International Journal of Applied Engineering & Technology

ANALYSIS OF DEVELOPMENT OF SEMI-REPLACEMENT OF CONCRETE THROUGH THE WASTE MATERIALS

Seeram Pulipati Rithesh[1] and Dr. Prashant S. Lanjewar[2]
[1]Research Scholar and [2]Research Guide, Department of Civil Engineering, Faculty of Engineering, Dr. A. P. J. Abdul Kalam University, Indore, MP, India
[1]ritheshseeram91@gmail.com and [2]pslanjewar@yahoo.com

ABSTRACT
Concrete, a vital building material, incurs significant costs in its production due to the use of materials like fine aggregate, coarse aggregate, and cement, alongside substantial energy consumption. Moreover, concrete production contributes to greenhouse gas emissions, prompting exploration into the feasibility of utilizing waste materials as substitutes for conventional concrete components. By replacing portions of concrete with waste materials, energy savings and positive environmental impacts can be achieved. Given the global scale of concrete usage—exceeding 4.2 billion tons in 2018—coupled with its CO2 emissions, finding alternatives becomes imperative. Redirecting industrial waste from landfills to concrete production not only mitigates environmental harm but also presents a financially sound solution. This research aims to identify suitable waste materials that can effectively replace concrete components, considering both mechanical and chemical properties to ensure the integrity of the resulting concrete structures.

Keywords: Semi- Replacement of Concrete, Waste Materials, Granite Powder, Marble Dust, Concrete Tile Waste.

1. INTRODUCTION
Concrete, a staple material in construction, faces challenges in meeting strength and durability requirements, especially in rapidly developing regions where traditional resources are scarce due to industrialization and urbanization. Despite the abundance of waste materials, such as pottery and polypropylene strands, produced annually, much of it remains underutilized in the concrete industry. This not only contributes to environmental degradation but also hinders cost-effective and sustainable construction practices. The utilization of waste materials, including concrete debris and industrial byproducts like fly ash, presents an opportunity to mitigate environmental harm while reducing costs and conserving natural resources. Moreover, the adoption of alternative materials in concrete production, as outlined in standards like IS 10262:2009, offers a practical approach to reducing CO_2 emissions without compromising structural integrity, thereby addressing both environmental and economic concerns.

Efforts to integrate waste materials into concrete production require advancements in crushing and blending technologies to ensure compatibility and optimize material properties. By enhancing the micro-structure and strength properties of concrete, these innovative approaches contribute to both environmental sustainability and material durability. However, achieving a balance between custom-fit qualities of waste materials and conventional concrete necessitates a profound understanding of material science. Through systematic research and development, including the exploration of unconventional waste materials like concrete tile residue, granite powder, and marble dust, the construction industry can pave the way for more economical and environmentally friendly building practices while addressing pressing ecological challenges.

2. DATA COLLECTION

2.1.1 Marble Dust
Marble is a stone that undergoes transformation due to the alteration of pure limestone. The marble's virtue accounts for its color and appearance: it is white if the limestone is entirely composed of calcite (100 percent $CACO_3$). Marble is used in construction and design because it is sturdy, has a respectable appearance, and is consequently widely used. Due to the ongoing consumption of quarry totals, development materials are becoming

more determined by their natural characteristics. Due to a lack of innovation and additionally illegal methods of marble quarrying, India produces a significant amount of waste marble. The marble cutting plants cycle and mineral industries produce a significant volume of powder. The result is that the stone sector handles 68 million tones of material annually. The large unattended bulk of marble trash, which contains incredibly small particles, is currently a global ecological problem. Finding a safe removal method for this kind of waste or a proper use for it is really important. The investigation offers an environmentally friendly solution for using leftover marble and aids in preserving our ecological system. We show how it is possible to use marble dust in place of some of the concrete while making concrete.

2.1.2 Granite Powder

A typical molten rock with a granular surface is granite. Depending on their composition, granites can typically be white, pink, or black in color. It contains between 20% and 60% by volume of quartz and about 35% by weight of feldspar. Granite is typically enormous, extremely hard, and extreme. Because of these characteristics, granite has served as a versatile building material throughout human history. In mainland covering than in marine outside, they are more common. A critical component of concrete is fine aggregate. Regular stream sand and M sand are the two most often used types of fine total. Sand is used extensively in the production of concrete, and in some non-industrialized countries, the stockpile of regular sand has recently been under pressure to fulfill the expanding demands of infrastructure improvement. A factor which may contribute to an increase in the price of concrete and sand. One of the ingredients used to make traditional concrete in India was stream sand, but it was expensive and in low supply. However, the industry's waste granite has accumulated over time. Only a small portion was really used, and the remainder was dishonestly dumped, which led to pollution problems. The need for a feasible use for this trash is necessary due to the enormous growth in the amount of waste that needs to be removed, severe lack of locations for unloading, and significant growth in the cost of transportation and unloading. The current research aims to develop concrete that uses granite powder, an industrial byproduct, as a replacement for fine aggregate. Thus, the objective of lowering the cost of development can be achieved, and it will also help in resolving problems associated with its removal, such as local environmental difficulties.

2.1.3 Concrete Tile Waste

A tile is a little object that is often rectangular or square in shape. One of the most well-known types of materials used in homes nowadays is concrete tile. Sand, everyday objects, and muds are the main ingredients of these concrete tiles. Strong garbage is growing gradually as more and more developments are torn down in the modern development globe. Concrete tiles are being used to great effect in current construction projects, which is continuing and steadily growing. Concrete products are essential for the basic construction materials used in many projects. Wall tiles, floor tiles, clean products, family concretes, and specialized concretes are a few examples of commonly created concretes. Most of the time, they are given using common materials that are rich in soil minerals. However, despite the glamorous benefits of concrete, its waste, among other things, greatly disturbs the climate. Additionally, waste tile on the other side is being made from demolished construction trash. Each year, the concrete industry in India produces 100 million tonnes of tiles, with 15% to 30% of that amount being trash. Currently, this garbage is not recycled, yet concrete waste is strong, robust, and incredibly resistant to both natural and man-made corrupting forces. Therefore, in order to repurpose them and reduce the amount of heavy debris supplied from building teardowns, we chose these waste tiles as a replacement material for the basic normal total.

3. METHODOLOGY AND DATA ANALYSIS

3.1 Major Ingredients

3.1.1 Concrete Waste

Stoneware powder, categorically in powder forms, is the typical waste that is combined and sent into industry. The wastes are given as an unlucky side effect of the operation of dressing and cleansing. The trades of concrete waste materials take over significant land areas and spread throughout, ruining the trendy location that is renowned throughout the entire neighborhoods. Finding a purpose for manufactured stoneware trash is extremely challenging. Concrete can benefit from the addition of ceramic waste to increase quality and other durability aspects.

3.1.2 Cement

In this project, regular Portland cement was employed.

3.1.3 Fine Aggregate

The term "fine total" refers to pieces with a size between 4.75 mm and 150 m. According to the requirements, stream sand is utilised in a mix as fine total changing. To remove harmful elements and particles, the stream sand is cleaned.

3.1.4 Coarse Aggregate

These aggregates are produced by manually shattering the pebbles and assigning them on a regular basis.

4. RESULTS AND DISCUSSIONS

4.1 Results

4.1.1 Coarse Aggregate

1) Fineness Modulus = 6.436

2) Specific Gravity = 2.7

3) Water Absorption = 1%

4) Maximum Aggregate Size = 20mm

4.1.2 Fine Aggregate

1) Fineness Modulud = 2.71

2) Specific Gravity = 2.64

3) Water Absorption Percent = 1.5%

4) Free Surface Moisture = 2%

4.1.3 Cement

1) Initial Setting Time = 29 min

2) Final Setting Time = 595 min

3) Soundness = 7.64 mm

4) Fineness = 228.5 m2 /kg

4.1.4 Concrete's compressive strength seven days after employing concrete debris to replace the cement.

Table: 1: Compressive strength test results after seven days with cement that has been partially replaced with concrete waste

Replacement of cement in percent by concrete waste	Failure Load (KN)	Failure Load (KN)	Failure Load (KN)	Average Load	Compressive Strength (Mpa)
1	440.36	454.06	627.77	655.3	35.63
6	692.29	452.65	442.22	353.36	32.97
11	647.64	562.46	549.62	572.72	32.48
14	543.04	340.36	524.50	593.24	18.35

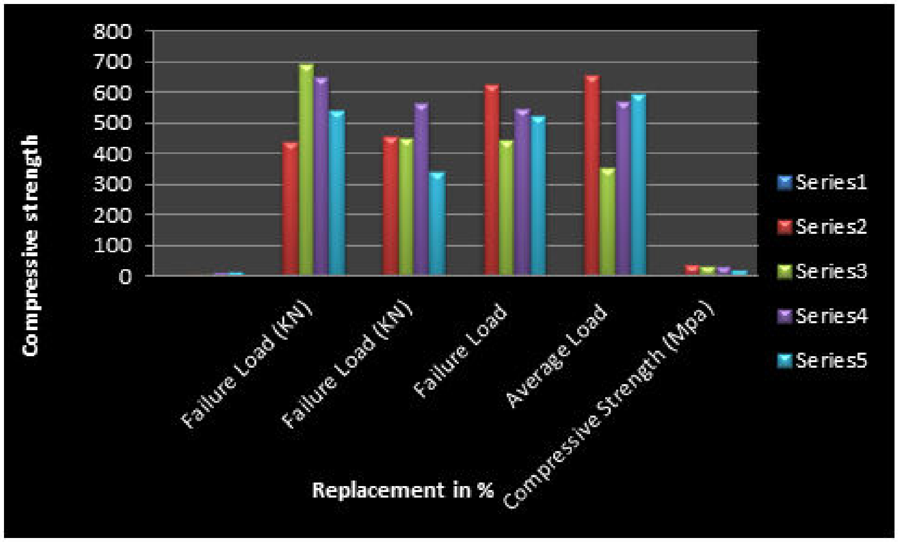

Figure: 1. Compressive Strength Chart for Replacement of Concrete Waste

4.1.5 Compressive Strength of cube after adding PPF for 7 days and replacing cement with concrete waste.

Table: 2. Results of a seven-day compression strength test with cement partially replaced by concrete debris and PPF added.

Replacement of cement in percent by concrete waste	Failure Load (KN)	Failure Load (KN)	Failure Load (KN)	Average Load	Compressive Strength (Mpa)
6	427.47	423.49	650.12	435.28	32.18
11	549.49	567.86	562.78	572.4	32.50
16	500.3	505.92	530.26	507.73	17.16

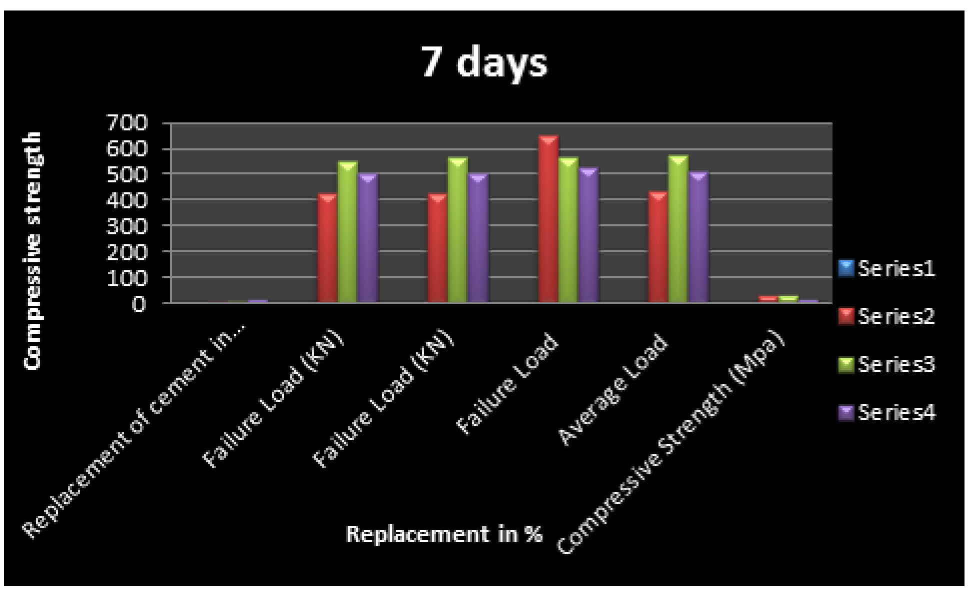

Figure: 2. Compressive Strength Chart for Using Concrete Waste in Place of Cement and Adding PPF

4.1.6 Concrete's compressive strength after 28 days with cement that has been partially replaced by concrete waste.

Table: 3. Compressive Strength Test Results following a 28-day period in which cement was replaced in part with concrete scrap

Replacement of cement in percent by concrete waste	Failure Load (KN)	Failure Load (KN)	Failure Load (KN)	Average Load	Compressive Strength (Mpa)
0	715.63	885.38	873.85	870.56	46.15
5	892.27	975.32	633.53	828.2	23.67
10	560.3	534.36	767.74	565.66	38.18
15	682.05	460.02	645.52	686.88	34.68

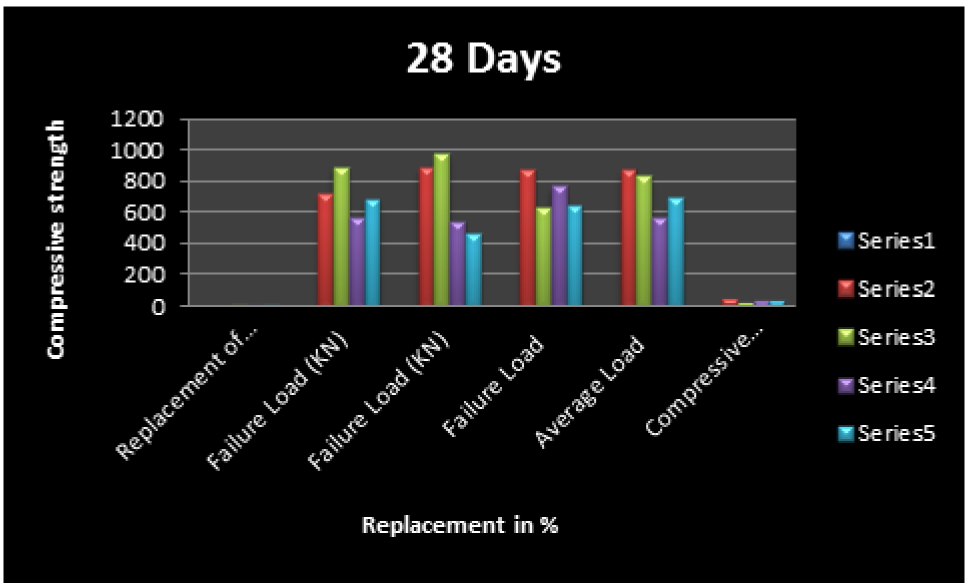

Figure: 3. Compressive Strength Chart for Concrete Waste in Place of Cement

4.1.7 Split tensile strength of concrete after seven days with partial replacement of cement and concrete waste.

Table: 4. Results of the Split Tensile Strength Test after Seven Days using Concrete Waste in Place of Cement

Replacement of CW (%)	Tensile Load (KN)	Tensile Load (KN)	Tensile Load (KN)	average tensile strength (Mpa)
0	3.40	3.65	3.6	3.36
5	3.48	3.42	3.52	3.55
10	3.35	3.43	3.33	3.36
15	3.30	3.22	3.08	3.15

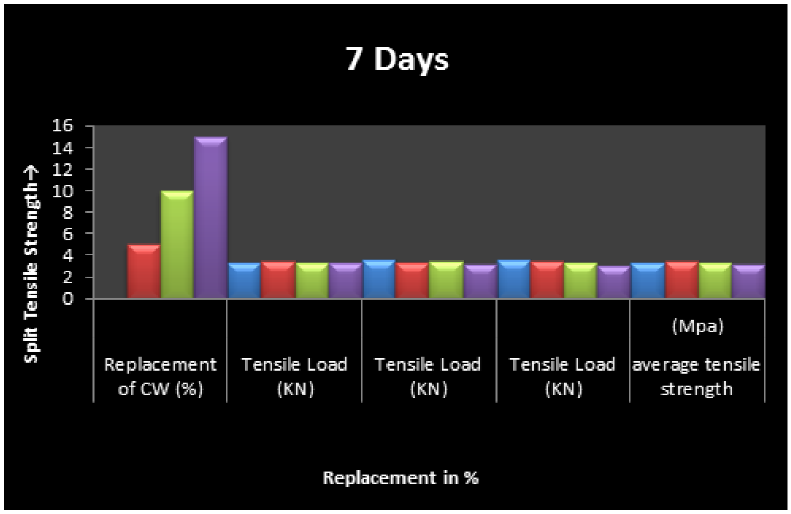

Figure: 4. Split Tensile Strength Graph for Concrete Waste in Place of Cement

4.2 DISCUSSION

- ❖ Concrete that has up to 10% of concrete waste replaced with it has superior compressive strength and flexibility.
- ❖ The strength of the concrete is reduced if concrete waste accounts for more than 10% of its replacement.
- ❖ In the porousness test, the penetrability of the concrete decreases as the amount of waste concrete increases.
- ❖ The strength will typically decrease after replacing 10% of the concrete waste with polypropylene while maintaining the same level of solidity.
- ❖ By employing concrete debris, you benefit the environment by reusing the waste that would otherwise be thrown off.

5. CONCLUSION

We currently live in a developing society that is clamoring for even more comforts and conveniences. Every industry is affected by these changes and upheavals, but instead of having a positive effect on the climate, resources are depleted and various natural sources are poisoned. We got to the conclusion after concentrating on each of these research articles that if we could reuse or minimise some materials in the industry of producing concrete, which is now booming, it would have a huge impact on the environment and contribute to a clean and serene atmosphere. Because of this, and as indicated in the writing survey above, we can look at replacing concrete, sand, and everything else to the best of our ability by recycling or offering waste material as a choice. Focusing on each of these research studies reveals that definite and beneficial outcomes are attained, given that additional research and study are conducted in this field.

We live in a developing world that yearns for even greater convenience and amenities. Every industry is affected by these changes and upheavals, but instead of having a positive effect on the climate, resources are depleted and various natural sources are poisoned. Concrete production can significantly affect the environment, resulting in a clean and serene atmosphere, by reducing or partially replacing raw materials with trash. Accordingly, the aforementioned writing audit's conclusion is that more study should be able to partially replace concrete up to its typically ideal level by using recycled or by giving waste material as an alternative. In addition to being more cost-effective than standard concrete, using locally accessible wastes as a partial replacement for concrete fixes may help ease the problem of offloading waste produced by various enterprises. The end result should be conservative, environmentally friendly concrete that has every desirable feature and strength that can be achieved with traditional concrete repairs.

6. REFERENCES

1. Agil. R, A. Kumar (2017) "Experimental study on replacement of cement with concrete tile powder in concrete" International Journal for Research in Applied Science & Engineering Technology, IC Value: 45.98; SJ Impact Factor: 6.887 Volume 5 Issue X.
2. Amit Kumar D. Raval, Dr. Indrajit N. Patel and Prof. Jayesh Kumar Pitroda (2013) "Concrete waste: Effective replacement of cement for establishing sustainable concrete". International Journal of Engineering Trends and Technology, Volume 4, Issue 6.
3. Divya S Dharan and Aswathy Lal (2016) "Study the effect of polypropylene fiber in concrete". International Research Journal of Engineering and Technology, volume: 03, Issue: 06.
4. Dr. M. Swaroopa Rani (2016) "A study on concrete waste powder". SSRG International Journal of Civil Engineering, Volume 3, Issue 7.
5. E. Tkaczewska, Effect of the super plasticizer type on the properties of the fly ash blended cement, Construction and Building Materials 70 (2014) 388–393.
6. F. Baeza, J. Paya, O. Galao, J.M. Saval, P. Garcés, Blending of industrial waste from different sources as partial substitution of Portland cement in pastes and mortars, Construction and Building Materials 66 (2014) 645–653.
7. Hardik Patel, Dr. N.K. Arora and Shraddha R. Vaniya (2015) "Use of concrete waste powder in cement concrete". International Journal for Innovative Research in Science & Technology, Volume 2, Issue 1, June 2015.
8. Khmiri, M. Chaabouni, B. Samet, Chemical behavior of ground waste glass when used as partial cement replacement in mortars, Construction and Building Materials 44 (2013) 74–80.
9. M.R. Karim, M.F.M. Zain, M. Jamil, F.C. Lai,Fabrication of a non-cement binder using slag, palm oil fuel ash and rice husk ash with sodium hydroxide, Construction and Building Materials 49 (2013) 894–902.
10. Mohamed Elchalakani, Tarekaly, Emadabu-Aisheh, Sustainable concrete with high volume GGBFS to build Masdar City in the UAE, Case Studies in Construction Materials 1 (2014) 10–24.
11. Mohammed Safidduin, Syed Mohsin, U. Bhavitha (2016) "Study of strength properties of polyester fibre reinforced concrete". Journal for Research, Volume 02, Issue 08.
12. Ms.Hemali K. Khaire and Dr. Vagheesha S. Mathda (2016) "Study of effects of polyester fiber on compressive strength of concrete". International journal for Research in Applied Science & Engineering Technology, Volume 4 Issue 1, ISSN: 2321-9653.
13. N.Venkata Ramana, U.Raghu Babu and E.Aruna Kanthi (2016) "Performance of polyester and polypropylene fibers in concrete". International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016.
14. Naidugari M K Rao, Ch. Vinodh Kumar, K. Bhanuji Rao, G. Himala Kumari (2017) "Experimental study on partial replacement of cement with polypropylene fiber and admixtures individually". International journal for Technology Research in Engineering, Volume 4, Issue 12.
15. O. Rodríguez, L. Kacimi A. López-Delgado, M. Frías, A. Guerrero, Characterization of Algerian reservoir sludges for use as active additions in cement: New pozzolans for eco-cement manufacture, Construction and Building Materials 40 (2013) 275–279.

16. Ramvilas Yadav, Gopal Routiya and Nitin Jethwani (2017) "Effective replacement of cement for establishing sustainable concrete using concrete waste". International Journal of advance Research in Science and Engineering, Volume No. 06, Special issue No. 02, Icittese-17.

17. Salahaldein Alsadey and Muhsen Salem (2016) "Influence of polypropylene fiber on strength of concrete". American Journal of Engineering Research, Volume-5, Issue-7, pp223-226.

18. Sonu Pal, M.K. Mishra and V. Pandey (2016) "Effects of surface treatment of polyester fibre on properties of concrete". International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 5.

19. Telma Ramos, Ana Mafalda Matos, Bruno Schmidt, João Rio, Joana Sousa-Coutinho, Granitic quarry sludge waste in mortar: Effect on strength and durability, Construction and Building Materials 47 (2013) 1001–1009.

20. Wen-Ten Kuo, Shyh-Haur Chen, Her-Yung Wang, Jhan-Cyue Lin,A study on the mechanical and electricity properties of cement mortar added with GGBFS and piezoelectric powder, Construction and Building Materials 49 (2013) 251–256.