DOI: 10.56452/2021SP-8-054

ISSN: 0974-5823 Vol. 6 (Special Issue 4, November 2021)

International Journal of Mechanical Engineering

Stability Aspects of Concrete Using Bagasse Ash, Marble Dust and Waste Concrete Aggregate

Sourabh Dhiman[1], Syed Mohd. Arif[1], Vineet Pandey[1] and Sonia Rani[2]

[1]Department of Civil Engineering Department, Chandigarh Engineering College, Jhanjeri, Mohali-140307, Punjab, India

[2]Department of Computer Application, Chandigarh School of Business, Jhanjeri, Mohali-140307, Punjab, India

E-mail: sourabh.dhiman189@gmail.com; syed.aarif3@gmail.com

Abstract: As due to the heavy waste coming from industries or through any source can lead to the problem to the environment. But now demand for utilization of the industrial waste is at its peak and due to which different types of research work has been carried out so that waste material can be used suitably. The physical and chemical characteristics of concrete when material is replenished have thus been the subject of several experimental research. Therefore, using waste material as a replacement could result in a ground-breaking technology provided high strength standards were attained in accordance with code requirements. In this experimental study of suitable utilization of waste concrete aggregate, bagasse ash and marble dust have been done as a replacement in concrete. Waste concrete aggregate's key benefit is that it may be sold because its qualities are so close to those of concrete. Bagasse ash is a burned by-product of sugarcane that is so thin that it can be used in place of fly ash in concrete. Another sort of substitute material employed in the study is marble dust, which is made by cutting and grinding the marble. The study was done to utilize these waste materials in the concrete. In design mix, fine aggregate gets partially replaced with marble dust in powder form, coarse aggregate with waste concrete aggregate (WCA) and cement gets replaced partially with baggage ash (BA) with different proportions. Further, various tests done to evaluate and determine the strength and stability aspects of concrete. The experimental study's result is that compressive and flexural strengths initially tend to rise and reach their peak for design mixes including 7.5 percent BA, 20 percent marble powder, and 30 percent WCA, respectively, before continuing to drop when the proportions are exceeded. The design blend, which contains 10% BA, 20% marble dust, and 30% WCA, produced the highest split tensile strength; other mixtures had acceptable results.

***Keywords**:* Bagasse Ash, Marble Waste dust, Waste Concrete Aggregate.

Introduction

Concrete material plays an impeccable role in the construction as it has attained the status of major building material in modern construction. It imparts high compressive strength and stiffness to the structure due to its properties

When all these raw ingredients mix by process of rolling, folding and spreading then slurry paste forms after the chemical reaction. But due heavy waste availability of the raw material is posing a great threat to the environment as they are being used profusely for construction purposes. To overcome these issues, utilization of by-products of industrial production as it is the only solution to the problem. Various minerals like fly ash, bottom ash, metakaolin, iron and baggage ash, rice husk ash, marble powder, etc are the various types of material that are being used for replacement of the raw ingredients. These materials have diverse properties which affect the concrete in different manner when these are used as admixtures in concrete. Some material improves strength parameters, some are used for enhancing workability and others are used for targeting other properties of concrete.

DOI: 10.56452/2021SP-8-054

Baggase ash:
Burned off sugarcane waste is known as bagasse ash (*Saccharumofficinarum*) and Additionally, it is exceedingly fine, making it suitable for replacement in concrete. As being one of the largest crop production in quantity in the world, it releases a huge amount of waste from sugar mills. So waste coming from industries should be recycled for the environment point of view. Bagasse ash is replaced with cement can be taken into consideration due to its some chemical and mineralogical composition which makes it a possible additional material. The properties of Bagasse ash may vary with its source shown below:

Table 1: Bagasse Ash Properties

S.No	Physical properties	Range
1	SG	2.38
2	LL	41
3	PL	Non-plastic
4	OMC (%)	48
5	Maximum dry density (g/cm^2)	1.27
6	Lime reactivity(kg/cm^2)	32

Fig.1 Bagasse Ash

Recycled concrete aggregate
Waste concrete aggregate is one of the easily available waste materials obtained when a building gets demolished and can be collect from construction site.The use of these recycled aggregate increases all around the world. Various techniques have been already developing to enhance the concrete properties by waste aggregate. Table 2 above lists the characteristics of recycled concrete aggregates.

DOI: 10.56452/2021SP-8-054

Table 2: Properties of RCA

Details	Values
Shape	Irregular
Size	10 mm, 20mm
Specific Gravity	2.40
Water Absorption	4.04

Fig.2 Recycled Concrete Aggregate

Marble waste powder

Another waste product that is substituted for fine particles in concrete is marble debris. This kind of debris is produced by the marble industry's cutting and grinding of marble. The marble dust is useless and cannot be used again in the marble business. As a result, they can be employed as a fine aggregate in concrete to lower the cost and pollution. Marble waste powder properties are mentioned in above table

Table 3: Marble dust characteristics

S.No	Characteristic	Values
1	Appearence	White
2	Form	Powder
3	Odour	Odourless
4	SG	2.67

Fig.3 Marble Waste Powder

Review of literature

Many pieces of literature were analysed using various approaches and methodologies in order to study the closely and sparsely linked studies in the area of substituting raw resources with waste and recycled materials. For the purpose of reviewing and settling on the topic of the current experiment, various renowned Journals, including the International Journal of Civil, the International Research Journal of Engineering and Technology (IRJET), the Architectural, Structural and Construction Engineering, the International Journal of Engineering Research and Applications (IJERA), ELSEVIER, and the International Journal of Engineering and Management Research, were consulted.

Yashwanth M K.et. al. (2016). Examined the impact of including fly ash and bagasse ash in concrete. In this investigation, bagasse ash and fly ash were physically and chemically described and replaced in concrete in the following percentages: 0%, 5%, 10%, 15%, and 20% by cement weight. Concrete's fresh qualities, such as the slump test, and its hardened properties, such as compressive strength, were investigated. According to the findings, the fresh properties of the bagasse ash and fly ash concrete, such as workability, increase as the percentage of bagasse ash and fly ash replacement increases. Additionally, the compressive strength of the bagasse ash and fly ash based concrete increases up to Comparing it to traditional concrete, the ash replacement level is 15%. When replacing cement to increase the workability of concrete, bagasse ash and fly ash have been found to have an additive effect of up to 15%. According to the results of cubes' compressive strength tests, replacing 15% of the ashes with cement will result in concrete with a higher compressive strength than regulated concrete. As a result, we may draw the conclusion that using fly ash and bagasse ash up to 15% instead of cement will generate concrete that can be used for real-world structural applications.

Puneet Jainet. al. (2017) We looked into the idea of substituting marble powder, which was recovered from waste marble slurry from marble processing machines, for sand (fine aggregate) in the manufacturing of concrete used in residential projects. The study work examines how well M20 grade concrete mixes function when fine aggregate is replaced by marble powder made from marble slurry in various proportions ranging from 0 to 20 percent (by weight). Waste marble slurry is gathered for this purpose from Indian Udaipur region marble processing facilities. M20 Concrete Mix is made using locally accessible resources in Udaipur, India, and is meant to produce M20 quality concrete. Results demonstrate that using marble waste powder in place of up to 20% of the sand in concrete production produces mixtures that are nearly as strong as those made entirely of sand.

Ragu.Ret. al.(2017) A number of tests are carried out to determine whether marble dust powder containing 15%, 20%, 25%, 30%, and 35% causes environmental issues. Environmental issues have a significant impact on both nature and human health. Utilizing this waste in the concrete mix will help us limit its effects, as will a comparison of the concrete mix's compressive, flexural, and split tensile strengths as well as its workability and durability. The concrete mix showed real slumps with diminishing consistency as the quality M- sand, and the M-sand sample was found to be highly graded. A variety of tests are carried out to determine the impact of 50% M-Sand. Environmental pollution is primarily caused by granite waste. Consequently, this project's goal is to use the surplus granite.

Er. GokulPrasadsharmaet. al.(2017) The many waste types that can be used in various sorts of projects, such as building projects, road projects, various ceramic projects, ready-mix concrete projects, and cement industry projects, have been studied. When waste is placed on land, the dust becomes airborne due to the wind and pollutes the environment. Marble slurry has an impact on and lowers soil fertility. Author has recommended using in concrete works in this essay. It will do two things at once: it will lower construction costs and protect the environment. The addition of marble waste has no impact on a building's strength. Results indicate that adding marble dust to concrete in 28 days increased its compressive strength, according to IS: 456-2000, by 38 N/mm2 and has further also increased 40.5% by adding marble dust.

Design Mix

Total 7 design mix prepared as per Indian Standard of bagasse ash, marble waste and waste aggregate with varying proportions along with control mix to determine their effect on concrete. Cement is partially replaced with baggase ash from 2.5 to 15% with increment of 2.5%. For marble powder 20%in proportion is used. Coarse aggregate partially replaced with 30% waste concrete aggregate.

Table 4: Different Proportions of BA, MWP and RCA for Concrete Mix

Design Mix	Baggage Ash (%)	Marble Powder (%)	RCA (%)
CONTROL MIX	0	0	0
MIX-1	2.5	20	30
MIX-2	5	20	30
MIX-3	7.5	20	30
MIX-4	10	20	30
MIX-5	12.5	20	30
MIX-6	15	20	30

For the investigation, various cubes measuring (150 X 150 X 150) mm were made, and their compressive strength was then tested in CTM in accordance with IS 516-1959. According to IS 5816-1999, a cylindrical mould with dimensions of 150 mm in diameter and 300 mm in height was cast. A beam measuring 100 X 100 X 500 mm was produced for flexural strength. All of these samples were subsequently analysed for 7 and 28 days.

Along with these tests, an IS: 13311.1-1992 ultrasonic pulse velocity test and a rebound hammer test were conducted after 28 days.

DOI: 10.56452/2021SP-8-054

Results

Compressive strength test results

Table 5's compressive strength at 7 and 28 days reveals an increase in Mix 3's compressive strength. The greatest compressive strength of Mix 3 was 24.09 MPa at 7 days and 36.45 MPa at 28 days. The compressive strength rating then starts to decrease between Mixes 3 and 6. But each of these combinations yields fruitful results.

Table: 5. Compressive Strength Test Results

Design Mix	Compressive Strength (7days)	Compressive Strength (28days)
Control Mix	20.87	31.25
MIX1	21.22	32.78
MIX2	23.09	34.26
MIX3	23.84	35.87
MIX4	24.65	37.85
MIX5	23.15	35.25
MIX6	21.89	33.45

Compressive strength increases with the inclusion of trash and recycled material. Beginning with Bagasse Ash, Marble Waste Powder, and RCA Till Mix Mix 4, the strength increases as a percentage of replacement. Mix 4 reaches a compressive strength of 37.85 MPa at this point. However, the compressive strength starts to decline from mix Mix 4 and continues until mix Mix 6. At 28 days, mix M6's minimum strength was determined to be 33.45 MPa. Little difference can be seen between the mixtures when compared to one another. However, variation in Mix 4 relative to the reference mix is high because there was a strength increase of about 6 MPa. The difference in particle size between cement and ash particles, which in this case is less than cement, is what causes this type of variation. As a result, the concrete's gaps are filled.

The bar graph below illustrates how the compressive strength test results for the test samples after 7 and 28 days varied. It serves as a comparative tool.

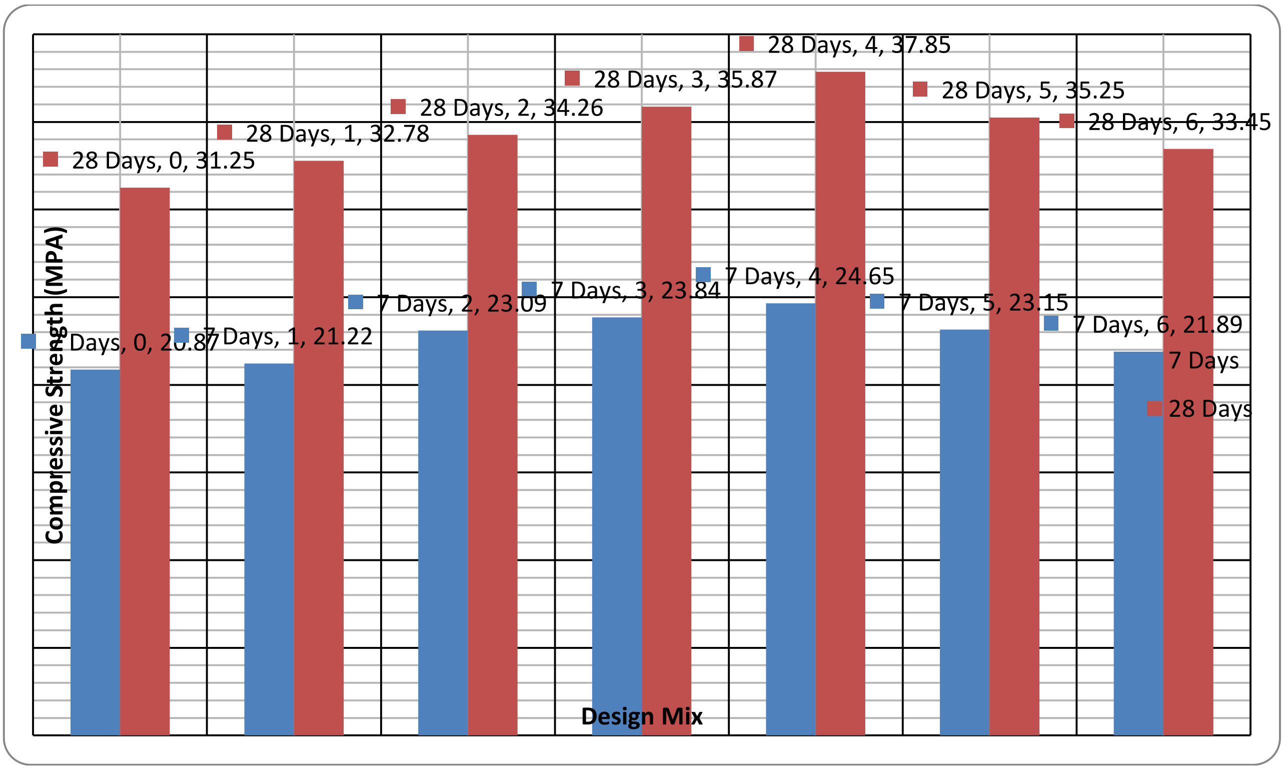

Fig.4 Compressive Strength Result Bar Chart

Flexural Strength Result:
According to Table 6, Mix 3 has the maximum flexural strength at 28 days, 5.61 Mpa, and Mix 6 has the lowest flexural strength at 28 days, Mpa.

Table:6 Flexural Strength Result

Design Mix	Flexural Strength (7days)	Flexural Strength (28days)
Control Mix	3.89	5.07
MIX1	4.23	5.87
MIX2	4.56	6.02
MIX3	4.97	6.12
MIX4	5.32	6.42
MIX5	4.67	5.89
MIX6	4.48	5.75

The test findings show that the specimen's average flexure strength increases up to concrete Mix Mix 4, after which it tends to decline as the replacement percentage rises. From the figure below, it can be deduced that Mix 4 exhibits more flexural strength than other design mixes at 28 days (6.12 MPa), and Mix 6 exhibits the lowest flexural strength at 28 days (5.75 MPa). Flexural strength variations are minimal for all combinations at both the 7-day and 28-day curing times. This kind of results are attained as a result of the ash's lower dry density. Dry density causes the concrete's water-to-cement ratio to drop, which weakens the structure.

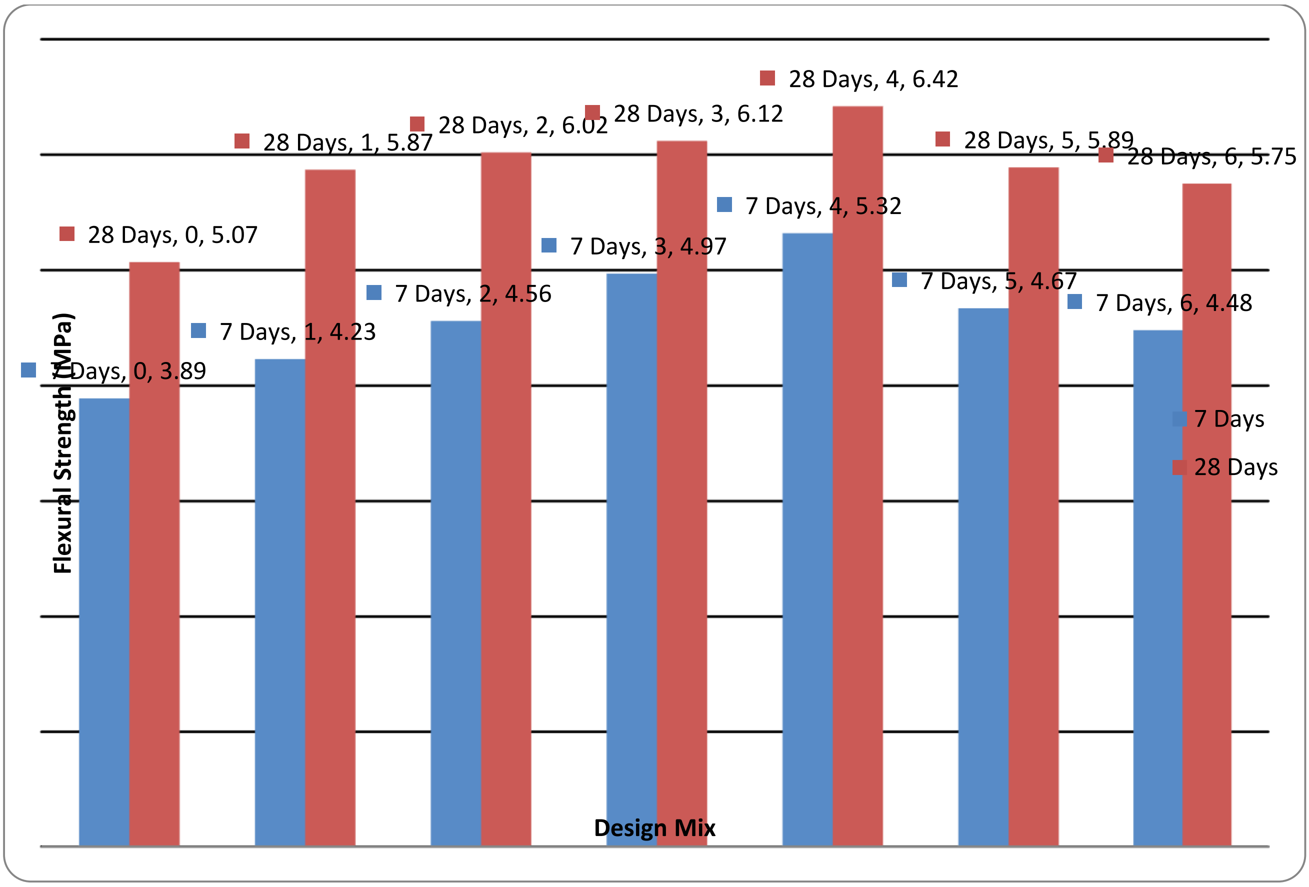

Fig.5 Flexural Strength Test Results

DOI: 10.56452/2021SP-8-054

Split Tensile Strength Test

Table 7 displays the differences between the split tensile strength data at 7 and 28 days. Mix 4's maximum split tensile strength at 7 days was 3.25 MPa, while at 28 days it was 4.89 MPa. The control mix, in contrast, has the least strength during both curing periods.

Table:7 Results of Split Tensile Strength Test of Specimen

Design Mix	Split tensile strength (7days)	Split tensile strength (28days)
Control Mix	2.57	3.54
MIX1	2.97	3.99
MIX2	3.02	4.12
MIX3	3.14	4.54
MIX4	3.25	4.89
MIX5	2.89	4.37
MIX6	2.57	3.94

The average tensile strength of the specified specimen changes with the varied proportions of replacement, it is concluded. The graph below shows how the split tensile strength findings varied after 7 and 28 days. For mix M4, the maximum split tensile strength was 3.25 MPa after seven days and 4.89 after twenty-eight. The control mixture, however, exhibits the least strength during both curing periods. Again, there is not much difference between these values, and the strength increases and decreases in a zigzag pattern. The high lime reactivity of the ash, which combines with the marble powder to increase the stiffness of the concrete, is primarily what accounts for the maximum split tensile strength.

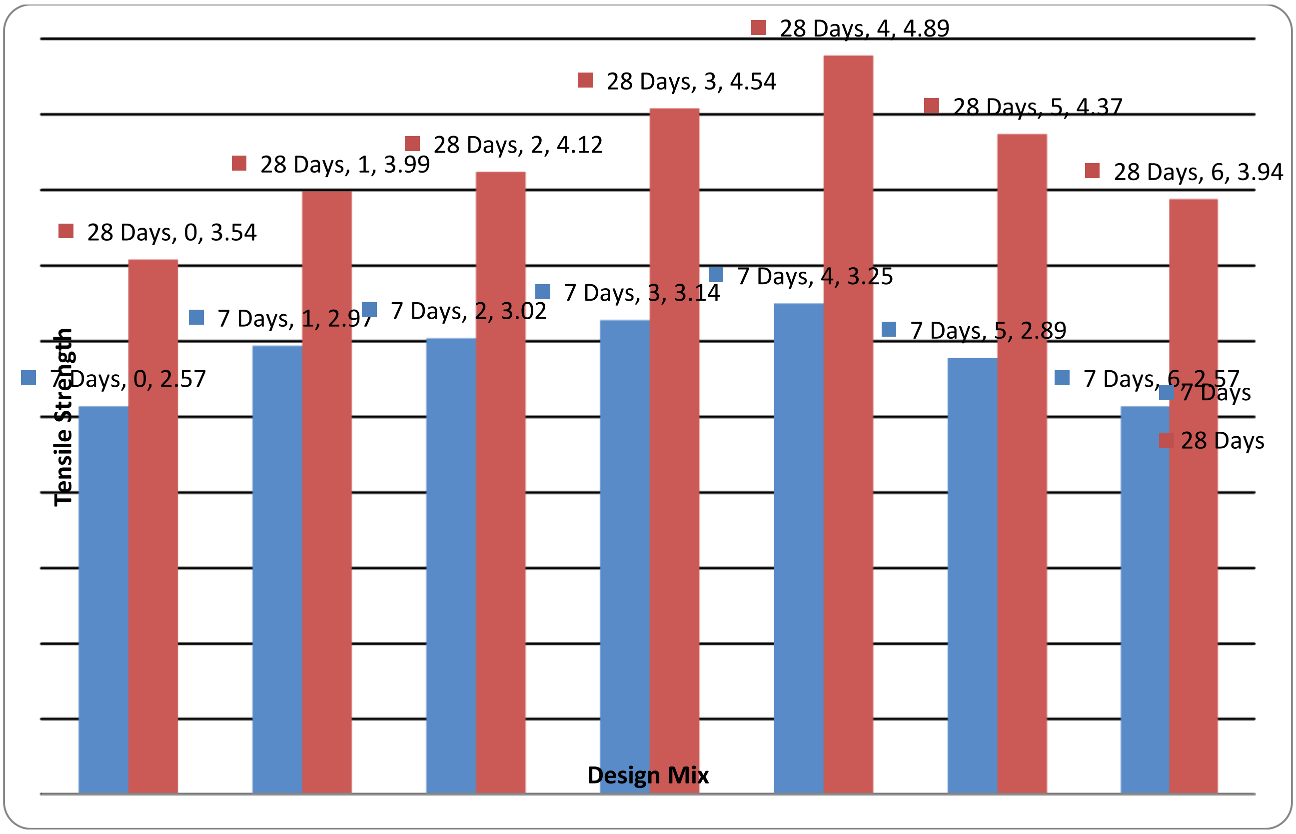

Fig. 6 Split Tensile Strength

DOI: 10.56452/2021SP-8-054

Conclusion

The design mix (reference mix and replacement mix) of grade M30 was prepared for the aforementioned experimental investigation. Bagasse ash is used to substitute cement to a degree ranging from 10% to 30% with each 10% increment. A mixture of 20 and 40 percent of marble waste powder was employed. With a fixed quantity of 25% recycled concrete aggregate, coarse aggregate was partially substituted. The conclusions that were drawn for the present investigation are presented below after doing this study and comparing the findings:

- A concrete mixture of 10% bagasse ash, 20% marble waste powder, and 30% RCA has the highest compressive and flexural strengths.
- Concrete mix Mix 4 with 10% bagasse ash, 20% marble waste powder, and 30% RCA has the highest value for split tensile strength.
- According to the current experiment study, replacing concrete with 10% bagasse ash, 30% waste concrete aggregate, and 20% marble dust will result in greater values.

References

1. "Experimental Study on Use of Sugar Cane Bagasse Ash in Concrete by Partially Replacement with Cement." *International Journal of Innovative Research in Science, Engineering and Technology*4.4 (2015). and Fly Ash in Concrete."
2. Bhanu Chaudhary Sourabh Dhiman. "Experimental investigation of strength of concrete using recycled demolished construction materials as coarse aggregate" Volume 48, Part 5, 2022, Pages 1194-1200.
3. S Dhiman, R Garg, S Singla. "Experimental investigation on the strength of chipped rubber-based concrete" 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* 961 012002.
4. A REVIEW." Abdulkadir, T. S., D. O. Oyejobi, and A. A. Lawal. "Evaluation of sugarcane bagasse ash as a replacement for cement in concrete works." *ACTA TechnicaCorviniensis-Bulletin of Engineering* 7.3 (2014): 71.
5. Aliabdo, Ali A., AbdElmoaty M. AbdElmoaty, and Esraa M. Auda. "Re-use of waste marble dust in the production of cement and concrete." *Construction and building materials* 50 (2014): 28-41.
6. Awargand, Vinod, and AbhijitWarudkar. "international journal of engineering sciences & research technology compressed cement earth block using bagasse ash:
7. BirukHailu et al, "Application of sugarcane bagasse ash as a partial cement replacement material"
8. Chusilp, Nuntachai, Chai Jaturapitakkul, and KraiwoodKiattikomol. "Utilization of bagasse ash as a pozzolanic material in concrete." *Construction and Building Materials*23.11 (2009): 3352-3358.
9. Dilbas, Hasan, MesutŞimşek, and Ö. Çakır. "An investigation on mechanical and physical properties of recycled aggregate concrete (RAC) with and without silica fume." *Construction and Building materials* 61 (2014): 50-59.
10. Gar, ParisaSetayesh, Narayana Suresh, and VivekBindiganavile. "Sugar cane bagasse ash as a pozzolanic admixture in concrete for resistance to sustained elevated temperatures." *Construction and Building Materials* 153 (2017): 929-936.
11. Gupta, RaghubanshBahadur, KirtiChandraul, and Manindra Kumar Singh. "EXPERIMENTAL STUDY ON STRENGTH OF CONCRETE USING SUGGAR CANE BAGASSE ASH." (2011).
12. Hebhoub, H., et al. "Use of waste marble aggregates in concrete." *Construction and Building Materials* 25.3 (2011): 1167-1171.
13. Kawade et al., "Effect of use of Bagasse Ash on Strength of Concrete" ISSN: 2319-8753 Vol. 2, Issue 7, July 2013.
14. Kou, Shi-Cong, Chi-Sun Poon, and MirenEtxeberria. "Influence of recycled aggregates on long term mechanical properties and pore size distribution of concrete." *Cement and Concrete Composites* 33.2 (2011): 286-291.
15. Kubissa, Wojciech, et al. "Properties of concretes with natural aggregate improved by RCA addition." *Procedia Engineering*108 (2015): 30-38.
16. Marcos oliveira de paula."Sugarcane bagasse ash as a partial Portland cement replacement material," Medellin, September, 2010. ISSN 00127353.
17. MK, Yashwanth, and P. Nagarjuna. "An Experimental Study on Synergic Effect of Sugar Cane Baggage Ash a Patel, Jayminkumar A., and Dr DB Raijiwala.