is comprised of for the most part normal sand material. Its properties are like the properties of common or made sand. In this way it can typically be utilized as a substitution of sand.

The transfer issue related with WFS in landfills has made its present utilize less ideal . Other than there is budgetary weight on ferrous enterprises, arrive filling WFS additionally make them subordinate for future natural expenses and remediation issues. This significant issue is consistently tended to by exchange alternatives of reusing WFS advantageously. Valuable reuses of WFS in assortment of utilizations identified with foundation designing and restoration works.

Figure 3. 2 Foundry sand

Types of foundry sand

Foundry sand can be divided into 2 categories

(a) Green Sand (Clay Sand)

(b) Resin Sand (Phenolic, Furan)

(a) Green Sand (Clay Sand)

Clay sand is the blend of water, clay, normal silica sand and other additives. Bentonite clay is used to prepare the green sand. The compressive strength is between 0.1 to 0.05 Mpa. The air permeability is more than 80 and water content is 3.5 to 5%,.

This sand can be used to pour fluid metal before drying. As the wet sand has a low strength, air permeability and a high moisture content, the castings can have the porosity, coarse, sticky sand and sand extension absconds. , the dimensional exactness is low, so it is by and large utilized just for the creation of little and medium measured iron castings and non-ferrous composite castings; while in mechanical representing, the castings have high dimensional precision, so it is broadly utilized for high-volume generation of castings.

The clay used to make dry sand clay is normal clay with a high moisture. The sand made ought to be dried in the temperature of 250 ~ 400 ℃. It is largely used for steel castings. Due to the long production cycle, low dimensional precision, high energy consumption dry sand is continuously eliminated.

(b) Resin Sand (Phenolic, Furan)

Resin sand is a sort of foundry sand with engineered resin (phenolic resin and furan resin) as the adhesive. The resin added is around 3% to 6% of the sand quality. Resin sand can solidify quick when warmed 1 to 2 minutes, its dry strength is high, so the castings made are exact in measure, the surface is smooth, and the collapsibility is excellent. *

Scientists have detailed the conceivable utilization of waste foundry sand in various structural designing applications. These other applications offer cost funds for the two foundries and client ventures and ecological advantages at the neighbourhood and national level.

Chemical properties of green foundry sand

Constituent	Value (%)
SiO_2	83.93
Al_2O_3	0.021
Fe_2O_3	0.950
CaO	1.03
MgO	1.77
SO_3	0.057
LOI	2.19

3.4.5 Waste Ceramic Tiles (WCT)

India positions in the best 3 rundown of nations as far as tiles generation on the planet. This tremendous measure of earthenware tiles are not reused but rather is frequently utilized as asphalt material or landfill. Clay tile are hard totals having unpleasant surface and smooth surface on opposite side, for the most part have qualities like significant particular gravity, light-weight than other typical stone totals and have low thickness.

Utilizing clay tile total in concrete it will be savvy, as well as give extensive quality to the solid. Development businesses requires enormous measure of fired tiles and other earthenware for design appearance, the creations of which are definitely expanded, because of this waste is additionally deliver amid taking care of and use of clay tiles.

As 30 to 40% of the aggregate generation from assembling units is strong waste. Along these lines, we chose these waste tiles as a substitution material to the essential regular total. At first tiles are a blend of various dirts which are squeezed to wanted shapes and accomplish their coveted properties, for example, hardness and so forth after they are terminated at high temperatures. Fired items are produced using regular materials which contain a high extent of dirt minerals. These, after a procedure of parchedness which is trailed by controlled terminating at temperatures extending in the vicinity of 700ºC and 1000ºC and henceforth gain the trademark properties of "let go earth". Clay waste may originate from two sources. The wellsprings of fired squanders are

(a) Non-perilous mechanical waste (NHIW).

(b) Construction and annihilation activity(CDW).

India positions in the main 3 rundown of nations regarding tiles generation on the planet. This gigantic measure of artistic tiles are not reused but rather is frequently utilized as asphalt material or landfill. Earthenware tile are hard totals having unpleasant surface and smooth surface on opposite side, by and large have attributes like extensive particular gravity, light-weight than other ordinary stone totals and have low thickness.

Utilizing clay tile total in concrete it will be savvy, as well as give impressive quality to the solid. Development ventures requires immense measure of earthenware tiles and other clay for compositional appearance, the creations of which are radically expanded, because of this waste is additionally deliver amid dealing with and utilization of fired tiles.

As 30 to 40% of the aggregate creation from assembling units is strong waste. Thus, we chose these waste tiles as a substitution material to the fundamental regular total. At first tiles are a blend of various dirts which are squeezed to wanted shapes and accomplish their coveted properties, for example, hardness and so on after they are terminated at high temperatures. Earthenware items are produced using common materials which contain a high extent of dirt minerals. These, after a procedure of lack of hydration which is trailed by controlled terminating at temperatures going in the vicinity of 700ºC and 1000ºC and henceforth secure the trademark properties of "let go earth". Clay waste may originate from two sources. The wellsprings of clay squanders are

(a) Non-risky mechanical waste (NHIW).

(b) Construction and devastation activity(CDW).

Pottery businesses are for the most part the essential source and the waste related with it is named non-risky mechanical waste (NHIW). Development and Demolition destinations are additionally real wellsprings of artistic waste is related with development and devastation movement, and contains a huge part of development and decimation squander (CDW). As it's implied that "reuse" is superior to reuse and along these lines legitimate reuse of this sort of waste has numerous points of interest, one of which are the monetary focal points which incorporates work creation in organizations which have some expertise in the obtainment and reusing of this sort of material/squanders.

Figure 3. 3 Waste Ceramic Tiles

3.5 First phase of experiments

3.5.1 Sieve Analysis of Aggregate

Sieve analysis was performed on all of the aggregates and the test results are as follows -

Sieve analysis of waste ceramic tiles

For this we used 10 mm, 4.75 mm sieves to pass the ceramic waste to see how much percentage of the waste is retained on the sieve. The process of shaking is horizontal or vertical. Sieving can also be done by the mechanical shaker, it is fast and easy. Particle size distribution plays a very important role in determining the performance of the material. Grading effects much properties of an aggregate. It effects permeability, bulk density, stability. With a proper selection of gradation we can find the maximum permeability, bulk density, stability. These parameters are important because for a pavement design, a workable stable mix with water resistance is required. "Open Gradation" is defined as with relatively low bulk density, lack of fine particles and quite high permeability. "Rich Gradation" is defined as with low bulk density, low stability and low permeability

Table 3. 1 Sieve analysis of waste ceramic tiles

Sr. No.	**Is sieve destination**	**% of passing**
1	20mm	92
2	10mm	77.6

Table 3. 2 Sieve analysis of coarse aggregate

Sr. No.	**Is sieve destination**	**% of passing**	**Standard requirement**
1	20mm	92	95-100
2	10mm	31	25-55
3	4.75mm	3	0-10

Table 3. 3 Sieve analysis of fine aggregate

Sr. No.	IS sieve Destination	% of passing	Standard requirement
1	4.75mm	98	90-100
2	2.36mm	95	75-100
3	1.18mm	87	55-100
4	600 micron	47	35-59
5	300 micron	51	80-30
6	Pan	NIL	0.00

3.5.2 Physical properties of aggregates

Specific gravity is defined as the ratio of density of a substance to the density of a reference liquid at the same temperature.

Table 3. 4 Physical Chrematistic of fine Aggregate:

Sr. No.	Particular of test	Results
1	Fineness modulus	2.68
2	Specific gravity	2.83
3	Zone	3
4	Water absorption	1.0%

Table 3. 5 Physical properties of foundry sand

Sr. No.	Particular of test	Results
1	Specific gravity	2.50
2	Bulk relative density (kg/m3)	2590
3	Water absorption,%	0.4

Table 3. 6 physical properties of coarse aggregate

Sr. No.	Particular of test	Results
1	Specific gravity	2.52
2	Bulk relative density (kg/m3)	1120
3	Water absorption,%	1.43

Table 3. 7 Physical Properties of waste ceramic tiles

Sr. No.	Particular of test	Results
1	Specific gravity	3.22
2	Bulk relative density (kg/m3)	1080
3	Water absorption,%	1.36

3.6 Second phase of experiments

3.6.1 Compressive Strength of concrete

Compressive strength of test gives an idea with respect to each one of the characteristics of cement. By this single test one judge that on account of Concreting has been done honestly or not. Concrete compressive quality for general improvement contrasts from 15 MPa (2200 psi) to 30 MPa (4400 psi) and higher in business and current structures.

Compressive quality of cement depends upon various parts, for instance, water-bond proportion, concrete quality, nature of solid material, quality control among age of cement et cetera.

Test for compressive quality is done either on 3D shape or chamber. Diverse standard codes endorses solid barrel or solid block as the standard case for the test. American Society for Testing Materials ASTM C39/C39M gives Standard Test Method to Compressive Strength of Cylindrical Concrete Specimens.

$$\textbf{Compressive Strength = load / area (N/mm}^2\textbf{)}$$

Figure 3. 4 Compression testing machine

3.6.2 Split Tensile Strength Of Concrete

The rigidity of cement is one of the fundamental and basic properties. Part rigidity test on solid barrel is a technique to choose the elasticity of cement.

The solid is uncommonly frail in pressure in view of its fragile nature and isn't foreseen that it would oppose the immediate strain. The solid creates breaks when subjected to pliable powers. Along these lines, it is fundamental to choose the elasticity of cement to choose the most extreme load at which the solid pieces may break.

The round and hollow shape ought to be of 150 mm breadth and 300 mm in tallness meeting the prerequisites of IS: 10086-1982.

Split tensile strength = load/ lateral surface area of cylinder (N/mm^2)

Figure 3. 5 Compression testing machine

Chapter 4 : Result and Discussion

4.1 Introduction

A number of specimens were casted according to the mix design as calculated in the appendix and various tests were performed. Specimens related to M30 and M30 concrete with different percentages of WFS and WCT were casted. These were kept in curing tank for a period of 7 days and 28 days. Results were obtained when cubes and cylinders were tested for their strength properties in CTM.

4.2 Compressive Strength of Concrete cubes

Compressive quality tests were performed on solid shape tests of size 150mm X 150mm X 150mm

utilizing pressure testing machine. Three examples for each cluster were tried with the comparing and normal quality qualities announced in tableA number of examples were threw by the blend configuration as figured in the index and different tests were performed. Examples identified with M30 and M30 concrete with various rates of WFS and WCT were threw. These were kept in curing tank for a time of 7 days and 28 days. Results were gotten when blocks and chambers were tried for their quality properties in CTM.

Compressive quality tests were performed on shape tests of size 150mm X 150mm X 150mm.

Specimen No. 1 : M30 concrete

Three samples were casted and cured each for 7 days and 28 days. Average strength after 7 and 28 days for normal M30 concrete was found to be 18.69 N/mm^2 and 30.12 N/mm^2. Detailed readings are provided in the table 5. Design of the concrete is in the appendix

Specimen No. 2 : M30 with 10% replacement of WFS and WCT

Three samples were casted and cured each for 7 days and 28 days. Average strength after 7 and 28 days for this sample was found to be 19.02 N/mm^2 and 31.78 N/mm^2. Here we observe that the compressive strength increases with increase in slight percentage of WFS and WCT. Detailed readings are provided in the table 5. Design of concrete can be found in appendix.

Specimen No. 3 : M30 with 20% replacement of WFS and WCT

Three samples were casted and cured each for 7 days and 28 days. Average strength after 7 and 28 days for this sample was found to be 20.14 N/mm^2 and 34.31 N/mm^2. Here we observe that the compressive strength increases with 20% replacement of WFS and WCT. Detailed readings are provided in the table 5. Design of concrete can be found in appendix.

Specimen No. 4 : M30 with 30% replacement of WFS and WCT

Three samples were casted and cured each for 7 days and 28 days. Average strength after 7 and 28 days for this sample was found to be 18.37 N/mm^2 and 32.02 N/mm^2. Here we observe that the compressive strength decreases with 30% of WFS and WCT. Still the strength is approximately equal to the M30 concrete. Detailed readings are provided in the table 5. Design of concrete can be found in appendix.

Specimen No. 5 : M30 with 40% replacement of WFS and WCT

Three samples were casted and cured each for 7 days and 28 days. Average strength after 7 and 28 days for this sample was found to be 16.20 N/mm^2 and 29.8 N/mm^2. Here we observe that the compressive strength decreases with 30% of WFS and WCT. The strength has started to decrease, therefore 40% is the nominal percentage. More than 40% replacement will lead to the decrease strength. Detailed readings are provided in the table 5. Design of concrete can be found in appendix.

Table 4. 1 7 day compressive Strength of concrete having WFS and WCT

Sr. No.	Percentage (%) Replacement of WFS & WCT	7days compressive strength of cube 1(N/mm^2)	7days compressive strength of cube 2(N/mm^2)	7days compressive strength of cube 3(N/mm^2)	7 days average compressive strength(N/mm^2)
1	0	18.72	18.59	17.97	18.69
2	10	19.08	19.19	19.92	19.02
3	20	20.21	20.04	20.74	20.14
4	30	18.94	18.34	17.85	18.37
5	40	17.04	16.65	16.31	16.66

Table 4. 2 28 day compressive Strength of concrete having WFS and WCT

Sr. No.	Percentage (%) Replacement of WFS & WCT	28 days compressive strength of cube 1(N/mm^2)	28 days compressive strength of cube 2(N/mm^2)	28 days compressive strength of cube 3(N/mm^2)	28 days average compressive strength(N/mm^2)
1	0	31.08	29.68	31.6	30.12
2	10	31.98	31.57	32.05	31.78
3	20	34.98	34.08	34.65	34.31
4	30	32.36	31.79	32.02	32.02
5	40	29.5	28.7	26.9	28.4

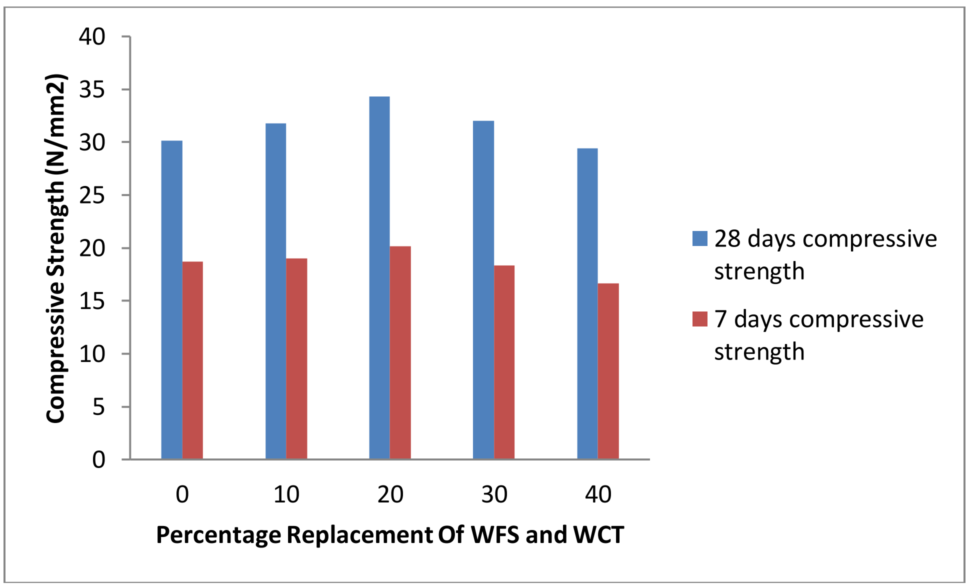

Figure 4. 1 %replacement of WFS &WCT vs 7 days compressive strength graph

4.2 7 Days split Tensile Strength of Concrete Cylinder

Splitting tests were performed on flexural testing machine utilizing barrel shaped examples of size 150 mm X 300 mm. The round and hollow example is set evenly between the stacking surfaces of a pressure testing machine. Limit pressing segments of reasonable material, for example, plywood is utilized to decrease the high pressure stresses. The heap is connected without stun and expanding ceaselessly at a rate of the example.

Specimen No. 1 : M30 concrete

Three samples were casted and cured each for 7 days and 28 days. Average strength after 7 and 28 days for normal M30 concrete was found to be 1.98 N/mm^2 and 3.02 N/mm^2. Detailed readings are provided in the table 5. Design of the concrete is in the appendix

Specimen No. 2 : M30 with 10% replacement of WFS and WCT

Three samples were casted and cured each for 7 days and 28 days. Average strength after 7 and 28 days for this sample was found to be 2.08 N/mm^2 and 3.29 N/mm^2. Here we observe that the split tensile strength increases with increase in slight percentage of WFS and WCT. Detailed readings are provided in the table 5. Design of concrete can be found in appendix.

Specimen No. 3 : M30 with 20% replacement of WFS and WCT

Three samples were casted and cured each for 7 days and 28 days. Average strength after 7 and 28 days for this sample was found to be 2.21 N/mm^2 and 3.50 N/mm^2. Here we observe that the split tensile strength increases with 20% replacement of WFS and WCT. Detailed readings are provided in the table 5. Design of concrete can be found in appendix.

Specimen No. 4 : M30 with 30% replacement of WFS and WCT

Three samples were casted and cured each for 7 days and 28 days. Average strength after 7 and 28 days for this sample was found to be 2.09 N/mm^2 and 3.21 N/mm^2. Here we observe that the split tensile strength decreases with 30% of WFS and WCT. Still the strength is approximately equal to the M30 concrete. Detailed readings are provided in the table 5. Design of concrete can be found in appendix.

Specimen No. 5 : M30 with 40% replacement of WFS and WCT

Three samples were casted and cured each for 7 days and 28 days. Average strength after 7 and 28 days for this sample was found to be 1.8 N/mm^2 and 29.8 N/mm^2. Here we observe that the split tensile strength decreases with 30% of WFS and WCT. The strength has started to decrease, therefore 40% is the nominal percentage. More than 40% replacement will lead to the decrease strength. Detailed readings are provided in the table 5. Design of concrete can be found in appendix.

Table 4. 3 Split Tensile Strength of concrete cylinder having WFS and WCT

Sr. No.	Percentage (%) Replacement of WFS & WCT	7 days tensile strength of cylinder 1 (N/mm^2)	7 days tensile strength of cylinder 2 (N/mm^2)	7 days tensile strength of cylinder 3 (N/mm^2)	7 days average tensile strength (N/mm^2)
1	0	1.89	2.08	1.95	1.98
2	10	2.03	2.11	2.15	2.08
3	20	2.19	2.28	2.15	2.21
4	30	2.02	2.13	2.05	2.09
5	40	1.4	1.9	1.6	1.8

Table 4. 4 28 Days split Tensile Strength of Concrete Cylinder

Sr. No.	Percentage (%) Replacement of WFS & WCT	28 days tensile strength of cylinder 1 (N/mm^2)	28 days tensile strength of cylinder 2 (N/mm^2)	28 days tensile strength of cylinder 2 (N/mm^2	28 days average tensile strength (N/mm^2)
1	0	2.98	3.04	3.01	3.02
2	10	3.31	3.27	3.34	3.29
3	20	3.52	3.49	3.45	3.50
4	30	3.34	3.09	3.01	3.21
5	40	2.95	3.05	3.03	3.01

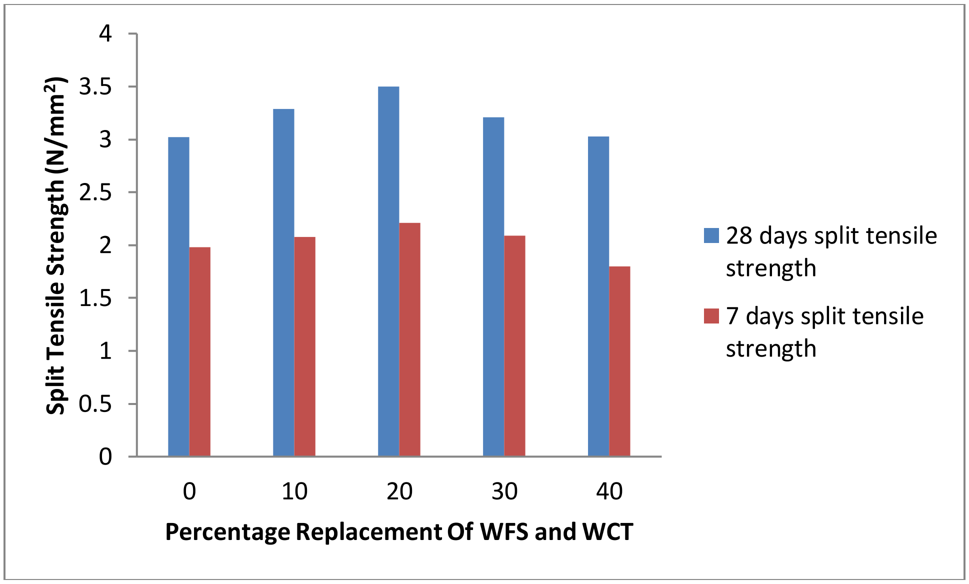

Figure 4. 2 %replacement of WFS &WCT vs tensile strength graph

4.3 Workability

Workability is the most critical parameter with respect to stream of cement. As coarse totals are supplanted by squander clay tiles, as coarse total assimilate water as a result of pours surface waste fired tiles gives preference here because of its one cleaned surface and thus ingest less water content as contrast with coarse totals in this way give more workable cement

Table 4. 5 Workability of concrete having WFS and WCT

Sr. No.	% replacement	W/C ratio	Slump (mm)	Degree of Workability
1	0	0.49	8	Low
2	10	0.49	38	Low
3	20	0.49	80	Medium
4	30	0.49	105	High
5	40	0.49	137	High

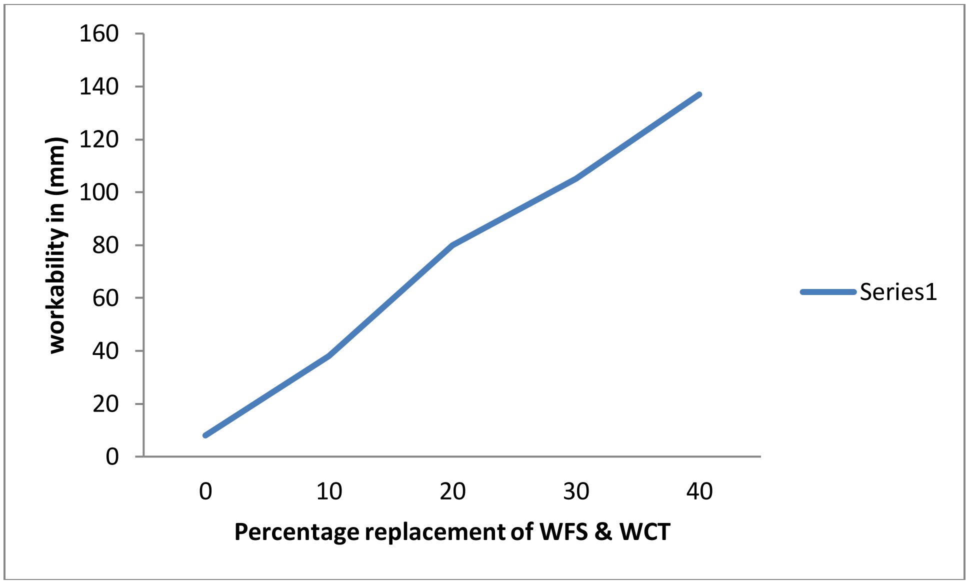

Figure 4. 3 % replacement of WFS &WCT vs slump (in mm) graph

Chapter 5 : Conclusion

Depending upon above results and methodology adopted following conclusion were made regarding properties of concrete incorporating waste foundry sand and waste ceramic tile.

- It is discovered that compressive quality of solid blend is increments with increment in level of waste foundry sand and waste earthenware tiles as contrast with customary cement. It was most extreme for 20 % substitution after that it diminishes.

- It is likewise discovered that split rigidity increments with increment in level of waste foundry sand and waste earthenware tiles up to 20 % substitution after that it diminishes.

- Workability of solid blend increments with increment in level of waste foundry sand and waste fired tiles as contrast with general cement.

- As squander foundry sand is squander from metal ventures and waste earthenware tiles is squander from development enterprises along these lines both waste can be successfully use in solid blend consequently an eco-accommodating development material.

- By utilizing this loss in solid, issues with respect to securely transfer is decreased.

Appendix

Mix design

M30 Concrete (1:1.5:2)

Grade of cement	OPC 53 grade
Maximum nominal aggregate size	20 mm
Minimum cement content	320 Kg/m^3
Water-cement ratio	.45
Specific gravity of coarse aggregate	2.88
Specific gravity of fine aggregate	2.605
Specific gravity of Ceramic Tiles	2.33
Specific gravity of Foundry Sand	2.50
Exposure	Normal
Workability	75 mm

For cube mould of dimensions 150x150x150 mm^3

Volume of cube mould	.00375 m^3
Density of concrete (kg/m^3)	2400
Mass	2400*.00375= 9 Kg
Water /cement	.45
Water	2*0.45= 900 ml

For normal M30 specimen

Volume of dry cement concrete = 1.54 times of volume of wet cement concrete

Unit weight of cement = 1440 Kg/m^3

For $1m^3$ of cube mould, cement required = [1/(1+1.5+2)]*1.54*1440 = 489.60 Kg

For .00375 m^3, cement = 489.60*.00375 = 1.90 Kg

Coarse aggregate = 3.80 Kg

Fine aggregate = 2.85 Kg

After 10% replacement of CA and FA with WCT and WFS respectively

Cement required = 1.90 kg

Water required = 1.90*0.45 = 855 ml

Waste Ceramic Tiles = .380 kg

Waste Foundry Sand = .285 kg

Coarse aggregate = 3.42 kg

Fine aggregate = 2.565 kg

After 20% replacement of CA and FA with WCT and WFS respectively

Cement required = 1.90 kg

Water required = 855 ml

Waste Ceramic Tiles = .20*3.80 =.760 kg

Waste Foundry Sand = .20*2.85 = .570 kg

Coarse aggregate = 3.04 kg

Fine aggregate = 2.28 kg

After 30% replacement of CA and FA with WCT and WFS replacement

Cement required = 1.90 kg

Water required = 855 ml

Waste Ceramic Tiles = .30*3.80 = 1.14 kg

Waste Foundry Sand = .855 kg

Coarse aggregate = 2.66 kg

Fine aggregate = 1.995 kg

After 40% replacement of CA and FA with WCT and WFS respectively

Cement required = 1.90 kg

Water required = 855 ml

Waste Ceramic Tiles = 1.52 kg

Waste Foundry Sand = 1.14 kg

Coarse aggregate = 2.28 kg

Fine aggregate = 1.71 kg

For Cylindrical mould of 150 mm diameter and 300 mm height

Volume of cylindrical mould =3.14*(75)^2*300 = .005 m^3

Density of concrete (kg/m^3) = 2400

Mass = 2400*.005 = 12 Kg

Water/cement = .45

Water = 2.5*.45 = 1125 ml

For normal M30 specimen

Cement required for 1 m^3 mould = 489.60 Kg

Cement required for .005 m^3 mould = .005*489.6 = 2.448 Kg

Water required = .45*2.448 = 1101.6 ml

Coarse aggregate = 2*2.448 = 4.90 Kg

Fine aggregate = 1.5*2.448 = 3.70 Kg

After 10% replacement of CA and FA with WCT and WFS respectively

Cement required = 2.5 Kg

Water required = 1101.6 ml

Waste Ceramic Tiles = .49 Kg

Waste Foundry Sand = .37 Kg

Coarse aggregate = 4.41 Kg

Fine aggregate = 3.33 Kg

After 20 % replacement of CA and FA with WCT and WFS respectively

Cement required = 2.5 Kg

Water required = 1101.6 ml

Waste Ceramic Tiles = .98 Kg

Waste Foundry Sand = .74 Kg

Coarse aggregate = 3.92 Kg

Fine aggregate = 2.96 Kg

After 30% replacement of CA and FA with WCT and WFS respectively

Cement required = 2.5 Kg

Water required = 1101.6 ml

Waste Ceramic Tiles = 1.47 Kg

Waste Foundry Sand = 1.14 Kg

Coarse aggregate = 3.43 Kg

Fine aggregate = 2.66 Kg

After 40% replacement of CA and FA with WCT and WFS respectively

Cement required = 2.5 Kg

Water required = 1101.6 ml

Waste Ceramic Tiles = 1.96 Kg

Waste Foundry Sand = 1.52 Kg

Coarse aggregate = 2.94 Kg

Fine aggregate = 2.28 Kg

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