IARJSET

ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 13, Issue 8, August 2026

DOI: 10.17148/IARJSET.2026.13809

Experimental Investigation on Concrete with Partial Replacement of Aggregates by Marble Pieces and Plastic Granules

Jayesh Yashwant Gawade[1], Prof. R. S. Patil[2]

Department Of Civil Engineering, Deogiri Institute of Engineering and Management Studies, Chhatrapati Sambhajinagar - 431005. Dr. Babasaheb Ambedkar Technological University, Lonere- 403103, Maharashtra, India[1,2]

Abstract: Concrete is the most widely used construction material because of its strength, durability, versatility, and availability. At the same time, the construction sector consumes large quantities of natural aggregates and generates or receives large quantities of waste materials. Marble processing produces solid waste in the form of pieces and fragments, while plastic waste creates long-term environmental concerns because of its persistence and difficult disposal. This study investigates the possibility of using these two waste materials in concrete as partial replacements for conventional aggregates.

The experimental study considers M30 grade concrete. Marble pieces are used as a partial replacement for natural coarse aggregate, while plastic granules are used as a partial replacement for natural fine aggregate. The project methodology includes material testing, concrete mix proportioning, casting and curing of specimens, and strength evaluation after 7, 14, and 28 days. The synopsis specifies compressive strength, split tensile strength, and flexural strength as strength characteristics to be evaluated.

The reported results show that concrete strength generally increases with curing age. Among the replacement levels considered, the mixes containing 30% marble pieces and 7% plastic granules produced the highest reported strength performance. The synopsis concludes that higher replacement levels of 40% marble pieces and 9% plastic granules resulted in a reduction in strength, attributed to weaker bonding and increased voids.

The study therefore identifies 30% marble pieces with 7% plastic granules as the optimum combination among the investigated mixes. The findings indicate that appropriately proportioned marble and plastic waste can be incorporated into concrete while reducing dependence on natural aggregates and supporting more sustainable construction practices.

Keywords: M30 concrete, marble waste, plastic granules, coarse aggregate, fine aggregate, compressive strength, split tensile strength, sustainable concrete.

1. INTRODUCTION

Concrete is a composite construction material consisting primarily of cementitious material, fine aggregate, coarse aggregate, and water. Its extensive use in buildings, bridges, pavements, foundations, industrial structures, and infrastructure is associated with its ability to develop high compressive strength and its flexibility in production and placement.

The large-scale use of concrete, however, is accompanied by significant consumption of natural resources. Aggregates form a major proportion of concrete volume, and continuous extraction of natural aggregate can contribute to depletion of resources, landscape disturbance, and environmental pressure. The search for alternative aggregate materials is therefore relevant to sustainable civil engineering.

At the same time, marble processing and plastic consumption generate waste materials. Marble waste may occur as pieces and fragments during cutting, processing, transportation, and handling. Plastic waste is generated from numerous consumer and industrial applications and is difficult to degrade naturally. Using suitable waste materials in concrete can provide a route for partial resource substitution while creating a beneficial use for materials that might otherwise require disposal.

The present project examines marble pieces as a partial replacement for coarse aggregate and plastic granules as a partial replacement for fine aggregate in M30 grade concrete. The experimental programme compares a conventional control

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⋊ Peer-reviewed & Refereed journal ⋊ Vol. 13, Issue 8, August 2026

DOI: 10.17148/IARJSET.2026.13809

mix with combinations of marble and plastic replacement. Strength development is considered at 7, 14, and 28 days of curing.

The project synopsis reports that the combination of 30% marble pieces and 7% plastic granules produced the highest strength among the investigated mixes. It further indicates that excessive replacement at 40% marble and 9% plastic reduced strength.

2. MATERIALS AND EXPERIMENTAL METHODOLOGY

Materials

The methodology in the synopsis includes testing of cement, plastic granules, fine aggregate, marble pieces, coarse aggregate, and water before concrete preparation. The quality and suitability of each material are important because changes in aggregate properties can influence workability, density, interfacial bonding, and strength.

Cement

Cement serves as the primary binder in the concrete matrix. Its properties influence setting, hydration, paste strength, and bond development with aggregates. The synopsis identifies cement as one of the materials subjected to material testing, although individual laboratory test values are not included in the supplied synopsis.

Natural Aggregates

Natural coarse and fine aggregates provide the granular skeleton of concrete. In the proposed experimental system, natural coarse aggregate is partly substituted by marble pieces, while natural fine aggregate is partly substituted by plastic granules.

Marble Pieces

Marble pieces are used as a partial replacement for coarse aggregate. As a mineral-based waste material, marble can provide a comparatively rigid aggregate phase. The literature summarized in the synopsis attributes strength improvement at moderate replacement to factors including angular particle shape and filler effects, while excessive replacement may reduce performance because of weaker bonding and higher void content.

Plastic Granules

Plastic granules are used as a partial replacement for fine aggregate. Plastic differs substantially from mineral aggregate in density, surface characteristics, stiffness, and water interaction. Its hydrophobic nature can reduce workability and influence the bond between the plastic particles and cement paste.

Water

Water is required for cement hydration and workability. Consistency of water content is important when comparing mixes so that observed changes can be associated primarily with the aggregate replacement system.

3.EXPERIMENTAL METHODOLOGY

1. Collection and testing of cement, fine aggregate, coarse aggregate, marble pieces, plastic granules, and water.
2. Preparation of M30 grade concrete mix.
3. Partial replacement of coarse aggregate with marble pieces and fine aggregate with plastic granules.
4. Preparation of control and modified concrete mixes.
5. Casting of concrete specimens for different mixes.
6. Curing of specimens for 7, 14, and 28 days.
7. Testing of specimens for compressive strength, split tensile strength, and flexural strength.
8. Comparison of the test results with the conventional concrete mix.
9. Identification of the optimum replacement percentage based on the strength results.

4. TESTS CONDUCTED

Slump Cone Test

The slump cone test was conducted to determine the workability and consistency of fresh M30 **concrete**. The test was performed for the control mix as well as the concrete mixes containing different percentages of marble pieces and plastic granules.

DOI: 10.17148/IARJSET.2026.13809

A standard slump cone was placed on a smooth, level surface and filled with freshly mixed concrete in three approximately equal layers. Each layer was compacted properly using a tamping rod. After filling and leveling the top surface, the cone was carefully lifted vertically without disturbing the concrete. The concrete was allowed to subside, and the difference between the original height of the cone and the height of the concrete after subsidence was measured.

The measured difference was recorded as the slump value in millimetres . The slump values of the different mixes were compared with the control mix to determine the effect of marble pieces and plastic granules on the workability of fresh concrete.

Compressive Strength

Compressive strength is a principal indicator of concrete load-bearing capacity. The project methodology includes compressive-strength testing at 7, 14, and 28 days. The synopsis contains a graphical representation of the compressive-strength test but does not reproduce a complete numerical table in its parsed text. The conclusion states that the 30% marble and 7% plastic combination achieved the highest reported strength performance.

Split Tensile Strength

Concrete is relatively weak in direct tension. Split tensile testing provides an indirect measure of tensile resistance and is useful for assessing cracking-related performance. The synopsis supplies a complete cylinder test table containing split tensile strength and corresponding failure loads at 7, 14, and 28 days.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⅙ Peer-reviewed & Refereed journal ⅙ Vol. 13, Issue 8, August 2026

DOI: 10.17148/IARJSET.2026.13809

5.M30 Concrete Mix Design as per IS 10262:2019 and IS 456:2000

The concrete mix for the present investigation was designed in accordance with the provisions of IS 10262:2019 – Concrete Mix Proportioning Guidelines and IS 456:2000 – Plain and Reinforced Concrete Code of Practice. The mix was designed to achieve the characteristic compressive strength of 30 MPa at 28 days while satisfying the requirements of workability, durability

Table Mix Proportion for M30 Concrete

Material	**Quantity (kg/m³)**
Cement	390
Water	168
Fine Aggregate	710
Coarse Aggregate	1225
Superplasticizer	3.90
Water–Cement Ratio	0.43

Replacement Mix Design

After designing the control mix for M30 grade concrete in accordance with IS 10262:2019 and IS 456:2000, the modified concrete mixes were prepared by partially replacing natural coarse aggregate with marble pieces and natural fine aggregate with plastic granules. The quantities of cement, water, and superplasticizer were kept constant for all mixes, whereas only the quantities of coarse and fine aggregates were varied according to the selected replacement percentages Mix–1 (20% Marble Pieces + 5% Plastic Granules)

Material	**Quantity**
Cement	390 kg
Water	168 kg
Superplasticizer	3.90 kg
Fine Aggregate	674.50 kg
Plastic Granules	35.50 kg
Coarse Aggregate	980.00 kg
Marble Pieces	245.00 kg

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 8, August 2026

DOI: 10.17148/IARJSET.2026.13809

Mix–2 (30% Marble Pieces + 7% Plastic Granules)

Material	Quantity
Cement	390 kg
Water	168 kg
Superplasticizer	3.90 kg
Fine Aggregate	660.30 kg
Plastic Granules	49.70 kg
Coarse Aggregate	857.50 kg
Marble Pieces	367.50 kg

Mix–3 (40% Marble Pieces + 9% Plastic Granules)

Material	Quantity
Cement	390 kg
Water	168 kg
Superplasticizer	3.90 kg
Fine Aggregate	646.10 kg
Plastic Granules	63.90 kg
Coarse Aggregate	735.00 kg
Marble Pieces	490.00 kg

Consolidated Mix Proportion Table

Mix ID	Cement (kg)	Water (kg)	SP (kg)	Fine Aggregate (kg)	Plastic Granules (kg)	Coarse Aggregate (kg)	Marble Pieces (kg)
Control Mix	390	168	3.90	710.00	0.00	1225.00	0.00
20% MP + 5% PG	390	168	3.90	674.50	35.50	980.00	245.00
30% MP + 7% PG	390	168	3.90	660.30	49.70	857.50	367.50
40% MP + 9% PG	390	168	3.90	646.10	63.90	735.00	490.00

Cube Compressive Strength Test Results

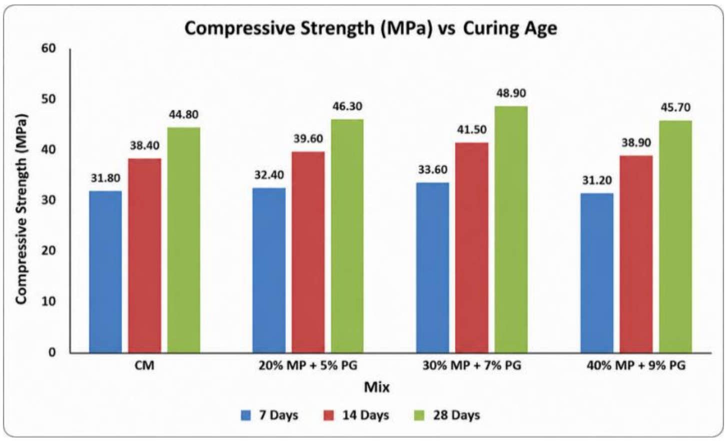
Mix ID	Cube No.	Failure Load (kN)	Compressive Strength (MPa)
20% MP + 5% PG	C1	905	40.22
	C2	918	40.80
	C3	910	40.44
Average		911.0	40.49
30% MP + 7% PG	C1	948	42.13
	C2	955	42.44
	C3	951	42.27
Average		951.3	42.28
40% MP + 9% PG	C1	882	39.20
	C2	890	39.56
	C3	886	39.38
Average		886.0	39.38

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

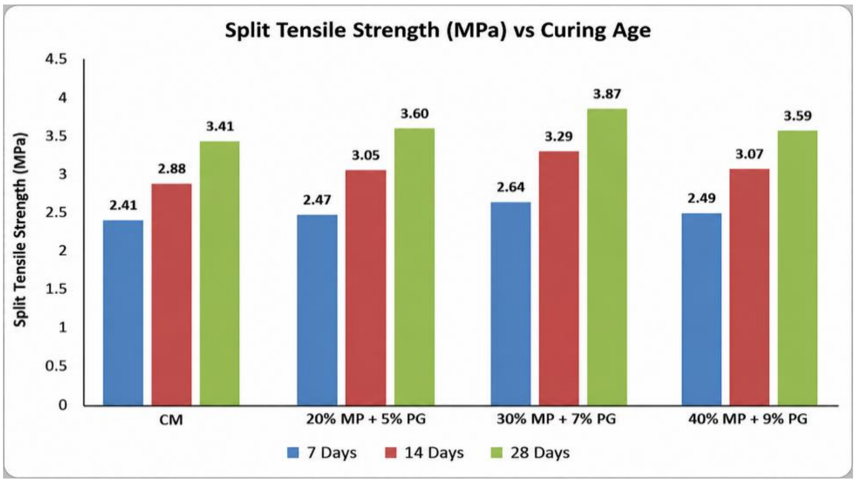
Impact Factor 8.066 ⁒ Peer-reviewed & Refereed journal ⁒ Vol. 13, Issue 8, August 2026

DOI: 10.17148/IARJSET.2026.13809



Split Tensile Strength Test Results

Mix ID	7 Days Strength (MPa)	Failure Load (kN)	14 Days Strength (MPa)	Failure Load (kN)	28 Days Strength (MPa)	Failure Load (kN)	Average Strength (MPa)
M1	2.62	185	3.18	225	3.82	270	3.21
M2	2.66	188	3.23	228	3.87	274	3.25
M3	2.60	184	3.15	223	3.79	268	3.18
M4	2.78	196	3.42	242	4.08	289	3.43
M5	2.84	201	3.48	246	4.16	294	3.49
M6	2.80	198	3.45	244	4.11	291	3.45
M7	2.54	180	3.08	218	3.70	262	3.11
M8	2.57	182	3.12	221	3.75	265	3.15
M9	2.51	178	3.04	215	3.66	259	3.07



6.CONCLUSION

The present study investigated the strength characteristics of M30 grade concrete by partially replacing natural coarse aggregate with marble pieces and natural fine aggregate with plastic granules. The experimental results demonstrated that both compressive strength and split tensile strength increased with curing age for all concrete mixes.

Among the various replacement levels studied, the mix containing 30% Marble Pieces (MP) and **7%** Plastic Granules (PG) exhibited the best overall performance, achieving the highest compressive and split tensile strengths. The improved performance is attributed to better particle packing, reduced voids, and enhanced bonding within the concrete matrix.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 8, August 2026

DOI: 10.17148/IARJSET.2026.13809

However, higher replacement levels of 40% MP and 9% PG resulted in a reduction in strength due to weaker aggregate-paste bonding and increased void content.

The study confirms that marble waste and plastic waste can be effectively utilized in concrete as partial replacements for natural aggregates without significantly affecting its mechanical properties. Their incorporation not only conserves natural resources but also provides an environmentally sustainable solution for waste management.

Therefore, it can be concluded that 30% replacement of coarse aggregate with marble pieces and 7% replacement of fine aggregate with plastic granules is the optimum combination for producing sustainable concrete with satisfactory strength and durability characteristics.

REFERENCES

[1]. **Bureau of Indian Standards. (2019).** *IS 10262:2019: Concrete Mix Proportioning — Guidelines (Second Revision).* Bureau of Indian Standards, New Delhi.
BIS – IS 10262:2019

[2]. **Bureau of Indian Standards. (2016).** *IS 383:2016: Coarse and Fine Aggregate for Concrete — Specification (Third Revision).* Bureau of Indian Standards, New Delhi.
BIS – IS 383:2016

[3]. **Singh et al.** *Experimental Study on Concrete with Partial Replacement of Coarse Aggregate by Waste Marble Aggregate.*

[4]. Batayneh, M., Marie, I., and Asi, I., "Use of Selected Waste Materials in Concrete Mixes," *Waste Management*, Vol. 27, 2007, pp. 1870–1876.

[5]. Saikia, N., and de Brito, J., "Use of Plastic Waste as Aggregate in Cement Mortar and Concrete Preparation: A Review," *Construction and Building Materials*, Vol. 34, 2012.

[6]. Ismail, Z.Z., and Al-Hashmi, E.A., "Use of Waste Plastic in Concrete Mixture as Aggregate Replacement," *Waste Management*, Vol. 28, 2008.

[7]. **Patel, P. & Patel, et al.** *Experimental Study on Concrete Using Marble Coarse Aggregate and Plastic Fine Aggregate.*