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Investigative study on using granite waste in concrete paver blocks

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***Abstract*:** Interlocking Concrete paving blocks are widely used in India in various conditions where the conventional types are less durable due to various reasons, if they are planned properly and constructed according to standard, they can last for several years. The main objective of this work is to study the feasibility of granite waste produced in granite industry as a cement replacement in maximum percentage that is from 70% to 90% in the order 70%, 80% and 90% for concrete paver blocks. Initially chemical configuration of sample of granite waste is found in laboratory.M-30 grade concrete with water cement ratio 0.42 is chosen for this research. Various tests such as Compressive Strength Test and Flexural Strength Test, durability properties such as Water Absorption test, Abrasion resistance test are performed and the strength values are compared to conventional one and analysed for acceptance. From the experiment it has been found that compression strength of 70% replaced concrete is more compare to other replacement percentages and can be used for the places where traffic is less but strength is less than conventional and it decreases as the percentage increases. Same trend is followed by other strength parameters. Cost analysis is also done to know whether the experimental is economical, from the analysis we came to know that the cost has been reduced to almost 40% when compared to conventional and also cost goes on decreasing as the percentage of granite waste increases.

***Keywords*: Concrete paver blocks, Granite waste powder, Cement replacement, compression strength, cost analysis.**

1. Introduction

In the year 2018, India was the second largest cement producer and reached to 337.32 million tonnes production in 2018-2019, and demand of cement industry is expected to achieve 550-650 million tonnes per annum by 2025 if the trend continues the same. When it comes to highways, concrete develops and maintain a sustainable, environmental-friendly infrastructure, and hence they are used for various purposes i.e., new payments, reconstruction, resurfacing, restoration or rehabilitation, paver blocks in footpaths etc. Due to this concrete consumption throughout the world is increasing and hence the materials used to prepare concrete are getting deficient and costly hence

requires alternatives which can fully or partially replace concrete ingredients.

Interlocking concrete paver blocks are used in various conditions where the conventional types are less durable due to various reasons, the design of pavements is associated with traffic, foundations, materials, environmental conditions, sub grade soils, economics and construction details. Concrete paves blocks which are properly designed and constructed gives an excellent performance and can be applicable for all type of traffic conditions. Due to its demand and performance there is a need to reduce its cost by using locally available waste which is eco-friendly.

Granite waste is the waste produced in powder form from granite industry during cutting of granite. Processing and handling of granite in industry leads to the waste generation and are dumped into the arbitrary ways, the process such as cutting, processing, polishing and grinding generates different types of waste, and these wastes has accumulated over the years and only negligible amounts have been used, and other are dumped resulting in environmental problems

2.Literature Review

From the literature we can say that different wastes replacement in concrete paving blocks has shown good result, for example Mr K. Jagadeesh in 2015 showed that inclusion of rubber and recron fibres improves property like compressive strength. Also Upadhyay in 2015 showed that by including rubber tyre waste powder in concrete as substitute for sand can make concrete lighter in weight as well as shows high impact and abrasion resistance when compared to conventional one. And also Marshey in 2015 investigated marble slurry incorporation in concrete paving block as partial replacement of cement from where he found that 20% of marble improved the properties of

concrete paver block.

From the literature review it also evident that granite waste has shown a favourable result either it is replaced by cement or sand, for example Allam in 2014 showed that incorporation of granite slurry waste in green concrete improved properties of concrete. And Divakar in 2012 showed that granite fines can be effectively used as substitute for sand.

But from all these literature review it was observed that granite wastes have been replaced up to certain limit that is almost experiments have been done for up to 50% of cement replacement therefore there is need to study the properties of concrete paver blocks by using granite waste powder as binder up to maximum limit. Here in this systematic work study of concrete paving blocks, granite waste slurry has been used in proportions up to 90% in concrete to replace cement.

A. *Objectives of the study*

- To prepare concrete paves blocks of M30 grade containing granite waste as cement replacement partially that is 70%, 80% and 90%.
- To evaluate and compare mechanical properties that is compression strength, flexural strength, and water absorption and abrasion resistance of prepared paver blocks.
- To make cost analysis of concrete paver blocks with granite waste.

2. Materials and Methodology

A. Materials used

1) **Cement:** In this work we used cement of OPC 53 grade with uniform texture and grey in colour. And throughout the work we have used cement bags from same production unit and also cement we used was clean, dried and homogeneous without any mass blocks in it.

2) **Coarse aggregates:** Coarse aggregates are the stones with size larger than fine aggregates which are blended with each other in concrete mix. As it occupies more space which in turn reduces the amount of cement paste and also helps in deduction of shrinkage. In this study coarse aggregates are borrowed from place that is nearer for our working site as per IS: 383- 1970.

3) **Fine aggregate:** In this study we are using M-Sand to serve as fine aggregate. It is produced from gravel, slag, and crushed stone which is used as substitute to river sand, physical properties of M-Sand should be followed as in Indian Standard (IS: 2386 and IS: 383).

4) **Granite waste:** In this research the granite waste is collected from granite industry near Ramanagar. Which is in powder form with white colour and specific gravity of waste is 2.6

Fig 1: Sample of granite waste powder

5) **Chemical admixture:** Forsoc brown water reducing concrete admixture is used in this study.

B. METHODOLOGY

1) **Mix Proportion:** In this study, the mix design used is of M30 grade for conventional concrete prepared with the help of guidelines IS: 10262 (2009) and IS: 456 (2000) and based on this the mix proportion of concrete for 70% ,80% and 90% replacement of cement with granite waste is prepared that has the mandatory desired properties.

2) **Casting of concrete paver blocks:** Here in this study we are using the specimen of interlocking concrete paver block which is casted as per the mix design in metallic mould of I shape with area of specimen is 29125 mm^2 with 75mm of thickness.

Fig 2: Sample of concrete paver block after casted

3) **Curing:** In this research After 24 hours of concrete paver blocks are casted, all the prepared specimens were marked and kept for a period of 7 and 28 days inside water tank for the purpose of curing. Room temperature maintained throughout the curing period.

4) **Tests performed:**

i. Compression strength test: In this investigation, the specimens of concrete paver blocks prepared with different mix proportions are made to test for 7 days and 28 days as per IS 15658:2006.

Fig 3: Compression testing machine of concrete paver block

ii. **Flexural strength test:** It helps in determining tensile and modulus of rapture. For this the flexural strength of concrete was determined by using two point loading test as per IS 15658:2006.

iii. **Abrasion resistance test:** The ability of specimen to withstand the wearing that occurs due to contact of one surface with another surface is abrasion resistance, Abrasion resistance test were performed on the prepared specimens as per guide lines of IS: 1237 (2012).

iv. **Water absorption test:** this test is conducted after 28 days of curing as per IS: 1237(2012).

5) Cost analysis: here material cost analysis for various replacement percentages of granite waste as substitute to cement is done.

3. RESULTS AND DISCUSSION

The results of test conducted are shown in the tables below.

Table 1: Results of Compression strength test

Sl. No.	% of Granite waste	Compressive test in N/mm^2 (7 days)	Compressive test in N/mm^2 (28 days)
1	**0%**	24.96	41.6
2	**70%**	22.65	33.2
3	**80%**	20.25	29.15
4	**90%**	14.54	23.9

Table 2: Results of tests conducted on concrete paver blocks

Sl. No	% of Granite waste	Flexural strength in N/mm^2 (28 days)	Abrasion resistance test at 28 days(mm 3)	Water absorption at 28 days
1	**0%**	4.26	-	-
2	**70%**	2.9	19440	5.2
3	**80%**	2.6	24420	4.5
4	**90%**	2.1	28910	4.4

Table 3: Results of Cost analysis.

Description	Cost per 1m3 of production
Conventional concrete with 0% of granite waste	4445.5 Rs
Concrete with 70% of granite waste replaced to cement	2636.5 Rs
Concrete with 80% of granite waste replaced to cement	2378.1 Rs
Concrete with 90% of granite waste replaced to cement	2119.4 Rs

The above table shows the various properties with respect to various replacement levels of granite waste powder that is (0%, 70%, 80%, and 90%). On considering this we can obtain conclusions that are provided below.

4.CONCLUSION

1. From results it was noted that the compression strength goes on decreasing as the percentage of granite waste increases and we can say that concrete paver block with 70 % and 80 % of granite waste replacement can be used for non traffic places such as foot paths, embankment slopes, sand stabilization area and domestic drives as per standard IS 15658-2006 as their compression strength is more than 30 MPa.
2. Inclusion of granite waste decreases flexural strength.
3. The minimum volume loss was found at 70% replacement of granite waste to cement that is 19440mm^3 and the value

increases as the percentage of granite waste increases. Hence the specimens cannot be used in extreme exposure condition where the traffic movement is more as their volume loss is more than 15000mm^3.

4. For any concrete paver blocks the water absorption should be less than 6% and the maximum water absorption we have got is 5.2% for 70% replacement of granite waste to cement which is less than 6% and hence the specimens are under limit.
5. By replacing granite waste to cement in concrete paver blocks with replacement levels of 70%, 80% and 90% can reduce the material cost for more than 40%.
6. By using granite waste as substitute for binder will help to find solution for the disposal problem associated with granite waste material. Also modified concrete paving blocks with replacement of cement with granite waste will reduce the CO2 emission. Hence, Utilization of granite waste in concrete paving blocks at suitable place can produce good results.

5. SCOPE OF FUTURE STUDY

- Research may be conducted by testing other durability properties through tests such as chloride penetration test, sulphate attack testing, freezing and thawing etc.
- Study on improving flexural strength can be done by incorporating fibres.
- Use of different alternative materials for fine aggregate can be investigated and check for various properties.
- Various water cement ratios with different grades of concrete can be investigated and can be compared with this.

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