International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-9, Issue-2, April 2022
https://doi.org/10.55524/ijirem.2022.9.2.87
Article ID IJIR-2290, Pages 554-561
www.ijirem.org

Replacement of Fine Aggregates of Concrete by Over Burnt Bricks and Broken Tiles

Nazima Imtiaz[1], and Richika Rathore[2]

[1] M. Tech. Scholar Department of Civil Engineering, RIMT University, Mandi Gobindgarh, Punjab, India
[2] Assistant professor, Department of civil Engineering, RIMT University Mandi, Gobindgarh, Punjab, India

Correspondence should be addressed to Nazima Imtiaz; Nazimaimtiaz0@gmail.com

ABSTRACT- In this research work, study of the effect on the properties of concrete: (compressive strength, split tensile strength and workability in particular) by the replacement of conventional fine aggregates:(sand), by a pulverized mixture of Over-burnt Bricks and Broken Tiles, in equivalent proportions was carried out. Over burnt bricks and broken tiles are among toxic constructional waste products thus, their use in the form of fine aggregates will serve as a purpose and it will also help to mitigate their disposal problems. Sand is a naturally available resource thus in order to minimize its exploitation use of these waste materials as fine aggregates provides an alternative thereby reducing burden on the environment. Replacement of conventional fine aggregates by over burnt bricks and broken tiles also makes the concrete economical, more water proof, resistant to cracks as well as resilient to various alkali and chemical attacks compared to conventional concrete with no any such replacements that too without reducing strength. In conduction of tests, definite proportion of conventional fine aggregate:(sand), was substituted in various trials, till 100% of sand got replaced by mixture of pulverized over burnt bricks and broken tiles. The results obtained for various tests conducted on samples with replacements were examined and compared with the results of standard design mix of M25 grade concrete. The test observations revealed that, as the percentage of replacement of fine aggregate (sand) by a mixture of overburnt bricks and broken tiles increased, the strength of concrete mix first decreased then increased with respect to standard M25 grade concrete with 0% or no replacement of the conventional fine aggregates(sand) and the maximum value of strength attained was at 80% replacement of fine aggregate by pulverized overburnt bricks and broken tiles mixture.

KEYWORDS- Compressive Strength Test, over-burnt bricks, pulverized tiles, Slump test, Split Tensile Strength test.

I. INTRODUCTION

Concrete as is known is the elixir of the modern construction industry & is used all around the world. Concrete is composed of: - Fine aggregate, Coarse aggregate & a Binder. The construction industry requires various types of materials such as manufactured materials like bricks, tiles, cement, etc. and naturally available materials like sand, aggregates, etc. The rapid and unchecked growth of construction and other related industries and practices is hampering the environment with unforeseen consequences to be bore by the future generations of all living species, if something remedial is not done.

The unchecked sand mining in high demand areas, where the rate of mining is greater than the rate of replenishment in particular and all areas in general, results in degrading the natural geomorphology of the river systems and consequently traumatizing the ecosystem.

The agony does not stop here either, Industries related to the construction industry, spotlighting the brick & tile industry in particular, produce large amounts of hazardous solid waste pollutants, in addition to the air pollution that it already causes. These industries produce waste products in the form of over burnt bricks, disfigured bricks, broken bricks, broken tiles etc. which eventually are useless to the producer as well as a reason of nuisance due to its unscientific disposal. The demolition of buildings also produces a humongous volume of broken-down building components, which include bricks, tiles, concrete, etc. which conventionally are useless & whose disposal is a big task in itself. Disposing off such types of waste materials by conventional methods demands a large area of land, which is expensive and unavailable in most of the cities in present times.

Moreover, in colder regions where various heating systems are used inside the buildings for example in Kashmir, in winters the use of Hamam (a traditional heating room in which thick, hand-hewn rectangular slabs of stone are laid over a hollowed-out floor warmed up by burning few logs of wood underneath) is very prominent. But due to overheating, the concrete of walls as well the stones of floor cracks. This problem can also be solved to a greater extent by replacing fine aggregate of concrete by a mixture of overburnt bricks(surkhi) and broken tiles as powdered over burnt bricks(surkhi) as well as pulverized ceramic tiles are known to be among the best heat absorbing agents that can withstand high temperatures thus resulting in prevention of cracks of concrete by overheating.

The focus of the research is laid on reusing the above said wastes in replacement of fine aggregates of concrete, which not only will reduce the load on sand mining, but also provide an effective method of reusing wastes.

Pulverized form of Over Burnt Bricks has been used frequently as a substitute of Sand as it imparts strength and hydraulicity to concrete. It is a pozzolanic material which also results in increasing the waterproofing capability of the concrete. It imparts strength to the concrete to a significant extent as well as results in the formation of low-cost concrete. It also increases the water proofing ability, resistance against alkali attacks of concrete, causes reduction in cracking and temperature rise at the time of hydration of cement concrete.

In order to use a mixture of over burnt bricks and broken tiles in the form of fine aggregate, these need to be pulverized. This pulverized or in other words powdered form was appropriately sieved passing through IS: Sieve No. 4.75mm. Concrete of grade M25 was prepared with a water cement ratio of 0.45 and this conventional mix as specimen P1 for compressive test and N1 for split cylinder test with 0% replacement of sand with powdered mixture of over burnt bricks and broken tiles was tested for reference and comparison purpose. After that part of fine aggregate(sand) was replaced by this mixture of powdered form of over-burnt bricks(surkhi) as well as broken tiles in certain percentages(both the substitute materials present in equal proportions in each replacement), initially with 20% replacement in specimen P2 obtained for conduction of compressive strength test and specimen N2 obtained for split tensile test, then 40% in specimen P3 and N3, similarly 60% in specimen P4 and N4,80% in specimen P5 and N5 and 100% for specimen P6 and N6 correspondingly. In compressive strength test cube specimen and for split tensile test specimens in the form of cylinders were prepared. Slump test was also conducted on all the trial mixes with various percentages of replacement of fine aggregate by mixture of over burnt bricks and broken tiles percentage replacement ranging from 0% to 100%.

II. OBJECTIVES OF STUDY

This study focuses upon the use of waste materials in the form of overburnt bricks and broken tiles as replacement for sand in cement concrete and thus on determining its strength and durability characteristics.

Following are the objectives carried in the present work

- To focus on reusing the waste materials (over burnt bricks and broken tiles) in replacement of fine aggregates of concrete, which not only will reduce the load on sand mining but also provides an effective method of reusing wastes
- To determine the feasibility of the use of waste materials i.e., over burnt bricks and the broken tiles, in fine crushed form in the replacement of fine aggregates of concrete. It is intended to replace conventional fine aggregate(sand) (20%, 40%, 60%, 80% up to 100%) in ordinary concrete by waste materials (mixture of powdered over burnt bricks and broken tiles in equal proportions) and subsequently test the 7 days and 28 days strength (compressive and tensile) of the concrete and compare it with that of ordinary(conventional) concrete. Any significant decrease in compressive strength would lead to the rejection of that particular material or just limit the use of such concrete. In case of increase in the compressive strength would drop the gates for further research and development.
- To find out economical means of construction and reduce the menace of disposal of material thereby saving the environment.
- To deliver light weight concrete by partially replacing fine aggregates(sand) of concrete by waste materials over burnt bricks and broken tiles, without influencing strength

III. LITERATURE REVIEW

A. Zeena Adel Mohammad et al 2011 [1]

Findings obtained by Zeena Adel Mohammad have shown that the use of ceramic crushed fillers has affected the properties of concrete as it has caused a drop in the concrete density up to 6.07% at a replacement %age of 40% and increase in compressive and tensile strength up to 18% at a replacement %age of 20% compared to the normal concrete.

B. Jan Wakeel Ahmad Wani et al 2017 [2]

Their research was based on the investigation of the influence of surkhi on properties of concrete bricks. The fine aggregate was replaced by surkhi and then the tests were studied at various replacements and it was concluded that due to the properties of surkhi there was a gradual increase in compressive strength in earlier stages and the gradual decrease of compressive strength in later stages which was attributed to the high bleeding and shrinkage property of surkhi. The fine aggregate used was stone dust instead of sand because stone dust has better properties than sand as well as it is finer than sand. The bricks then obtained were found to be sufficiently hard with less water absorption value. The compressive strength of concrete brick in which surkhi is replacing fine aggregate shows almost a parabolic variation increasing with increase of replacement 5% to 20% and then decreasing for 25% & 30% replacements of fine aggregate by surkhi. Concrete in which surkhi has been used is more resistant to cracking due to heat, bleeds less segregates less as compared to ordinary concrete and it is also used for reduction of temperature rise during hydration in the mass of concrete.

C. Utkarsh Singh Chandel et al 2017 [3]

In this research paper, study of partial replacement of natural sand with the waste ceramic tiles in a range of 10% to 40% in the interval of 10% in M20 & M25 grade of concrete was done. The results show that tile aggregates can be effectively used in concrete as partial replacement of sand with improved strength & durability. All mixes containing pulverized tile as aggregate had stature slump thus commendable workability. Compressive quality results speak to that concrete within M20 & M25 review at 7, 14, 28 & 50 days are enlargements, when the level of the ceramic waste goes from 0% to 40%. Split tensile strength of concrete was also extended when the level of ceramic tile waste was raised from 0% to 40%.

D. Bidve Ganesh Shivkanth et al 2019 [4]

According to their investigations, it was concluded that replacement of coarse aggregate by over burnt bricks resulted in 3% increase in the compressive strength at 20% replacement and at 40% replacement there was 3.3% decrease in compressive strength. Also, 5.3% increment in the tensile strength was found at 20% replacement. The water cement ratio adopted was 0.45.

E. Mohd. Aaqib Bhat et al 2019 [5]

The workability of concrete gets decreased with the addition of brick ballast. From the test results, brick ballast replaced for fine aggregates give a max. strength at 30% when compared to conventional concrete. Partial replacements by brick ballast with various percentages as 0%,5%,10%.15%20%,25% & 30% was done and strength and workability parameters were studied. The workability of concrete got decreased while strength got increased with the increase in the percentage of replacement of fine aggregate with brick ballast.

IV. MATERIALS USED

A. Cement

Cement is a binding substance that is derived from calcination of lime and clay material. when mixed with water it forms cement mortar and with sand, gravel and water it forms concrete. This study considers use of Ordinary Portland Cement of grade 53 having a standard consistency of 30% conforming to IS: - 12269-1987. Setting time of cement initial and final, was found to be 120 minutes and 300 minutes respectively. Specific gravity and Fineness modulus of cement was: 3.15 and 2.80% as shown in table 1.

Table 1: Properties of Cement

Cement Brand Name	JK Cement
Cement Grade	53 OPC
Initial setting time	120 minutes
Final setting time	300minutes
Standard Consistency	30%
Specific Gravity	3.15
Fineness Modulus	2.80%

B. Sand

It is a naturally available granular material derived from rocks and is present in finely divided form consisting of mineral particles. Its size may be defined as the finer than gravel but coarser than silt. Sand that was locally available confirming to grading zone III of IS: 383-1970 was used in the study. Particle size of sand was 4.75mm and less. Specific gravity of sand was found to be 2.6 as shown in table 2.

Table 2: Properties of Sand

Grading Zone	Zone III confirming IS: 383-1970
Specific Gravity	2.6
Fineness Modulus	3.1%
Water Absorption	1%
Surface Texture	Smooth

C. Coarse aggregate

Crushed angular Coarse aggregate confirming to IS: 383-1970 was used, passing through 20mm sieve and retained on 4.75 mm sieve. Graded aggregates of 20mm (60%) and 10mm (40%) were used for better workability. Specific gravity of 20mm and 10mm aggregates was found to be 2.885 and 2.912 respectively as shown in table 3.

Table 3: Properties of Coarse Aggregate

Sp. Gravity of 20mm aggregates	2.885
Sp. Gravity of 10mm aggregates	2.912
Sp. Gravity of combined aggregates	2.899
Fineness-Modulus	7.5
Water Absorption of 20mm aggregates	0.97%
Water Absorption of 10mm aggregates	0.83%
Water absorption of combined aggregates	0.9%
Particle-shape	Angular

Figure 1: Coarse Aggregate

D. Over-burnt Bricks (Surkhi)

Pulverized over burnt bricks mixture (Surkhi) is defined as a finely powdered burnt clay made from burnt bricks. It is used as a substituent for fine aggregates due to its pozzolanic nature and on mixing with concrete renders concrete water proof and makes it resilient towards alkali and salt attacks. Surkhi was collected from a nearby local kiln. Surkhi is frequently being used as a substituent of sand as its addition results in imparting strength and hydraulicity to concrete. It is a pozzolanic material thus, it also increases the waterproofing ability of the concrete. Apart from imparting strength to the concrete, it also increases the economy of the concrete to a significant extent. It is prepared by grinding over burnt bricks or burnt clay to powder form. It is also responsible in reducing cracking and rise in temperature during the hydration reaction of concrete. Concrete in which surkhi has been used is more resistant to cracking due to heat, bleeds less, segregates less as compared to ordinary concrete and it is also used for reduction of temperature rise during hydration in the mass of concrete. Chemical composition of surkhi used is shown in below table 4.

E. Broken Tiles

India ranks in the top 3 list of countries in terms of tile production in the world. The huge production is due to boom in housing sector. Ceramic tile fine aggregate is hard having considerable value of specific gravity, rough surface on one side and smooth on other side, having less thickness and are lighter in weight than normal stone fine aggregates. Using Ceramic tile aggregate in concrete not only will be cost effective, but also provides considerable strength to concrete. Ceramic materials are crystalline, inorganic, nonmetallic material made from compounds of metal and a nonmetal. These are chiefly composed of clay;(kaolinite), formed as a result of the action of heat and successive cooling mechanism.

In this study, disposed tiles are chosen to partially replace the basic materials of concrete. The Ceramic tiles thus needed to be bought to the powdered form through grinding.

Figure 2: Broken Tiles

F. Water

In the study, Water used for mixing as well as for curing is portable water. Water that was used, was free from suspensions and other impurities. pH of water as specified by IS: - 456-2000, should not be less than 6. The pH of water used was found to be 6.85. Water also is very important ingredient in concrete as it actively takes part in the chemical reaction with the cement. Water helps in the formation cement gel which is responsible for strength attainment of cement, thus the quantity of water as well as its quality is to be taken into consideration. The pH of water used for making concrete should be in the range of 6 and 8. Water content affects the workability of concrete to a greater extent. For a given volume of concrete, water content will have a significant influence on workability. Higher the water content per cubic meter of concrete, higher will be the fluidity of concrete thus higher will be its workability as fluidity of concrete is one of the important factors affecting workability.

V. PREPRATION OF SPECIMENS

A. Concrete mix design

Table 4: Chemical composition of Surkhi

S.no.	Chemical Constituent	Value in %age
1	Alumina	20-30
2	Silica	50-60
3	Lime	5
4	Oxides of Iron	5-6
5	Magnesia	2-3

Based on the properties of the above- mentioned materials, the required design mix of M25 grade concrete was calculated based on the procedure as given in IS: 10262-2009.Thus the mix ratio calculated was: 1:1.70:2.68, at 0.45 water cement ratio(w/c). Required materials were measured on an electronic weighing balance. Concrete was then placed in moulds in layers and tampered with tamping rod. After 24 hours, the casts were removed after and the specimens were kept in water for curing. The mix design proportioning of concrete for various percentage replacements is shown in table 5.

Table 5: Mix Design Proportioning

S.no	Mix Propor-tioning	Cement	Fine Aggregates			Coarse Aggre-gates
			Sand	Ceramic Tiles	Surkhi	
1	M1	100%	100 %	0%	0%	100%
2	M2	100%	80%	10%	10%	100%
3	M3	100%	60%	20%	20%	100%
4	M4	100%	40%	30%	30%	100%
5	M5	100%	20%	40%	40%	100%
6	M6	100%	0%	50%	50%	100%

B. Mixing of Concrete

Concrete mixing may be defined as the blending of various ingredients of concrete to produce a homogenous concrete mix. It should be ensured that on mixing of concrete, the mass becomes homogenous, uniform in consistency as well as in colour.

In this study, the preparation of specimen was done by hand mixing which thus accounted for 10% increase in the amount of cement to be used.

In the study using hand mixing process the measured quantity of coarse and fine aggregates were spread in the form of alternate layers one over the other, then cement was poured on top and mixed well in dry form by shovel till uniform a colour is achieved. Water should be added in small quantities and towards the end of mixing to obtain desired consistency.

C. Specimens

Specimens were prepared properly with due care. Moulds were coated with oil before concrete was poured in them so that removal of specimens becomes easy from the moulds without any damage. For each mix with various percentage replacements, firstly three cubes of 150mm × 150mm size were tested to determine compressive strength of concrete and three cylinders of 150mm diameter and 300mm length were tested to determine split tensile strength of concrete after 7 days. Similar process was repeated for 28 days test.

Figure 3: Specimens

D. Curing of Concrete

In order to maintain satisfactory moisture content and temperature in concrete for a period of time curing is done immediately after placing and finishing to attain desired properties of concrete. For complete attainment of strength of concrete specimen proper curing is very essential. Then the Specimens were kept immersed in a water tank for 28 days' time period.

VI. BRIEF DISCRIPTION OF TESTS

A. Slump test

The concrete slump test is used for the measurement of workability and consistency of fresh concrete and is most commonly used test to obtain consistency of concrete due to its simplicity and ease to use. It is an empirical method and can be carried out either in laboratory or at site. The slump test result is a measure of behaviour of a compacted inverted cone of concrete under the action of gravity. This test determines the workability of concretes which are neither too harsh nor too lean. Slump test apparatus(frustum) dimensions are as follows

Height(H) = 300mm
Base diameter(d1) = 200mm
Top diameter(d2) = 100mm

The slump test was performed on the freshly mixed concrete, replaced with over burnt bricks and broken tiles as fine aggregate and the results were noted. The water cement ratio used was 0.45 and the results were as below in the table 6

Table 6: Slump Test Results

S.no.	Specimens	%age Replacement	Slump in mm
1	P1 and N1	0%	75
2	P2 and N2	20%	90
3	P3 and N3	40%	62.30
4	P4 and N4	60%	40.65
5	P5 and N5	80%	25.34
6	P6 and N6	100%	13.20

As is shown in the above table that slump of concrete mix first increases at 20% replacement of fine aggregates(sand) by mixture of powdered over burnt bricks & broken tiles than decreases with further increase in the percentage of replacement with minimum value of slump at 100% replacement for specimens P6 & N6 respectively. The slump test results is represented in the graphical form in figure 4:

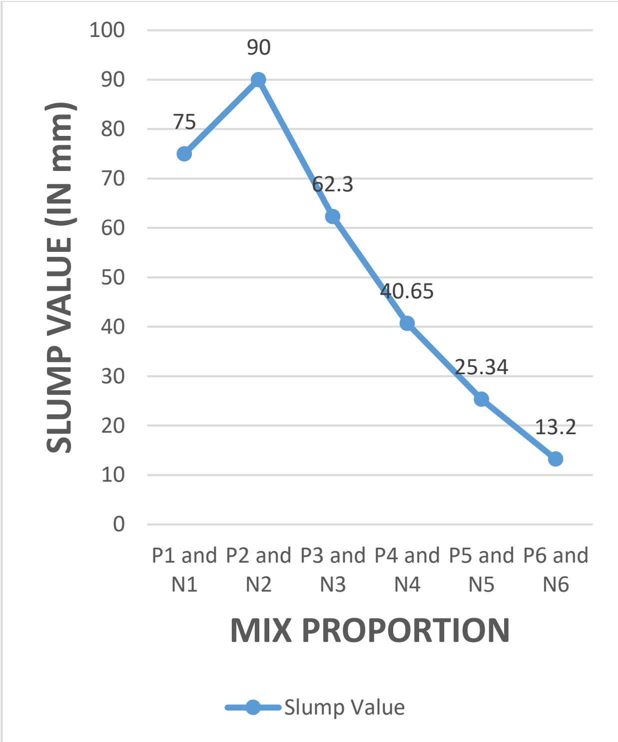

Figure 4: Variation of Slump Value

Figure 5: Slump Test

Figure 6: Slump Test

Figure 7: Slump Test

Table 7: Compressive Strength Test Results

S.no	Specimen	%age of Replacement	Weight in (Kg)	Compressive Strength after 7 days in N/mm2	Compressive Strength after 28 days in N/mm2
1	P1	0%	8.150	20.89	32.45
2	P2	20%	8.040	13.34	21.78
3	P3	40%	8.026	14.23	22.67
4	P4	60%	8.030	17.78	27.56
5	P5	80%	7.786	21.78	33.34
6	P6	100 %	7.824	13.12	21.34

B. *Compressive strength test of concrete*

(IS: 516-1959) Compressive strength of concrete may be defined as the resistance offered by it to withstand compressive loads. In the test it is the resistance offered by the specimen to loads which tend to reduce size.

The specimens were tested for compression strength test under compression testing machine (CTM), after 7 day and 28 days curing, under gradually applied loads.

The specimens should be properly finished with no lumps and voids. After mixing and curing in a proper manner, the specimens were then placed in CTM and loads were applied gradually. The Load at the failure of the specimen was recorded and then this load divided

by the cross-sectional area of the specimen gives the compressive strength of the concrete cube. The compression strength test was performed on hardened concrete, replaced with pulverized overburnt bricks and broken tiles as fine aggregates and the results were noted.

It is clear from the above results in table number 7, that the compression values of the compressive strength for specimen P2(20% Replacement), P3(40% Replacement), P4(60% Replacement) and P6(100% Replacement) are less than conventional mix P1(0% replacement). But in case of specimen P5(80% Replacement) these values are higher. Maximum compressive strength value was found to be 33.34 N/mm2 for specimen P5 and minimum value of 21.34 N/mm2 for specimen P6 after 28 days. Figure 8 and figure 9 shows graphical representation of compressive strength test results of concrete at different percentages of replacement.

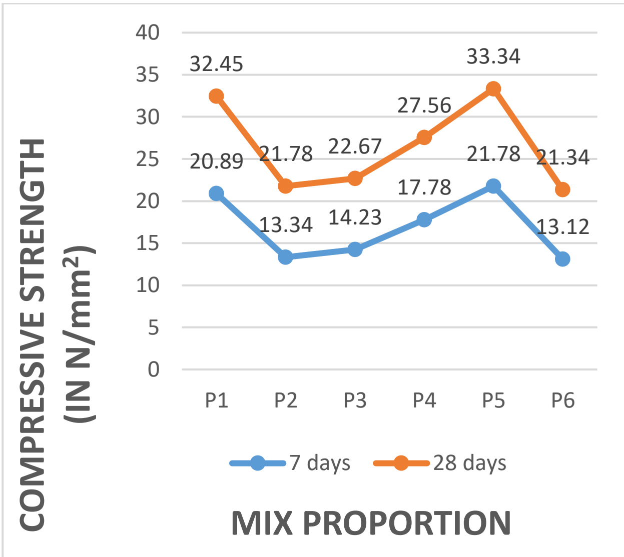

Figure 8: Variation of Compressive Strength of concrete for Different Specimens After 7 and 28 days

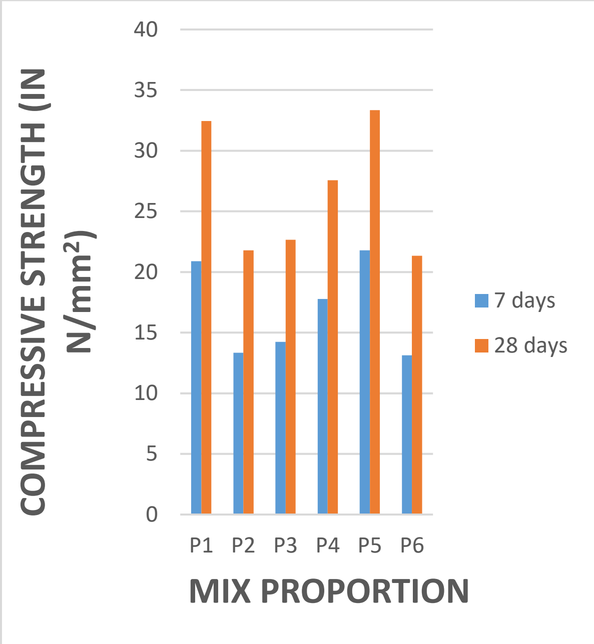

Figure 9: Variations of Compressive Strength of Concrete for Different Specimens After 7 and 28 days

Figure 10: Compressive Strength Test

C. Split tensile strength test

Split tensile strength test on concrete as is suggested by its name is a test that determines the split tensile strength of concrete. This test is done as per IS: - 5816-1959. These tests were conducted on compression testing machine (CTM) after 7 days and 28 days curing, and the load was applied gradually. Load at the failure was recorded and used to calculate the split tensile strength of concrete as

$$Tsp = \frac{2P}{\pi DL}$$

Where, Tsp = Split Tensile Strength.
P = Load at failure.
D = Diameter of the Specimen.
L = Length of the Specimen.

The split tensile tests were conducted on compression testing machine (CTM) after 7 days and 28 days respectively after proper curing and load was applied gradually. Load at failure was recorded and was used to calculate the split tensile strength of concrete.

Table 8: Split Tensile Strength Test Results

S no	Specimen	%age Replacement	Weight in (kg)	Split tensile strength after 7days (N/mm2)	Split tensile strength after 28 days (N/mm2)
1	N1	0%	3.900	2.40	4.03
2	N2	20%	3.800	1.84	2.68
3	N3	40%	3.750	1.76	2.83
4	N4	60%	3.700	2.12	3.11
5	N5	80%	3.750	2.54	4.10
6	N6	100%	3.703	1.63	2.54

From the split tensile test results as shown in table 8 above, it was found that the values of split tensile strength for Specimen N2, N3, N4 & N6 is less than N1(conventional mix with 0% replacement of sand by over burnt bricks & broken tiles) while in specimen N5 it is more than conventional mix N1 thus we can say as the proportion of the surkhi-ceramic mixture is increased to 80% the strength also increases having a value of 4.10 N/mm2 for specimen N5 after 28 days with 80% replacement of sand by powdered over burnt bricks & broken tiles. Figure 11 and figure 12 shows graphical representation of split tensile strength test results.

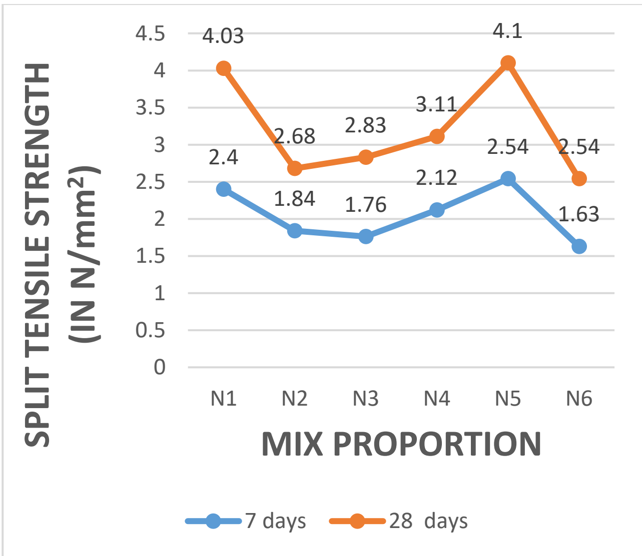

Figure 11: Split Tensile Strength of specimens after 7 & 28 days

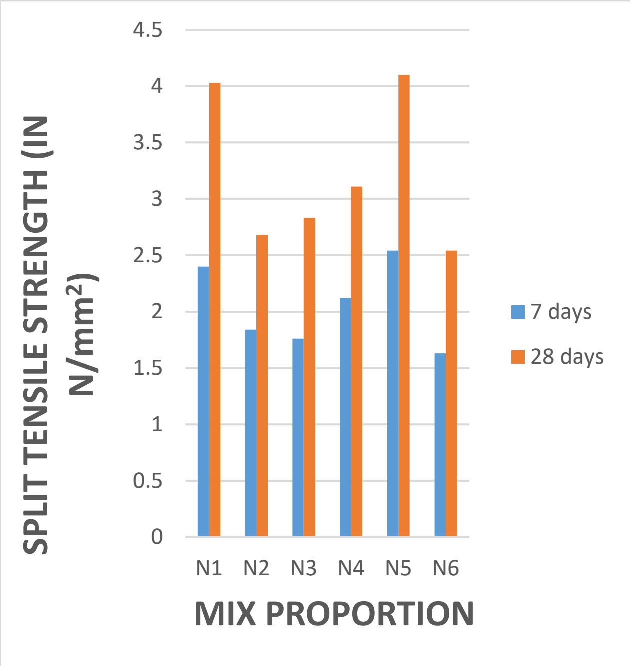

Figure 12: Split Tensile Strength of Different Specimens After 7 and 28 days

VII. CONCLUSION

As evident from the results of the tests conducted, the Compressive as well as Split Tensile Strength of Concrete has in fact increased by replacement of the fine aggregates(sand) by over burnt bricks and broken tiles with maximum value of strength at 80% replacement. This increase in the strength of concrete which is more than the conventional concrete thus encourages the use of otherwise a waste material. Since ages, finding methods to increase value of strength as well as maintaining economy has always been the main point of consideration when it comes to the advancements made in the field of concrete technology thus this objective has been fulfilled by this research work to a great extent as the concrete produced proved to be more economical than conventional concrete of same grade.

In this research, the fine aggregates were replaced by waste materials such as broken tiles and overburnt bricks in a definite proportion and pattern. This replacement has resulted in increasing the strength as well as making the concrete economical to an extent that is considerable, the value of maximum Compressive and Split Tensile Strength being 33.34 N/mm2 & 4.10 N/mm2 (for specimens P5 and N5 respectively) after 28 days for concrete of grade M25. In case of specimens P5 & N5, there was 80% replacement of sand by broken tiles and over burnt bricks powder.

It has been observed that the strength of concrete initially is less than conventional concrete of grade M25 but later it increases as the percentage of replacement of sand by over burnt bricks and broken tiles increases with maximum value of strength at 80% replacement(for specimen P5 & N5) out of all the prepared specimens with various percentages of replacements in definite proportions and then it again decreases for 100% replacement (for specimen P6 &N6) of sand by a mixture of over burnt bricks and broken tiles. The slump value first increases with its 90mm value at 20% replacement then decreases as the percentage of replacement increases with minimum value at 100% replacement.

Over all it can be concluded that this replacement is most suitable for higher percentage (80%) of replacement taking strength into consideration because at this percentage replacements the strength of this concrete proved to be more than that of the conventional concrete.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

AKNOWLEDGEMENT

I would like to articulate my gratitude and appreciation to my guide, Richika Rathore, Assistant Professor, Department of Civil Engineering, RIMT University Mandi Gobindgarh, Punjab and all other individuals of my department for their needful contributions in completion of my work, this work would not have been possible without their support.

I am very thankful to Dr. Sandeep Singla, Head of Civil Engineering Department, RIMT University Mandi Gobindgarh, Punjab, for allowing me to work on this project.

I am also very thankful to almighty and I extend my sincere appreciation to all my family, friends and colleagues for their valuable inputs, help, cooperation, support and suggestions during this work.

REFERENCES

[1]. Zeena Adel Mohammad, Effect of Partial Replacement Fine Aggregate on some Engineering Properties of Concrete, Al-Rafidain Engineering Journal (AREJ.), 2011.

[2]. Jan Wakeel Ahmad Wani, Ravi Kumar, Influence of Surkhi on Various Properties of Concrete Bricks, International Journal of Engineering Research & Technology (IJERT.), Vol.6 Issue 04, April,2017.

[3]. Utkarsh Singh Chandel, Rambharosh, Experimental Study on Partial Replacement Fine Aggregate by Broken Tiles in Concrete, International Journal of Engineering Research & Technology (IJERT.), Vol.6, Issue 10, October,2017.

[4]. Bidve Ganesh Shivkanth, G.N. Shete, Experimental Study on Effect of Partial Replacement of Coarse Aggregate by Over Burnt Brick Bats, International Journal of Research in Engineering, Science and Management Vol.2, Issue-4, April,2019.

[5]. Mohd. Aaqib Bhat, Panshul jamwal, Ankush Tanta, Rohit Sharma, Effect of Partial Replacement of Fine Aggregate with Brick Ballast Using M30 Grade of Concrete, International Educational Applied Research Journal (IEARJ.), Vol.3, Issue 07, July 2019.