Utilization of Waste Bricks as Substituent of Fine Aggregate

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Abstract-The purpose of this study was to determine whether brick fragments might be used in place of fine aggregate in concrete. Brick rubble came from dismantled masonry walls that were crushed in a lab and added as a partial replacement for fine aggregate. Comparisons between the control and four replacement levels, 5%, 10%, 15%, and 20%, were made. Concrete testing revealed that the mechanical characteristics (compressive strength test) of concrete including brick debris and concrete without ground brick were very equivalent.

Index Term: Fine aggregate, Brick powder, demolition waste, concrete and Compressive strength

1.INTRODUCTION

Cement, water, fine aggregate, and other ingredients are combined to form concrete, which is then mixed in varying ratios to produce a desired strength[1]. Not just in India but all throughout the world, there are enormous amounts of waste generated during building and destruction. Mostly, these wastes are growing each year. According to estimates, 11 billion metric tonnes of concrete are produced annually, of which 70–75 percent is fine aggregate (mainly made of natural rock), 15–20 percent is water, and 10–15 percent is cementing agent. The concrete industry has implemented a number of strategies to meet the growing environmental demand to decrease solid waste and recycle as much as possible, including using diverse waste materials in place of fine aggregate and coarse aggregate[2,1]. Notably, the need for fine aggregate is extremely high in the modern world, which is always focusing on building bigger and better infrastructure.

One of the current issues is that as we continuously deplete the natural resources, the growing usage of natural fine aggregate leads to an ecological imbalance. Thus, it is essential for the building industry to substitute fine aggregate in part. In addition to sand from other water bodies, researchers and scientists are also working on robot silica or sand, brick debris, filtered sand, treated and sieved silt removed from dams and reservoirs, treated and manufactured sand, and other recent innovations to reduce or completely replace the use of fine aggregate. Use of building waste as fine aggregate can be used as an alternative to quarry and river sand replenishment. One of the current problems is that when natural resources are progressively depleted, the increasing use of natural fine aggregate causes an ecological imbalance. The building sector must therefore partially replace fine aggregate. Researchers and scientists are working on robot silica or sand, brick debris, filtered sand, treated and sieved silt removed from dams and reservoirs, treated and manufactured sand, as well as other recent innovations to reduce or completely replace the use of fine aggregate. These alternatives to natural sand include sand from other water bodies. Building debris can be used as fine aggregate as an alternative to quarrying and replenishing rivers with sand.

A REVIEW FOR OTHER SOURCE S

Construction work in the civil engineering field is frequently related to new projects and developments. The classic building materials including earth, sand, stones, bricks, cement, concrete, steel, aluminium, and wood are utilised in significant amounts for projects like houses, industrial infrastructure, power plants, docks, and harbour works, among others. In a geometric development, there is an increase in demand for certain materials. Sustainable development entails a dedication to discovering and utilising renewable resources. In light of this attitude, it is vital to maximise the reuse of building waste materials that are left behind after the destruction and renovation of ancient structures. Finding substitute sources and materials to replace fine and coarse aggregates has recently received more attention. Numerous researchers have experimented with a variety of materials, including organic materials, herbs, glass, demolition trash, timber waste, plastic garbage, and electronic waste, among others. Investigating the use of these materials for future reuse is worthwhile.

Gamashta and Gumashta [3]investigated various qualities in recycled concrete and brick masonry waste materials and made appropriate recommendations for extending the life of structures, which would sufficiently reduce building costs. The impact of partial replacement of natural coarse aggregates (NCA) and natural fine aggregates (NFA) with recycled coarse aggregates (RCA) and recycled fine aggregates (RFA) on the compressive strength, tensile strength, and flexural strength of recycled concrete was examined by[4] through their experiments. RCA and RFA, respectively, were used to replace 10%, 20%, and 30% of NCA and NFA. Compressive strength test, split tensile test, and flexural test results were compared to those of standard concrete. According to the experimental investigation, replacing 20% of natural aggregates with recycled aggregates boosted the compressive strength and tensile strength of concrete, but it decreased the flexural strength of recycled concrete as the percentage of RCA and RFA grew. Muthulakshmi and Nivedhitha[4] conducted experiments to determine the effects of partial replacement of natural coarse aggregates (NCA) and natural fine aggregates (NFA) with recycled coarse aggregates (RCA) and recycled fine aggregates (RFA) on the compressive strength, tensile strength, and flexural strength of recycled concrete. 10%, 20%, and 30% of NCA and NFA, respectively, were substituted by RCA and RFA. Results from tests for compressive strength, split tensile strength, and flexural strength were compared to those of conventional concrete. The experimental examination revealed that substituting recycled aggregates for 20% of natural aggregates increased the compressive strength and tensile strength of concrete, but as the percentage of RCA and RFA increased, it decreased the flexural strength of recycled concrete. Waste glass of all types, primarily container glass, thin film transistor liquid crystal display (TFT-LCD), crushed clay brick aggregate, various plastic types, such as polyethylene (PET), scraped PVC pipes and rubbers, recycled ceramic materials from sanitary installation, and recycling ornamental stones are six types of waste materials (Granite and Marble). Mechanical and durability qualities are covered for all six types of recycled materials. Reusing these resources in concrete was also assessed from the perspectives of economic effectiveness and environmental impact. It is concluded that new views for concrete technology and efficiency may be anticipated by introducing some of these materials' excellent qualities.

In order to produce the test samples in various batch mix proportions with 53 grade cement, Sriharsha and Murthy[5] used demolition debris from old structures of the construction industries and the blast furnace slag, which is easily available from iron ore industries. This set the stage for further research in this area using the feasible results from experimental studies, in order to produce test blocks or bricks as practicable. Laboratory tests are performed to evaluate the physical characteristics of these test samples, such as compression strength and water absorption. All of the aforementioned samples' strength characteristics are investigated using both conventional mixes and altered proportions. Every sample's compressive strength and water absorption are computed, compared to every combination, and conclusions are drawn.

In order to examine concrete that had coarse aggregate partially replaced with construction and demolition waste materials such broken bricks, plastic garbage, and waste ceramic tiles, Kumar and Siva[6] conducted laboratory tests. The final concrete so created underwent tests for compressive strength, workability, and flexural strength. The outcomes are contrasted with a concrete made of simple cement. They achieved light weight concrete by using low weight ingredients, such as plastic waste. When compared to regular cement concrete, the workability of concrete made from building waste is unreliable, but the compressive strength was significantly increased.

Dinesh Kumar et al. [7] concentrated on substituting fine aggregate with coal bottom ash. Up to 25% of the entire amount of ash is made up of bottom ash, and the remaining 75% is made up of fly ash. They experimented with concrete behaviour utilising coal bottom ash at various sand replacement levels. The study assessed the possibility of using coal bottom ash to substitute sand in concrete to varying degrees (0, 10, 20, 30, 40, and 50%). M25 grade was fixed in order to evaluate the mechanical characteristics of concrete. Because of the water need, the workability of existing is reduced when bottom ash is used as a component of concrete. At last, the utilization of coal bottom ash in concrete isprescribed as a different option for fine aggregates in concrete but limited to 20% by weight of fine aggregate.

Sai Samanth and Prakhar [8] and Nili, M. Biglarijoo[9] examined the characteristics of concrete that has recycled construction and demolition waste in place of fresh aggregates. This research presents experimental findings to determine the replacement ratio of this waste as fine and coarse aggregate. In addition to helping with solid waste management, this efficient use of the debris as aggregates without changing the qualities of traditional concrete also aids in finding a partial replacement for sand and quarry.

The current research project concentrates on the demolished bricks as an alternative source in light of the literature evaluation. Bricks are sometimes utilized in place of coarse aggregate since they are often left over after a construction site is demolished. About 30% of the construction in India is carried out on the sites of previous structures, where the majority of the waste construction is lost. Concrete blocks can be made from such leftover construction materials.

2.MATERIALS AND METHODS

Cement, aggregates, water, and other readily accessible ingredients are mixed to create concrete. Throughout the project, ordinary Portland cement of grade 53 was employed. The clean river sand, with a maximum size of 4.75 mm, and complying to grading zone II, was the fine aggregate used in this experiment. Table 1 displays the materials' characteristics.

Table 1 Properties of the constituent materials

No.	Parameter	OPC used	BrickDebris	Fine Aggregate	Coarse Aggregate
1.	Normal Consistency	29%	--	--	--
2.	Initial Setting Time (minutes)	45	--	--	--
3.	Final Setting Time(minutes)	240	--	--	--
4.	Specific Gravity	3.15	2.00	2.45	--
5.	Bulk density	--	975	1135	1169
6.	Fineness modulus	--	3.76	4.62	--
7.	Water Absorption	--	5.26%	2.04%	--
8.	Apparent specific gravity	--	2.23	2.57	--
9.	% of Voids	--	112.99%	55.02%	154.65%

Bricks were utilised as a fine aggregate for concrete, crushed into a coarse powder. The broken building's garbage was collected, the waste bricks were ground up, and the particles retained on the 0.075 mm screen were sized to produce fine aggregate. In the trials, brick powder is used in place of fine aggregate in amounts of 5, 10, 15, and 20%.

The experiment's objective was to evaluate the characteristics of concrete made from crushed brick and to investigate significant issues such compressive strength of concrete made from brick trash with various replacement percentages of fine aggregate. The Indian Standard for control concrete served as the basis for the proposed concrete mix design (IS 10262:1982). The grade was M20. The Proportion of materials shown in Table 2. The replacement levels of sand by brick powder were used in terms of 5%, 10%, 15%, and 20% in concrete.

Table.2 Mix proportion

No.	Ingredients	Kg/m^3	Proportion
1.	Ordinary Portland Cement	383	1:1.5:3 W/C = 0.5
2.	Fine Aggregate	546	
3.	Coarse Aggregate	1187	

The parameters specific gravity, fineness, consistency test, and setting time were assessed on the cement used in the study. The fineness modulus, specific gravity, water absorption, bulk density, and void ratio of the aggregate were all examined. Four different mixes were used to test the compressive strength of concrete blocks. In CC mix, water was added to the traditional mixture of cement, coarse aggregate, and fine aggregate, which was then tested for strength criteria. Brick debris only makes up 5% of the fine aggregate in R-1 mix; all other elements were the same as in CC mix. Only 10% of the fine aggregate in the R-2 mix is substituted with brick debris; the rest of the elements are the same as in the CC mix. Only 15% of the fine aggregate in the R-3 mix is substituted with brick shards; the remaining elements are the same as in the CC mix. Brick debris only makes up 20% of the fine aggregate in R-4; the other elements were the same as in the CC mix.

Twelve 150mm x 150mm x 150mm cubes were cast and used as test specimens to assess the compressive strength at 7, 14, and 28 days in order to explore the effects of replacing sand in various ratios with brick debris. Every time a sample was tested, the needed number of days passed, and the mean value was calculated. Table 3 and Table 4 displays the results of the sieve analysis (IS 2386-PART I) on the river sand, cement mortar fragments, and brick bat debris as shown in Table 3 and Table 4.

Table 3 Gradation analysis of the fine aggregate

No.	Sievesize	Weight ofAggregate retained	Weight retained (%)	Cumulative %weight retained	Percentagepassing (%)
1.	4.75	0	0	0	100
2.	2.36	10	10	1	99.0
3.	1.18	215	225	22.5	77.5
4.	500µ	385	610	61.0	39.0
5.	300µ	215	825	82.5	17.5
6.	150µ	140	965	96.5	3.5
7.	75µ	25	990	99.0	1
8.	pan	10	1000	100.0	--

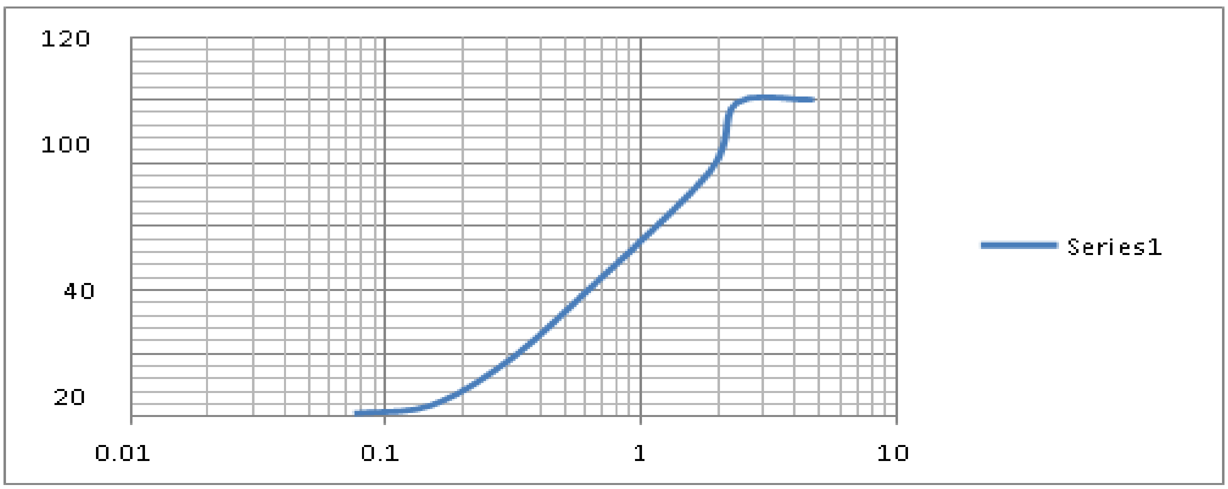

Fig. 1 Sieve analysis graph for fine aggregate

Table 4 Gradation analysis of the brick debris

No.	Sievesize	Weight ofAggregate retained	Weight retained(%)	Cumulative %weight retained	Percentagepassing (%)
1.	4.75	0	0	0	100
2.	2.36	40	40	4.0	96.0
3.	1.18	125	165	16.5	83.5
4.	500µ	175	340	34.0	66.0
5.	300µ	155	495	49.5	50.5
6.	150µ	290	785	78.5	21.5
7.	75µ	155	940	94.0	6
8.	Pan	10	1000	100.0	--

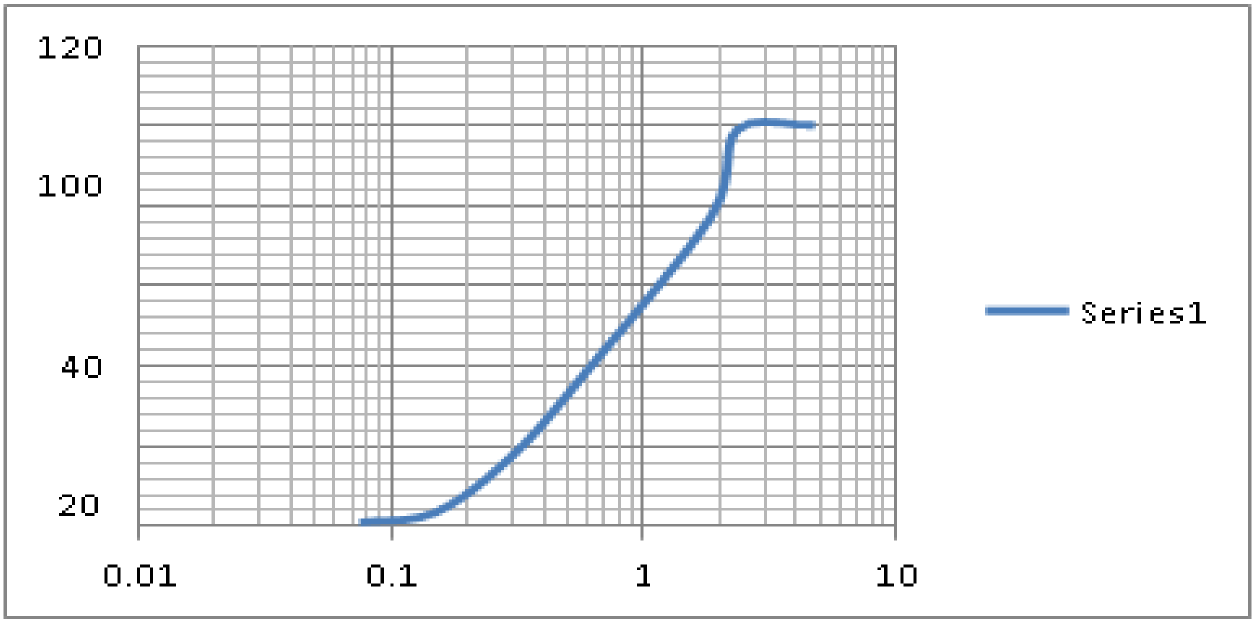

Fig. 2 Sieve analysis graph for brick debrisExperimental observations

Compressive strength tests were performed on the cast cubes at 7, 4, and 28 days after casting. Following are Tables 6, 7, and 8, which show the compressive strength values for 7, 14, and 28 days, respectively.

Table 6 Compressive strength values for 7 days

No.	Mix % ofbrick debris	Days	Area mm^2	Weightkg	LoadkN	Compressivestrength N/mm^2
1	Normal	7	150x150	8.100	520	23.11
2	5%	7	150x150	8.025	615	27.33
3	10%	7	150x150	8.086	596	26.49
4	15%	7	150x150	7.910	535	23.78
5	20%	7	150x150	7.865	484	21.51

Table 7 Compressive strength values for 14 days

No.	Mix % ofbrick debris	Days	Area mm^2	Weightkg	Max Load kN	Compressive strength N/mm^2
1	Normal	14	150x150	8.250	627	27.87
2	5%	14	150x150	7.930	807	35.87
3	10%	14	150x150	7.810	878	39.02
4	15%	14	150x150	8.210	664	29.51
5	20%	14	150x150	7.950	680	30.22

Table 8 Compressive strength values for 28 days

No.	Mix % ofbrick debris	Days	Areamm^2	Weightkg	LoadkN	Compressivestrength N/mm^2
1	Normal	28	150x150	7.925	508	22.57
2	5%	28	150x150	7.345	561	24.93
3	10%	28	150x150	8.355	564	25.06
4	15%	28	150x150	8.060	448	19.91
5	20%	28	150x150	7.405	474	21.06

3.RESULTS AND DISCUSSIONS

The experimental studies conducted in the lab to ascertain the strength characteristics of the concrete with the inclusion of crushed brick mixture and test results are explained. For concrete of the M-20 grade, the mix proportion of different elements (namely, cement, coarse aggregate, fine aggregate, and water) is determined in line with the design obtained in accordance with code IS-10262. The cubes were cast and put through testing in the lab. Figure 1 compares and displays the cube compressive strength findings for 7, 14, and 28 days for various mixtures. When brick debris was substituted for 5%, 10%, 15%, and 20% of the fine aggregate in conventional/natural concrete, the compressive strength was compared.

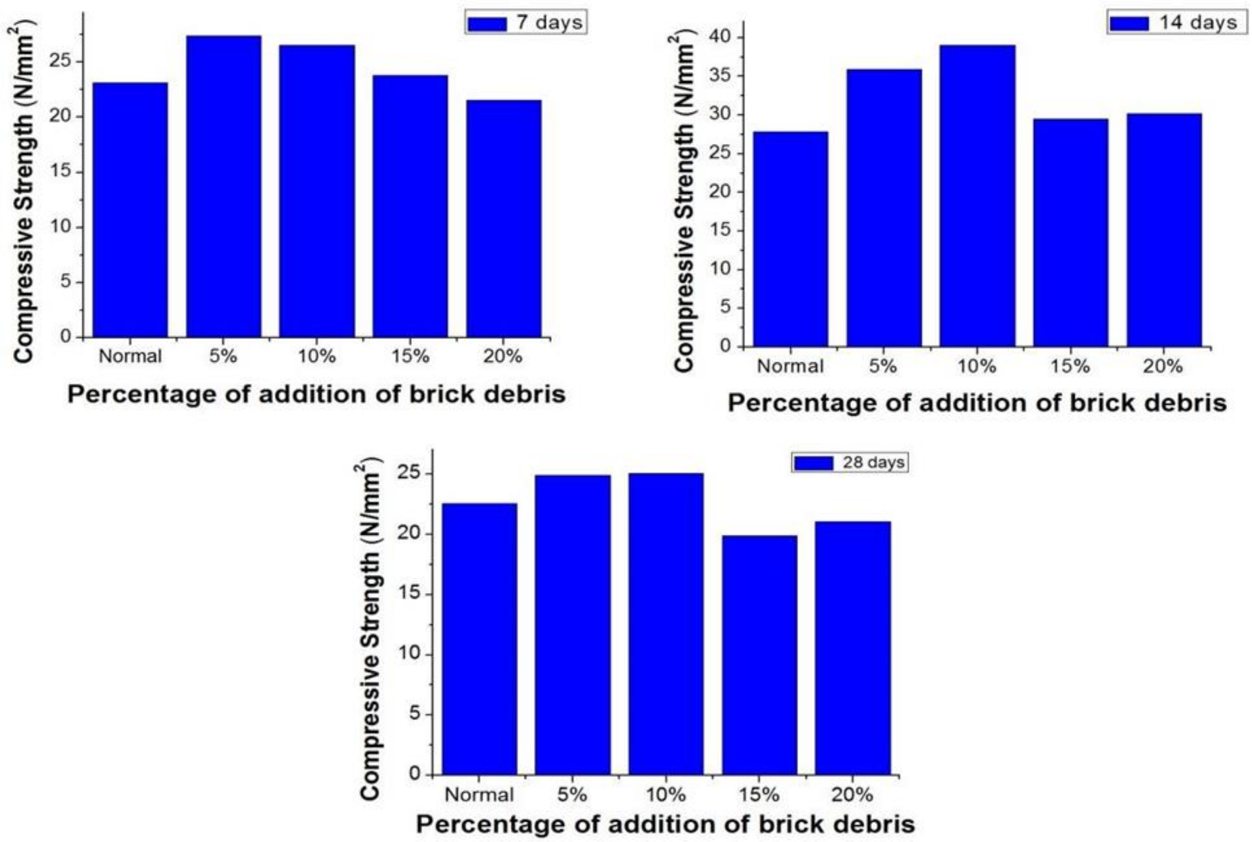

Fig. 3 Comparison of Compressive strength for various proportions of brickdebris @ 7, 14 and 28 day

Out of all the tests done on concrete, the compressive strength test is the most significant and provides all the key information about a concrete. A total of 12 concrete blocks in various proportions, including OPC, have been cast. For the experiments, cube moulds of 150mmx150mmx150mm are used for the concrete blocks. To prevent voids, the concrete is poured into the mould and manipulated. Test moulds are removed after a period of time, and specimens are then kept in water to cure. After casting, these specimens are evaluated using a compressive testing equipment seven, fourteen, and twenty-eight days later.

4.CONCLUSION

The following conclusions, which are specific to the study's materials, were drawn from an experimental study looking into the use of brick fragments in concrete. Because it consumes the refuse from demolished bricks, this concrete is environmentally friendly. This process can save up to the full cost of cement purchased via the traditional way. The percentage of cost savings rises as mix design complexity rises. Concrete builds strength quickly, allowing shuttering to be removed earlier and lowering secondary overhead copy.

According to the compressive strength test findings, 10% of fine aggregate substitution with crushed brick debris is accomplished in comparison to the corresponding conventional concrete strength. The possibility exists for the partial replacement of fine aggregate with brick debris which is produced during demolition of construction site. Other industrial and agricultural waste materials can also be effectively used in civil building projects. Therefore, further investigation is required into the endurance of these materials as well as the economic viability of such applications. Recycling materials like stone, aggregate, bricks, etc. has the clear advantage of reducing the need for stone mining and quarrying. As a result, the earth's surface can be further preserved, and the activity's impact on the environment will be lessened. For instance, all of the raw materials used to manufacture bricks come from the soil. Reusing bricks reduces the likelihood of removing fertile soil, soil vegetation, and forests. Overall environmental damage will be reduced as a result of this. It is noted that there can be significant uncontrolled growth of brick kilns with large building projects and to fulfill their demand, which contributes to environmental ruin.

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