OPEN ACCESS
International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

# Effect of the Partial Replacement of Cement with Microsilica and Coarse Aggregate with Crushed Ceramic Tiles on the Properties of Concrete

**Basharat Nabi, Anuj Sachar, Manish Kaushal**

***Abstract:** Re-use of waste, otherwise deemed to be of no use, in concrete will lead to green environment. The concrete made so is called sustainable concrete which can also be called as Green concrete. The main focus of this research is to study the strength of concrete with crushed waste ceramic tile and silica fume as partial replacement of coarse aggregate and cement respectively. Rapid construction and total reliance on conventional materials of making concrete are leading to dearth of the materials and increased construction cost. In this research an attempt is being made to find the sustainability of waste ceramic tile as coarse aggregate and silica fume as a possible replacement for conventional aggregate and cement in concrete. In this study we replace the micro silica for cement partially in the percentage of 5%,10%, 15%, 20%, and 20% of coarse aggregate is replaced with crushed waste ceramic tiles. The replaced concrete is compared with the normal concrete. Tests are done following codes of Bureau of Indian Standards. Mix design of M30 grade of concrete is designed by following the specification given in the IS 10262:2009. For all the materials, physical properties shall be determined and fresh concrete is prepared. Concrete is then tested for determination of physical properties in fresh state. In hardened concrete, mechanical properties such as compressive strength & split tensile strength of concrete and durability properties like resistance against acid and alkaline attack would be examined and compared with conventional concrete.*

***Keywords:** Green concrete, Mix Design, Durability, acid attack, Mechanical properties.*

## I. INTRODUCTION

Concrete is a versatile product having multi-uses and is only in second place after water as being the most utilizing substance in the world nowadays. The peculiarity of the concrete is due to the fact that from the common ingredients, the properties of concrete are engineered to make it useful in any application.. The demand for concrete is increasing day by day all over the world due to its engineering properties like versatility, mould ability, high compressive strength and many more advantages.

Revised Manuscript Received on March 30, 2020.
* Correspondence Author
**Basharat Nabi,** Research Scholar, Department of Civil Engineering, RIMT University, Punjab, India.
**Anuj Sachar,** Assistant Professor, Department of Civil Engineering RIMT University, Punjab, India.
**Manish Kaushal,** Assistant Professor, Department of Civil Engineering RIMT University, Punjab, India



Hence, concrete has become indispensable in construction Therefore, demand of construction materials is increasing. There is a need to explore alternative construction materials that would cater the needs of the developing world.

## SILICA FUME

Silica fume is the non-crystalline polymorph of silicon dioxide. It is a byproduct of the production of elemental silicons or alloys having silicon. It is produced in electric arc furnaces. During the last three decades, great efforts have been taken in improving the performance of concrete as a building material. The use of silica fume as a pozzolanic additive has increased worldwide attention over the recent years because when used in a certain percent, it can enhance various properties of concrete both in the fresh as well as in hardened states like cohesiveness, strength, permeability and durability. Silica fume concrete may be appropriate in places where high abrasion resistance and low permeability are of utmost importance or where very high cohesive mixes are required to avoid defects like segregation and bleeding.

## WASTE CERAMIC TILES

Ceramic tile is produced from natural materials sintered at high temperatures. Indian ceramic production is 100 Million ton per year. In the ceramic industry, about 15% - 30% waste material is generated from the total production. This waste is not recycled in any form at present. However, the ceramic tile waste is durable, hard and highly resistant to biological, chemical, and physical degradation forces. The amount of ceramic tile waste on earth would be enough for use as a coarse aggregate in concrete. Ceramic waste can be transformed into useful Coarse aggregate. The advancement of concrete technology can reduce the consumption of natural resources. Effort is to focus on recovery, reuse of natural resources and to find other alternatives. The use of the replacement materials offer reduction in cost, energy savings, comparatively superior products, and lesser hazards in the environment. Ceramic tile wastes are generally used in fills. But it can be recycled and can be used as a construction material being economical, environment friendly as well as provides nearly the equivalent quality as that of a normal aggregate. Ceramic wastes can be used safely with no need for particular change in production and process of preparation of concrete. We can make the concrete with high strength and increased durability by using waste by-products of industries and construction.

In the present research, the silica fume is used in replacement of cement in the percentages of 5,10,15 and 20 percent in 0% and 20% WCT replacements of coarse aggregates. The concrete is tested for workability properties in fresh state.

The concrete is then tested in lab to meet the mechanical and durability requirements in hardened state.

The proposed work will be an approach towards a better environment to live in. It will lead to the use of the waste products in making concrete without neglecting the strength parameters. Use of waste ceramic tiles as partial replacement of coarse aggregate not only solves the environmental issue but also is relatively cheaper. 1 cum of concrete with 20 percent use of waste ceramic tiles is 16 percent cheaper than the cost of conventional concrete.

Use of micro silica will increase the diffusion resistivity and lower the penetrability of the ceramic tile based concrete which was an issue with the reinforcement of conventional concrete also.

A comprehensive study is needed in this field of remaking our planet green by green concrete.

According to the World Commission on Environment and Development: Sustainability means "Meeting the present needs without compromising on the ability of the future generations to meet their own needs".

Sustainability is an idea for concern for the well being of our planet with continued growth and human development.

## II. MATERIALS REQUIRED

The raw materials required for the experimentation are cement, fine aggregate, coarse aggregate, silica fume, ceramic tiles and water.

### a) Cement

The cement reacts chemically with water and other ingredient to form hard matrix (concrete) which binds all the materials together into a durable stone-like material that has many uses. In this study, ordinary Portland cement of grade 53 confirming to IS 12269-1987 with brand name KHYBER Cements was used. The properties of the cement were determined by some tests done in laboratory like consistency test, specific gravity test, setting time test.

**Table 1. Properties of cement.**

| Property | Test Results | Confirmity |
|---|---|---|
| Specific Gravity | 3.14 | IS 8112-1989 |
| Consistency | 32% | IS 4031(PART 4)-1988 |
| Initial setting time | 90 minutes | IS 4031(PART 5)-1988 |
| Final setting time | 6 hours 30 minutes | IS 4031(PART 5)-1988 |

### b)Fine aggregate

Aggregates whose considerable percentage passes through 4.75-mm BIS Sieve are called the fine aggregates.

Depending upon the particle size distribution, the fine aggregates are divided into four grading zones as per BIS: 383-1970 that are zone I, zone II, zone III and zone IV. Sieve analysis of fine aggregates was performed and it was confirming to grading zone II. It was brownish green in colour, taken from Shilwath Nallah (Bandipora). Befoe using, the sand is washed and screened to eliminate unwanted elements. Some tests were performed confirming the requirements of IS 383.

**Table 2. Properties of fine aggregate**

| S. No | Description | Test Results |
|---|---|---|
| **1** | Specific gravity | 2.72 |
| **2** | Water absorption | 1.419% |
| **3** | Fineness modulus | 2.8 |
| **4** | Sand zone | II |

### c) Coarse aggregate

Coarse aggregates are aggregates, the most of which are retained on 4.75-mm BIS Sieve. The grading of the coarse aggregate is described by their nominal size i.e. 40 mm, 20 mm, 16 mm and 10 mm. Regarding the characteristics of different types of aggregate, crushed aggregates tend to improve the strength because of interlocking of angular particles, while rounded aggregates improve the flow because of lower internal friction. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. Crushed aggregates of 20 mm size produced from local crushing plants were used. Seive analysis was done. The aggregates were tested for their physical requirements such as gradation, fineness modulus and specific gravity according to IS: 2386-1963 and the test results are tabulated as

**Table 3. Properties of coarse aggregate**

| S. No. | Description | Test Results |
|---|---|---|
| 1 | Nominal size used 20mm | 20mm |
| 2 | Specific gravity | 2.7 |
| 3 | Water absorption | 0.81% |
| 4 | Aggregate crushing value | 18.48% |
| 5 | Fineness modulus | 6.93 |

### d) Crushed waste ceramic tiles

Broken tiles were collected from the solid waste of ceramic manufacturing unit at Khonmoh and from demolished building. The waste tiles were crushed into small pieces manually and by using crusher and separated the average size of 20 mm to use them as replacement of cement. The required size of crushed tile aggregate was separated to use them as partial replacement to the natural coarse aggregate. Crushed tiles were partially replaced in place of coarse aggregate by a constant percentage of 20% individually and along with partial replacement of fine aggregate with silica fume also. The various tests were performed and the results are summarised as:

**Table 4. Properties of waste ceramic tiles.**

| S. No | Description | Test Results |
|---|---|---|
| **01** | Specific gravity | 2.46 |
| **02** | Water absorption | 1.81% |

| | | |
|---|---|---|
| 03 | Crushing value | 25.65% |

**e) Silica Fume**

Silica fume or Microsilica is used as an artificial pozzolanic admixture. The silica fume used in this study was ordered from NAKODA enterprises, Manorama Ganj, Indore , the properties of which are tabulated as

**Table 5. Properties of silica fume**

| | |
|---|---|
| Specific gravity | 2.2 |
| Size | Less than 1 micron |

**f) Water**

Water plays an important role in the process of the concrete formation. Water inflences the strength and durability development of concrete. Portable is generally suitable for the concrete preparation. Thr confirmity of available water for making concrete can be guided by IS 456-2000. PH value of water should not be less than 6.

## III. DESIGN MIX

The concrete is designed as M30 grade following the procedure as given by IS 10262-2009. This is also used to prepare the test specimen. The design mix proportion is as:

**Table 6. design mix ratio**

| Proportions by | Water | Cement | Fine aggregate | Coarse aggregate |
|---|---|---|---|---|
| Weight in $kg/m^3$ | 191 | 425 | 678 | 1146 |
| Volume $m^3$ | 0.45 | 1 | 1.59 | 2.69 |

Based on this design mix , the replacement proportions for various concrete mixes are:

**Table 7. Proportions of design mix**

| S. No. | Concrete mix type | Cement replacement with silica fume | Coarse aggregate replacement with Waste ceramic tiles |
|---|---|---|---|
| 1. | $A_0$ | 0 | 0 |
| 2. | $A_1$ | 5 | 0 |
| 3. | $A_2$ | 10 | 0 |
| 4. | $A_3$ | 15 | 0 |
| 5. | $A_4$ | 20 | 0 |
| 6. | $A_5$ | 0 | 20 |
| 7. | $A_6$ | 5 | 20 |
| 8. | $A_7$ | 10 | 20 |
| 9. | $A_8$ | 15 | 20 |
| 10. | $A_9$ | 20 | 20 |

## IV. EXPERIMENTAL METHODOLOGY

After determining the material properties, the investigation to evaluate the effect of partial replacement of waste ceramic tiles for coarse aggregate and silica fume for cement is done by concrete testing. The ingredients are mixed in required proportions and concrete is prepared. Then it is tested in fresh as well as in hardened state. In this study we first replace cement in normal concrete with silica fume by 0%,5%,10% ,15% and 20% independently. Then we replace 20% of coarse aggregate with crushed waste ceramic tiles and and study its effect replacing cement with silica fume by the same proportions again. We thus get to know the individual effect of silica fume replacement and the replacement of both silica fume and waste ceramic tiles on the mechanical and the durability characteristics of concrete. For this study, cube samples of size 150mm×150mm×150mm are casted with the required percentage of replacements concrete and that of the normal concrete. The size of cylinder 150mm×300mm were casted.The specimen are prepared. After 24 hours the specimen are remoulded and are cured in the curing tank for 7 and 28and 56 days. Tests will be done following codes of Bureau of Indian Standards. The test for Compressive Strength on cubes will be measured at 7 and 28 days of curing as per IS:516-1959, and test for Split Tensile Strength on cylinder was measured at 7 and 28 days of curing as per IS:5816-1999. The durability tests will be done at 14,28 and 56 days of curing.

## V. RESULTS AND DISCUSSIONS

### A) TESTS ON FRESH CONCRETE:

**1) Slump test:**

When the concrete was green, it was tested to see the effect of the silica fume and waste ceramic tile replacements on the workability of the concrete. Test results show that slump increases slightly when 5 percent of silica is added as partial replacement of cement. After further addition the slump gets decreased continously due to decreased viscidity but the concrete paste remains cohesive due to increased surface area and ultra fine structure of silica fume and ball type structure of silica fume particles giving ball bearing action causing concrete to flow when slight energy is applied. With the further 20 percent replacement of coarse aggregate by the crushed waste ceramic tiles, the workability drastically decreases due to angularity and rough texture of crushed aggregate. Further to maintain same workability more water should be added because the slump gets decreased by 70 percent by these additions. The variation in slump is shown in the table and in figure below.

**Table 8: Test results for workability of concrete by slump test:**

| Mix | WCT% | Silica Fume% | Avg. Slump(mm) |
|---|---|---|---|
| $A_0$ | 0 | 0 | 105 |
| $A_1$ | 0 | 5 | 108 |
| $A_2$ | 0 | 10 | 94 |
| $A_3$ | 0 | 15 | 62 |
| $A_4$ | 0 | 20 | 43 |
| $A_5$ | 20 | 0 | 89 |
| $A_6$ | 20 | 5 | 93 |
| $A_7$ | 20 | 10 | 69 |

| | | | |
|---|---|---|---|
| **$A_8$** | **20** | **15** | **44** |
| **$A_9$** | **20** | **20** | **26** |

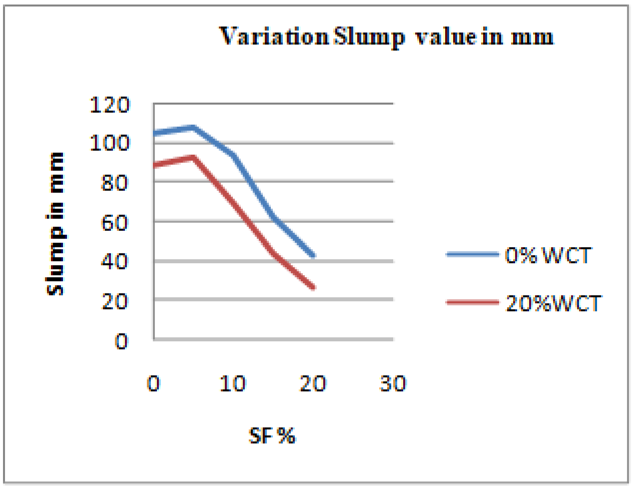


**Figure 1: Slump values of concrete with different replacement levels of Silica fume and 20 percent WCT.**

**2) Compaction Factor test**

The compaction factor test was conducted to the same mix that tested for workability by slump cone. The results obtained from the compaction factor test for the workability of various mixes of replacements of M30 grade of concrete are tabulated as follows:

**Table 9 Compaction factor test values for prepared concrete with different replacements**

| Mix | WCT% | Silica Fume% | Avg. Compaction factor value |
|---|---|---|---|
| **$A_0$** | **0** | **0** | **0.90** |
| **$A_1$** | **0** | **5** | **0.92** |
| **$A_2$** | **0** | **10** | **0.93** |
| **$A_3$** | **0** | **15** | **0.91** |
| **$A_4$** | **0** | **20** | **0.89** |
| **$A_5$** | **20** | **0** | **0.87** |
| **$A_6$** | **20** | **5** | **0.89** |
| **$A_7$** | **20** | **10** | **0.90** |
| **$A_8$** | **20** | **15** | **0.88** |
| **$A_9$** | **20** | **20** | **0.87** |

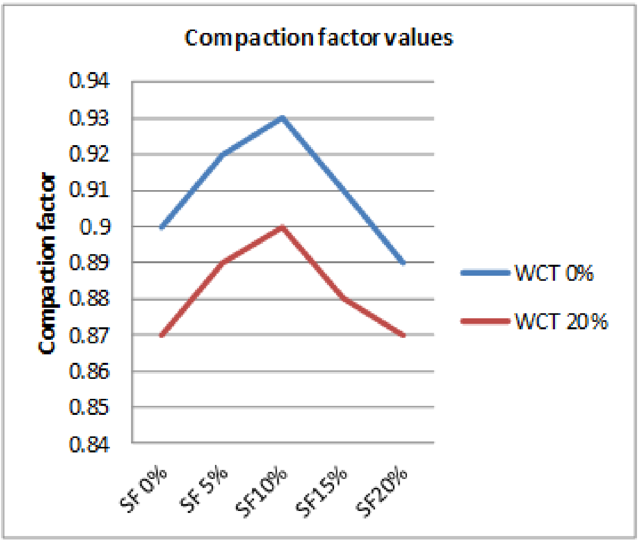


**Figure 2: Compaction factor values of concrete with different replacement levels of Silica fume and 20 percent WCT.**

## B) TESTS ON HARDENED CONCRETE:

### 1) Mechanical tests:

### A) Compressive strength test

The compressive strength of all the mixes was determined at the ages of 7 and 28 days for the various replacement levels of silica fume with cement and 20 Percent WCT with coarse aggregates. The values of average compressive strength for different replacement levels of silica fume (0%, 5%, 10%, 15%, 20%) and WCT (20%) at the end of curing periods (7 days, 28 days ) are given in Table. The effect of both waste materials on compressive strength at curing ages of 7 and 28 days is illustrated by Figures below. The rest results show that there is the increase in compressive strength with the addition of silica fume content. The compressive strength increases gradually with the increase in the percentage of silica fume content upto 15 percent after that the strength shows decreasing trend. With the replacement of coarse aggregate with WCT, there is a net increase in the compressive strength of hardened concrete. The results show 33.98 percent increase in compressive strength by 20 percent replacement by WCT and 15 percent SF. The highest strength achieved is with 20 percent replacement of coarse aggregate by WCT and 15 percent replacement of cement by slica fume.

**Table 10: Test results for average compressive strength of concrete**

| Mix | WCT% | SF% | Avg compressive strength(N/mm2) for given no. of curing days | |
|---|---|---|---|---|
| | | | 7 days | 28 days |
| $A_0$ | 0 | 0 | 25.13 | 38.90 |
| $A_1$ | 0 | 5 | 26.23 | 40.56 |
| $A_2$ | 0 | 10 | 29.50 | 45.41 |
| $A_3$ | 0 | 15 | 30.82 | 47.13 |
| $A_4$ | 0 | 20 | 30.69 | 46.52 |
| $A_5$ | 20 | 0 | 29.16 | 45.29 |
| $A_6$ | 20 | 5 | 30.31 | 46.69 |
| $A_7$ | 20 | 10 | 32.79 | 50.48 |
| $A_8$ | 20 | 15 | 33.91 | 52.12 |
| $A_9$ | 20 | 20 | 33.69 | 51.94 |

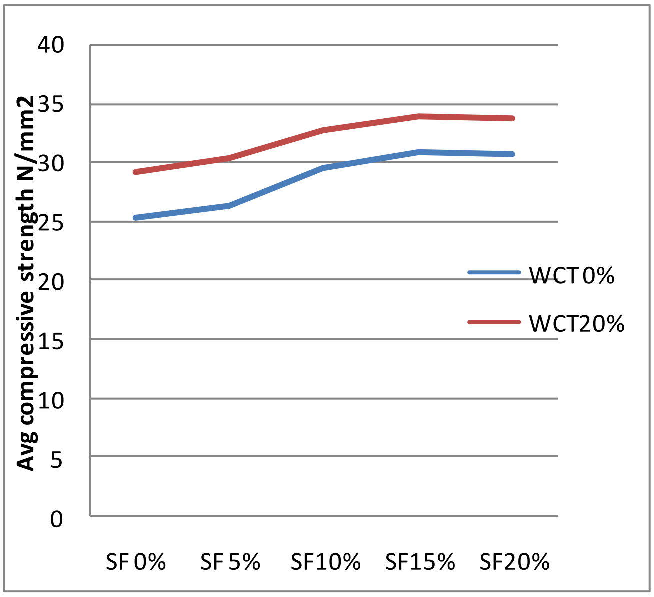


**Figure 3: Compressive strength of concrete with different replacement levels of cement with SF and coarse aggregates with 20 percent WCT at 7 days**

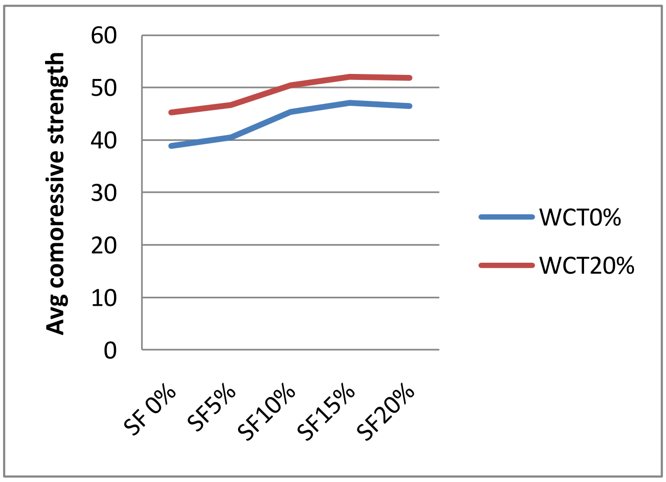


**Figure 4: Compressive strength of concrete with different replacement levels of cement with SF and coarse aggregates with 20 percent WCT at 28 days.**

### B) Split tensile strength test:

The split tensile strength is obtained by testing the cylindrical specimen for M30 grade of concrete to all the mixes designed for various replacements. The split tensile strength was tested on the cylindrical specimens in 7 days and 28 days of curing. The test results are tabulated as below. The test results show there is an increase in split tensile strength upto 15 percent addition of silica fume but shows a slight decline in tensile strength when 20 percent of silica fume is added. Further with 20 percent replacement of coarse aggregate with WCT, the split tensile strength increases .The highest tensile strength came out to be at 15 percent silica fume replacement with no WCT content, i.e, 2.765 Mpa and 4.24 Mpa at 7 and 28 days of curing respectively. However among the specimens with both the additions the specimen $A_8$ showed the maximum strength of 2.70 Mpa and 4.07 Mpa respectively.

**Table 11. Split Tensile strength test values of test concrete**

| Mix | WCT % | SF% | Average split tensile strength in N/mm2 after given no. of curing days | |
|---|---|---|---|---|
| | | | 7 days | 28 days |
| $A_0$ | 0 | 0 | 2.26 | 3.50 |
| $A_1$ | 0 | 5 | 2.36 | 3.65 |
| $A_2$ | 0 | 10 | 2.66 | 4.08 |
| $A_3$ | 0 | 15 | 2.765 | 4.24 |
| $A_4$ | 0 | 20 | 2.69 | 4.18 |
| $A_5$ | 20 | 0 | 2.35 | 3.62 |
| $A_6$ | 20 | 5 | 2.42 | 3.71 |
| $A_7$ | 20 | 10 | 2.58 | 3.94 |
| $A_8$ | 20 | 15 | 2.70 | 4.07 |
| $A_9$ | 20 | 20 | 2.68 | 3.98 |

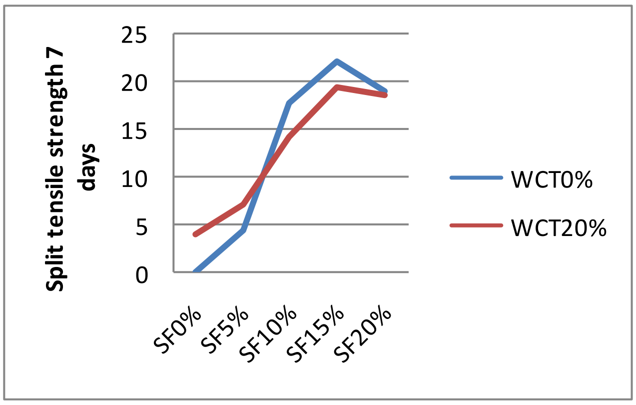


**Figure 5: Split tensile strength of concrete with different replacement levels of cement with SF and coarse aggregates with 20 percent WCT at 7 days**

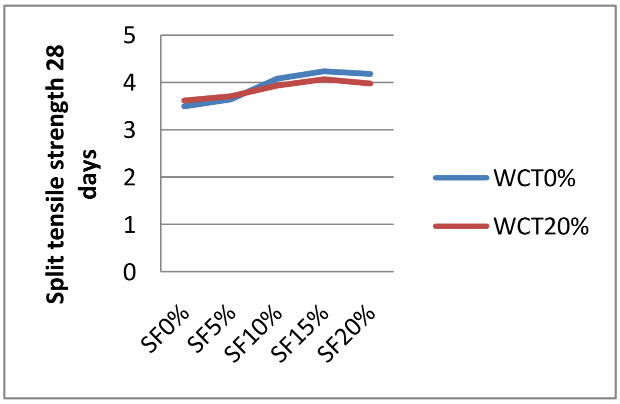


**Figure 6: Split tensile strength of concrete with different replacement levels of cement with SF and coarse aggregates with 20 percent WCT at 28 days**

### C) Durability tests

#### A) Test to determine resistance against acid attack

For acid attack test concrete cubes of size 150mm×150mm×150mm are prepared. After preparation, the cubes are cured in the mould for next 24 hours. After that the cubes are demoulded and cured for 7 days. After 7-days all specimens are put in normal air condition for 2-days for maintaining constant weight. The specimens are weighed and immersed in 5% HCL solution for 56-days. The pH value of the acidic media was at 1. The pH value was checked periodically and maintained at 1.0. The specimens were tested for 14 days, 28 days and 56 days of immersion in acidic medium. The specimen of mix $A_0$, $A_1$, $A_2$, $A_6$, $A_7$, and $A_8$ were tested. The control specimen along with five other mixes, i.e, mixes having 5 and 10 percent silica fume with 0 percent WCT and mixes having 5,10 and 15 percent silica fume content with 20 percent WCT replacement. Subsequently the specimens are weighed and loss in weight and hence the percentage loss of weight was calculated. The test results show that the percentage loss in wieght is approximately 3 percent in 14 days for control specimen while there is about 2.80 and 2.5 percent with 5 and 10 percent replacement of cement with silica fume. More interesting is , when we replace coarse aggregate by 20 percent WCT, the percentage weight loss increases for 5 percent SF with 20 percent WCT. But then after adding 10 and 15 percent SF , the wieght loss percentage gets decreased. Same behavior is shown by specimen after 28 and 56 days with an exception that the net wieght loss percentage is less at all additions ( including 5 percent SF with 20 percent WCT) than the normal concrete.. The test results shwing wieght loss percentages are shown as below. These graphs depict that the decreases in wieght loss percentage is mainly due to the action of slica fume because WCT is not so dense and is not resistant against acid attacks

**Table 12: Table showing percentage wieght loss of concrete in acid test**

| Mix | WCT % | SF % | Wieght loss % in no. of days | | |
|---|---|---|---|---|---|
| | | | 14 days | 28 days | 56 days |
| $A_0$ | 0 | 0 | 3 | 4.6 | 7.5 |
| $A_1$ | 0 | 5 | 2.8 | 3.9 | 5.8 |
| $A_2$ | 0 | 10 | 2.5 | 2.7 | 4.4 |
| $A_6$ | 20 | 5 | 3.1 | 4.2 | 6.7 |
| $A_7$ | 20 | 10 | 3 | 3.98 | 6.48 |
| $A_8$ | 20 | 15 | 2.74 | 2.81 | 5.1 |

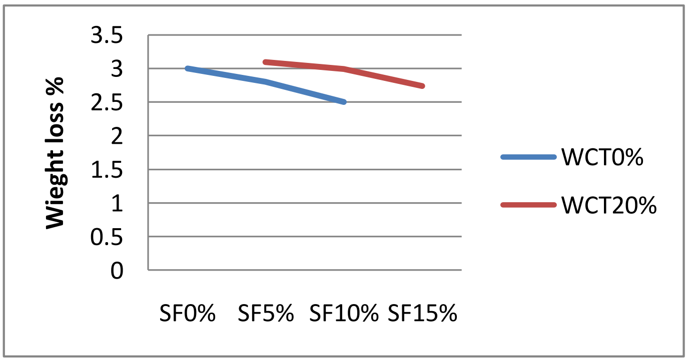


**Figure 7: Figure showing comparison of percentage weight loss of concrete in acid test with and without WCT after 14 days.**

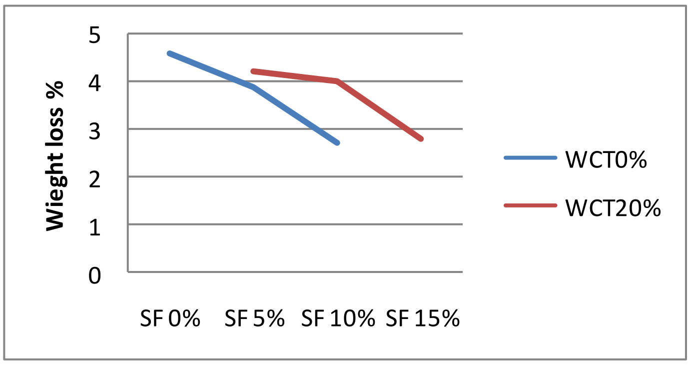


**Figure 8: Figure showing comparison of percentage weight loss of concrete in acid test with and without WCT after 28 days.**

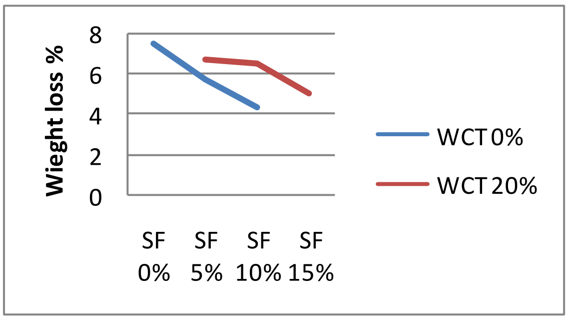


**Figure 9: Figure showing comparison of percentage weight loss of concrete in acid test with and without WCT after 56 days.**

### B) Test to determine resistance against alkaline attack

For alkaline attack test concrete cubes of size 150mm×150mm×150mm are prepared. After preparation, the cubes are cured in the mould for next 24 hours. After that the cubes are demoulded and cured for 7 days. After 7-days all specimens are put in normal air condition for 2-days for maintaining constant weight. Then, the specimens are weighed and immersed in 5% sodium sulphate ($Na_2SO_4$) solution for 56-days. The pH value of the alkaline media was at 12.0. The pH value was periodically checked and maintained at 12.0. After 56- days of immersing in alkaline solution, the specimens are taken out and are washed in running water and kept in atmosphere for 2-day for constant weight. The specimens were tested for 28 days and 56 days of immersion in alkaline medium. The specimen of mix $A_0$, $A_1$, $A_2$, $A_6$, and $A_7$, were tested. The control specimen along with five other mixes, i.e, mixes having 5 and 10 percent silica fume with 0 percent WCT and mixes having 5 and 10 percent silica fume content with 20 percent WCT replacement. . Subsequently, the specimens are weighed and loss in weight and hence the percentage loss of weight was calculated. The test results show that the percentage loss in wieght is approximately 0.16 percent in 28 days for control specimen while there is about 0.02 percent with 5 percent replacement of cement with silica fume. After 56 days the percentage wieght loss is 0.28 percent and 0.03 percent for 0 and 5 percent replacement of cement with silica fume. When we add 10 percent silica fume the percentage loss in wieght is zero for 28 and 56 days of immersion. When we replace coarse aggregate by 20 percent WCT, the percentage wieght loss increases for 5 percent SF with 20 percent WCT to 0.06 and 1 percent for 28 and 56 days respectively. But then after adding 10 percent SF, the wieght loss percentage is reduced to zero. The test results shwing wieght loss percentages are shown as below:

**Table 13: Table showing percentage wieght loss of concrete in acid test**

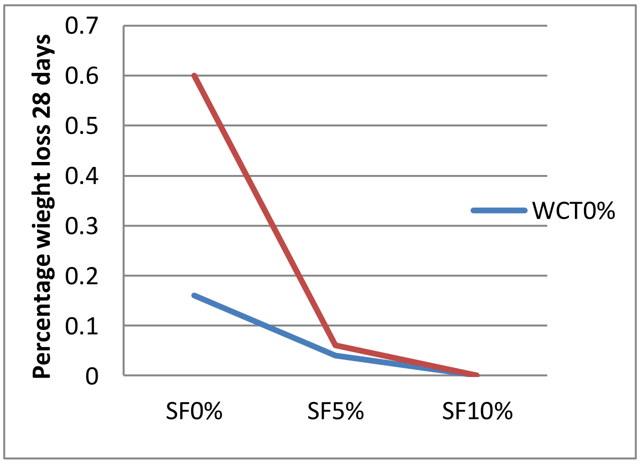


**Figure 10: Figure showing comparison of percentage wieght loss of concrete in alkaline test with and without WCT after 28 days.**

| Mix | WCT% | SF% | Wieght loss % in no. of days | |
|---|---|---|---|---|
| | | | 28 days | 56 days |
| $A_0$ | 0 | 0 | 0.16 | 0.28 |
| $A_1$ | 0 | 5 | 0.04 | 0.05 |
| $A_2$ | 0 | 10 | 0 | 0 |
| $A_4$ | 20 | 0 | 0.6 | 1.14 |
| $A_6$ | 20 | 5 | 0.06 | 1 |
| $A_7$ | 20 | 10 | 0 | 0 |

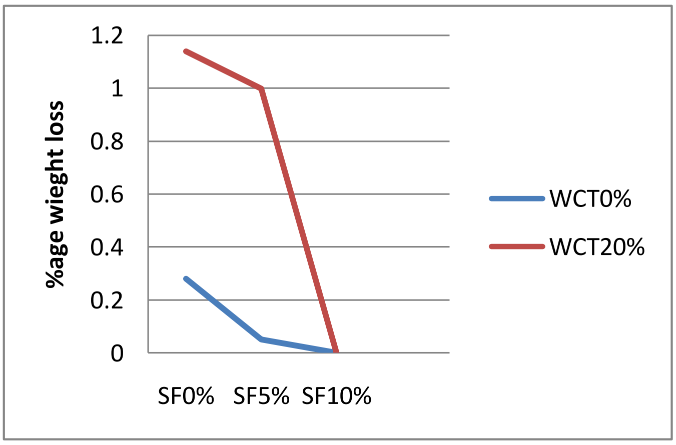


**Figure 11: Figure showing comparison of percentage wieght loss of concrete in alkaline test with and without WCT after 56 days.**

## VI. CONCLUSION

. The following conclusions can be made based on the experimental investigations:

a) Silica fume and waste ceramic tiles improve the mechanical and durability properties of concrete, thus being effective in improvement of enginering characteristics as compared to conventional concrete.

b) Workability of the concrete gets increases slightly at 5% replacement of cement with silica fume but the decreases continously with further replacement of cement with silica fume. The wokability is further decreased by the replacement of coarse aggregate by waste ceramic tiles. To maintain same workability, further water needs to be added.

c) Compressive strength gets increased by the addition of silica fume and waste ceramic tiles . Maximum compressive strength occurs for the dosage of 20% WCT replacement and 15% silica fume replacement with the strength of 33.91Mpa and 52.12Mpa for 7 and 28 days respectively.

d) Split tensile strength gradually increases with the additions of silica fume and waste ceramic tiles.The strength increases with silica fume replacement but with addition of 20% WCT, the strength decreases in comparison with Silica fume concrete but is higher than that of the conventional concrete. The strength decreases slightly after 20% WCT replacement and 15% silica fume replacement, however, the strength achieved is higher than that of conventional concrete. The maximum strength achieved is with 20% WCT and 15% silica fume replacements which is 2.70 Mpa and 4.07 respectively. Maximum stregth achieved for Silica fume replaced concrete,i.e, at 15%silica fume replacement is 2.76 Mpa and 4.24 Mpa respectively.

e) The resistance to acid attack increases in concrete with the increase in silica fume content in concrete but with the addition of waste ceramic tiles, the resistance gets decreased, however with increased silica fume percentage (10-15%) the 20% WCT replaced concrete has a considerable resistance against acid attack.

f) The ability to resist alkaline attack increases at higher rates with the silica fume replacements for cement in concrete. The percentage wieght loss decreases as fast rate and reaches zero when silica fume replacement reaches 10%. There is a decreses in the resisting property of concrete against alkaline attack due to addition of waste ceramic tiles but net loss percentage reaches zero when 10% silica fume replacement is reached.

g) The test results show the concrete mix of 20% waste ceramic tile replacement of coarse aggregate and 15% silica fume replacement of cement has the maximum strength in terms of compression and split tensile. Moreover, this mix is durable resisting acid and alkaline attack effectively.

h) Hence, both silica fume and crushed waste ceramic tiles can be used as partial rreplacements of cement and coarse aggregate effectively

However, further research is needed in this field to study the use of waste ceramic and silica fume as replacements in high strength concrete

## REFERENCES


1. BIS: 10262-2009: Recommended guidelines for concrete mix design, Bureau of Indian Standard, New Delhi-2004.
2. BIS: 1199-1959 (Reaffirmed 2004): Methods of Sampling and Analysis of Concrete, Bureau of Indian Standard, New Delhi-1999.
3. BIS: 2386 (Part I)-1963(Reaffirmed 2002): Methods of Test for Aggregates for Concrete, Bureau of Indian Standard, New Delhi-1963.
4. BIS: 383-1970 (Reaffirmed 2002): Specification for Coarse and Fine Aggregates from Natural Sources for Concrete, Bureau of Indian Standard, New Delhi-1997.
5. BIS: 4031 (Part 4, 5&6)-1988: Methods of Physical Tests for Hydraulic Cement, Bureau of Indian Standard, New Delhi-1988.
6. BIS: 456-2000(Reaffirmed 2005): Code of practice- plain and reinforced concrete, Bureau of Indian Standard, New Delhi-2000.
7. BIS: 516-1959 (Reaffirmed 2004): Methods of tests for strength of concrete, Bureau of Indian Standard, New Delhi-2004.
8. BIS: 8112-2013: Specification for 43 grade Ordinary Portland Cement, Bureau of Indian Standard, New Delhi-2005.
9. Aruna D, Rajendra Prabhu, Subhash C Yaragal, Katta Venkataramana IJRET:eISSN: 2319-1163 | pISSN: 2321-7308.]. Batriti Monhun R. Marwein, M. Sneha, I.
10. ASTM 2012. Standard Specification for Portland Cement, 2012.
11. Abdullah K.M, Hussein W, ZakariaF, Muhammad R, Abdul Hamid Z (2006). A potential partial replacement of silica fume proceeding of the 6th Asia-Pacific structural Engineering and construction conference (APSEC 2006) kualalumpur, Malaysia.
12. Investigation on microsilica(silica fume) as partial cement replacement in concrete by Faseyemi victor, Anjileye University of IBADAN.
13. “The effect on concrete by partial replacement by silica fumes”, Praveer Singh, Afaque khan, Babu Banarasi Das University, Uttar Pradesh.


## AUTHORS PROFILE

**Basharat Nabi,** received his B-Tech degree in Civil engineering in 2014 from University of Kashmir, J&K. Presently; he is research scholar in Department of Civil Engineering RIMT University, Punjab, India

**Anuj Sachar,** received his B-Tech degree in civil engineering in 2008 from Punjab Technical University, Jalandhar, and M-Tech from RIMT University. Presently, he is working as Assistant Professor in Department of Civil Engineering RIMT University, Punjab, India.
.

**Manish Kaushal,** received his B-Tech degree in civil engineering in 2011 from Punjab Technical University, Jalandhar, M-Tech from Punjab Technical University, Jalandhar in 2015.Presently, he is working as Assistant Professor in Department of Civil Engineering RIMT University, Punjab, India.