

# Experimental Investigation on Partial Replacement of Cement Use Only by Granite Powder and Addition of Coir Fiber as Admixture

Aravind A<sup>1</sup>, Sundari S<sup>2</sup>

P.G. Student, Department of Civil Engineering, Government College of Engineering, Salem, Tamil Nadu, India<sup>1</sup>

Associate Professor (CAS), Department of Civil Engineering, Government College of Engineering, Salem, Tamil Nadu, India<sup>2</sup>

**ABSTRACT:** The living planet earth has encountered global warming due to various issues. One of the main reasons is construction industries since the foremost component of concrete is cement, which has its own environmental problems. The cement industry is one of the prime producers of carbon-di- oxide. On other hand disposal of solid waste is a major problem. Granite powder industries produce the granite powder.

Therefore urgent changes are required relating to emissions, production and application of sustainable and eco-friendly materials. This led to concept of paver block in which cement replaced by granite powder in concrete. This paper aims to develop paver blocks using granite powder and coir fiber. Different mix proportions of 10%, 15%, 20%, are prepared using cement replaced by granite powder and 0.75 % of coir fiber maximum compressive strength and split tensile strength obtained from the percentage of granite powder and coir fiber and result taken from compare the conventional concrete paver block and maximum percentage replacement of granite powder and coir fiber. This project indicated that granite powder and coir fiber can be effectively used as cement replacement. The paver blocks developed are tested for their compressive, flexural strength test.

**KEYWORDS:** Coir fiber; concrete; granite powder; partial replacement of cement.

## I. INTRODUCTION

Concrete has been a leading construction material for over a century. Its annual global production is about 3.8 billion m<sup>3</sup> - roughly 1.5 tonnes per capita according to data obtained from Portland Cement Association. In the past few years, great emphasis was given on green concrete as it results in sustainable development. Green concrete is implied by application of industrial wastes to reduce consumption of natural resources, save energy and minimize pollution of the environment. Among the various varieties of solid industrial wastes generated the marble and granite wastes, have potentiality for utilisation in concrete. Granite waste is an industrial waste which is obtained from the granite polishing industry in a powder.

Indian Granite Stone Industry currently produces around 17.8 million tonnes of solid granite waste and out of which 12.2 million tonnes will be the rejects at the industrial sites, 5.2 million tonnes in the form of cuttings or trimmings and 0.4 million tonnes granite slurry at processing and polishing units.

Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. Marblestone industry generates both solid waste and stone slurry. Solid waste results from the rejects at the mine sites or at the processing units. Stone slurry is a semi-liquid substance consisting of particles originating from the sawing and the polishing processes and water used to cool and lubricate the sawing as well as polishing. The scientific and industrial community must commit towards more sustainable practices. There are several reuse and recycling solutions for this industrial by-product, both at an experimental phase and in practical applications. These industrial wastes are dumped in the nearby land and the natural fertility of the soil is spoiled. The reduction in waste generation by manufacturing value-added products from the granite stone waste will boost up the economy of the granite stone industry. The utilization of granite powder in high performance concrete could turn this waste material into a valuable resource with the added benefit of preserving environment.

The indiscriminate infrastructural growth is leading to rapid environmental degradation. Steel, cement, synthetic

polymers and metal alloys used for construction activities are energy intensive as well as cause environmental pollution during their entire life cycle. We have enough natural resources and we must keep on researching on these natural resources. Development of natural fiber composite has started to begin recently. Among the various natural fibers, bamboo fibers, coir fibers and jute fibers are of particular interest. These composites have high impact strength besides having moderate tensile and flexural properties and it can be regarded as an environment friendly material.

There has been growing interest in recent year in utilizing coir fiber as low cost building materials. Investigations are carried out on the use of coir fiber in cement paste, mortar and concrete. Incorporation of the fiber improves the ductility, flexural and tensile strengths, fracture roughness and crack inhibiting properties of the matrix. In this investigation the different size of short coir fiber is treated with natural rubber latex. The effect of fiber content, different fiber length, physical and mechanical properties of these composite have been analyzed.

## II. CONSTITUENT MATERIALS AND ITS PROPERTIES

**1. Cement:** Ordinary Portland cement 43 grade to B.I.S standards is used in the present investigations. Fineness test was conducted for cement and it was found to be 2.8% which conforms to IS 8122-1989.

**2. M-Sand:** The fine aggregate used for the experimental programme was locally available M-SAND and conformed to grading zone II as per IS:383-2016. The M-SAND was first sieved through 4.75mm sieve to remove any particles greater than 4.75mm and than washed to remove the dust.

**3. Coarse aggregate:** Locally available coarse aggregate having the maximum size 12.5mm were used in the present work. Testing of coarse aggregate was done as per IS: 383-2016. They was washed to remove dust and dirt and was dried to surface dry condition.

**4. Granite powder:** Granite is an igneous rock which is majorly used as a construction material in various forms. Granite powder obtained from cutting and polishing of granite is disposed in environment producing health hazards. The specific gravity of granite waste was 2.53 respectively and its size was less than 90 microns. The fineness modulus of granite waste was 2.43 respectively.

**5. Coir fiber:** Natural fibres can possibly be utilized as reinforcement in the concrete structures. In many countries, natural fibres are cheap and locally available. Natural fibres are sisal, jute, coir, bamboo, palm, cotton and sugarcane fibres. They are simple to handle and use because of their flexibility and low cost as compared to steel fibres. As a substitute to steel or artificial fibres, researchers have used natural fibres in composites such as cement paste, mortar and concretes. Among the natural fibres coir fibres is the toughest and capable of taking strains up to 4-6 times than other natural fibres. They are resistant to fungi, rot resistant, excellent insulation against sound and temperature, unaffected by moistness and wetness, tough and durable.



Fig No (1) Coir fiber



Fig No(2) Granite powder

## III. EXPERIMENTAL INVESTIGATION

The following tests were conducted on the M35 grade of concrete specimens are

**1. Compression test (conforming to IS 516):** The compressive strength testing machine (CTM) is used for the testing of specimen were kept on the plate and the loads were applied gradually. The ultimate load were observed. The is applied till the failure specimen occurs. The test are conducted over the specimens for various curing period. The sample observation for the specimen 100x100x100mm cube size. The result are tabulated for the each mix 3 specimen were tested at the age of 7, 14, 28 days respectively.

**2. Split tensile test (conforming to IS 5816-1999):** Split tensile strength test was conducted in compressive strength testing machine. The specimen size is 100mm diameter and 200mm height. The specimen is placed the specimen is placed in the machine in such a manner that the load is applied to the uppermost surface as cast in the mould. The axis

of the specimen is carefully aligned with the axis of the loading device. The load is increased until the specimen fails and the maximum load applied to the specimen during the test recorded. The appearance of the fractured faces of concrete and any unusual feature in the type of failure is noted. The results are tabulated for the each mix 3 cylinder specimens were tested at the age of 7, 14, 28 days respectively.



Fig.No (3)Compressive strength test



Fig.No (4) Split Tensile test

#### IV. OPTIMUM REPLACEMENT OF GRANITE POWDER AND COIR FIBER USING PAVERBLOCK

##### 1. COMPRESSION TEST

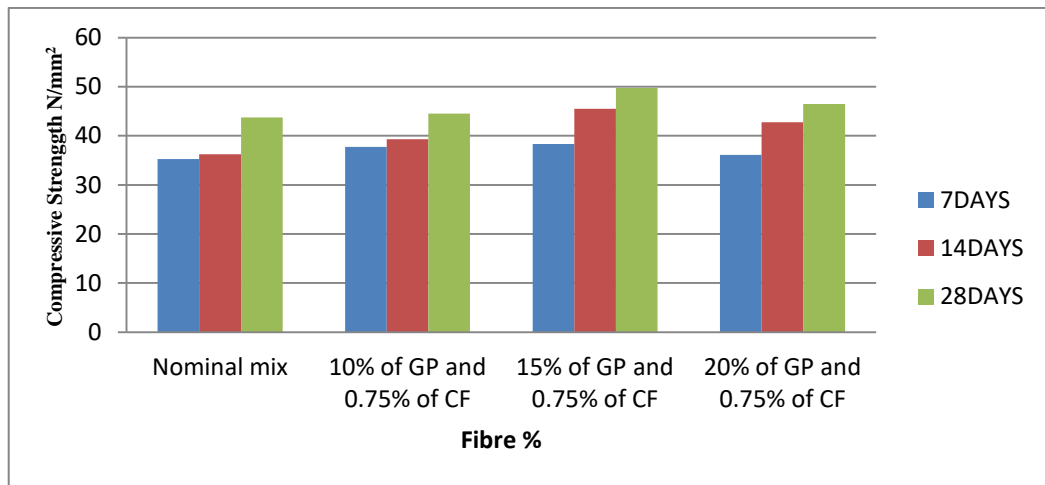


Fig No.5Compressive strengthtest at 3 days for various percentage of granite powder and fibre fraction

Compression strength at 3 days for variouspercentage of granite powder and fibre fraction shows 3days compression strength of M35 grade of concrete specimen with different percentage in granite powder and fibre fraction and compare to conventional concrete at M35 drade of concrete. First chart M35 grade of concrete at 7 days curing strength 35.25Mpa, 14 days curing strength 36.25Mpa, 28 curing strength 43.75Mpa. From the chart it can be clearly seen that granite powder and fibre fraction of 10% of granite powder and 0.75% of coir fiber showed the compressive strength of 37.75Mpa 7 days curing strength and 14days curing strength 39.30Mpa and 28 days curing strength 44.5 Mpa and then 15% of granite powder and 0.75% of coir fiber fraction 7 days curing strength 38.30 Mpa, 14 days curing strength 45.50 Mpa, 28 days curing strength 49.76Mpaand then 20% of granite powder and 0.75% of coir fiber fraction 7 days curing strength 36.13Mpa, 14 days curing strength 42.75 Mpa, 28 days curing strength 46.50 Mpa.

##### 2. Split Tensile test

Shows 3days split tensile strength of M35 grade of concrete specimen with different percentage in granite powder and fibre fraction and compare to conventional concrete at M35 drade of concrete. First chart M35 grade of concrete at 7 days curing strength 3.00Mpa, 14 days curing strength 4.15Mpa, 28 curing strength 5.32Mpa. From the chart it can

be clearly seen that granite powder and fibre fraction of 10% of granite powder and 0.75% of coir fiber showed the split tensile strength of 3.76Mpa, 7 days curing strength and 14days curing strength 4.80Mpa and 28 days curing strength 5.52Mpa and 15% of granite powder and 0.75% of coir fiber fraction 7 days curing strength 4.10Mpa, 14 days curing strength 5.00Mpa, 28 days curing strength 5.72Mpa and then 20% of granite powder and 0.75% of coir fiber fraction 7 days curing strength 4.0Mpa, 14 days curing strength 4.80Mpa, 28 days curing strength 5.40Mpa.

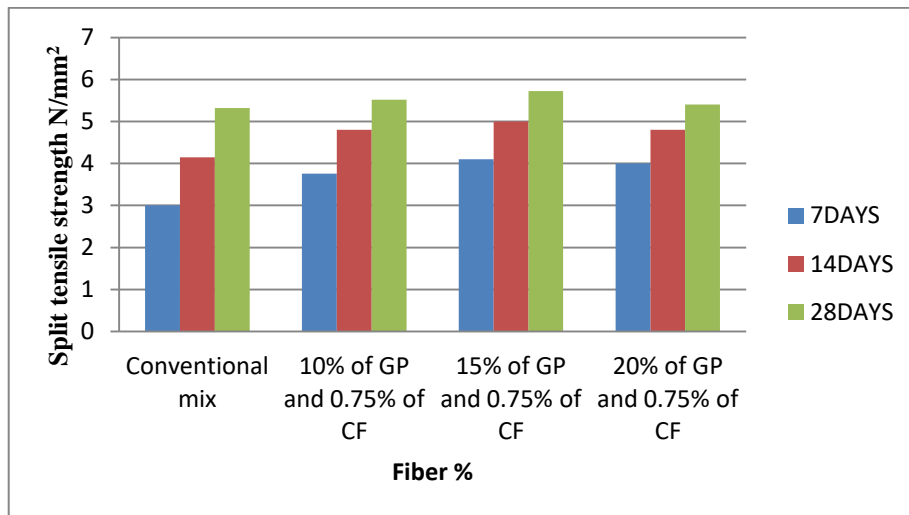


Fig.6 Split tensile strength at 3 days for various percentage of granite powder and fibre fraction

### OPTIMUM REPLACEMENT OF GRANITE POWDER AND COIR FIBER BY USING PAVER BLOCK

#### Optimum percentage result taken from paver block casting M35 grade of concrete

- It was observed that the compressive strength M35 grade of concrete is increased from 10% to 15% and decrease from 20% replacement of granite waste powder 0.75% of coir fiber.
- It was observed that the split tensile strength M35 grade of concrete is increased from 10% to 15% and decrease from 20% replacement of granite waste powder 0.75% of coir fiber.
- The maximum replacement level of granite powder is 15% and 0.75% of coir fiber for M35 grade of concrete by using paver block.

### V.PAVER BLOCK

#### INTRODUCTION

Interlocking Concrete Block has been presented in India in development, 10 years prior, for particular requirement to be specific footpaths and parking areas and so on. Presently Interlocking Concrete Block Pavement is received broadly in various uses where the traditional development of pavement utilizing hot bituminous blend (for flexible pavement) or cement concrete (for rigid pavement) is not desirable or attractive.

Strength properties of paver blocks comprising of granite waste powder is presented in 15%. Coconut fibers were added in proportions of 0.75% in volume of concrete.

Coconut fiber is extracted from the outer shell of a coconut. It is the natural fiber of the coconut husk where it is a thick and coarse but durable fiber. Coir fiber of length 3 cm is used.

1. Type of specimen ( I-Dumbled )
2. Casting of specimen
3. Curing of specimen



4. Testing of specimen

1. SIZE OF SPECIMEN

Length = 230mm  
Breath = 180mm  
Depth = 65mm



Fig.No(7) I-DUMBLE SPECIMEN

2.CASTING OF SPECIMEN



Fig.No(8) I- Dumble specimen



Fig.No(9)preparation of concrete



Fig.No(10) casting of specimen

### 3. CURING OF SPECIMEN



Fig.No(11) M-35 Grade of concrete



Fig.No(12) 15% of GP and 0.75% CF



Fig.No(13) Curing of specimen



Fig.No(14) curing of specimen

Casting of specimen at after 24 hours in demoulding of specimen and curing that specimen curing tank.

### 4. TESTING OF SPECIMEN

#### Compressive strength test on paver block

230x180x65 mm sized specimens were used for compressive strength test of concrete. A total of 2 concrete mixes were made, one corresponding to conventional concrete and one others with 15% of granite powder and 0.75% coir fiber. The total mixing time was 5 minutes the specimen were compacted by placing in vibrating machine and then leveled. After 24 hours they were demoulded and then placed for curing, until the day of test.



Fig.No(15) Compressive strength test



Fig.No(16) Crack developed at specimen

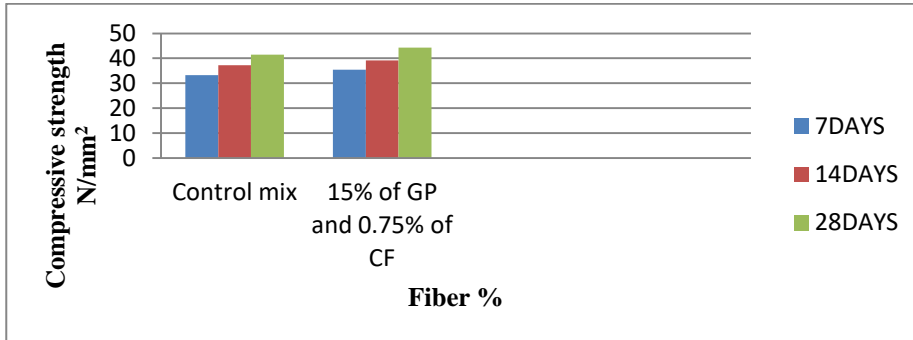


Fig.No(17)Compressive strength test compare to control and 15% of GP and 0.75% CF

First chart M35 grade of concrete at 7 days curing strength 33.25Mpa, 14 days curing strength 37.25Mpa, 28 curing strength 41.50Mpa. From the chart it can be clearly seen that granite powder and fibre fraction of 15% of granite powder and 0.75% of coir fiber showed the compressive strength of 35.45Mpa 7 days curing strength and 14days curing strength 39.20Mpa and 28 days curing strength 44.25Mpa.

**Flexural strength test on paver block**

230x180x65mm sized specimens were used for flexural strength test of concrete. A total of 2 concrete mixes were made, one corresponding to conventional concrete and one others with 15% of granite powder and 0.75% coir fiber. The total mixing time was 5 minutes the specimen were compacted by placing in vibrating machine and then leveled. After 24 hours they were demoulded and then placed for curing, until the day of test.



Fig.No(18)Flexural strength test



Fig.No(19)crack developed at specimen

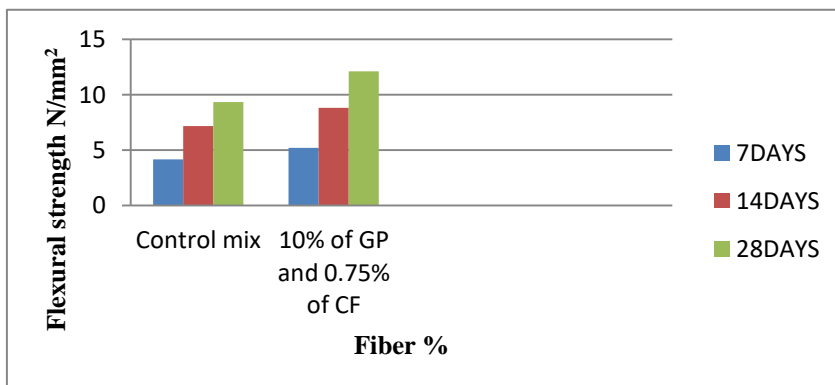


Fig.No(20)Flexural strength test on compare to conventional and 15% of GP and 0.75% of CF



First chart M35 grade of concrete at 7 days curing strength 4.15Mpa, 14 days curing strength 7.15Mpa, 28 curing strength 9.32Mpa. From the chart it can be clearly seen that granite powder and fibre fraction 15% of granite powder and 0.75% of coir fiber showed the compressive strength of 5.20Mpa 7 days curing strength and 14 days curing strength 8.80Mpa and 28 days curing strength 12.10Mpa.

#### . VI. CONCLUSION

From the above mentioned experimental investigation following conclusions has been determined

- Cement replacement up to 20% with granite waste powder and addition of coir fiber 0.75% leads to increase in compressive strength, for M35 grade of concrete. From 20% there is a decrease in compressive strength for 7, 14, 28 days curing period.
- It was observed that the compressive strength M35 grade of concrete is increased from 10% to 15% and decrease from 20% replacement of granite waste powder 0.75% of coir fiber.
- Cement replacement up to 20% with granite waste powder and addition of coir fiber 0.75% leads to increase in split tensile strength, for M35 grade of concrete. From 20% there is a decrease in split tensile strength for 7, 14, 28 days curing period.
- It was observed that the split tensile strength M35 grade of concrete is increased from 10% to 15% and decrease from 20% replacement of granite waste powder 0.75% of coir fiber.
- The maximum replacement level of granite powder is 15% and 0.75% of coir fiber for M35 grade of concrete paver block casting and testing.
- Compressive strength of paver block mix 15% replacement of granite powder and 0.75% addition of coir fibre by weight of cement is greater than conventional paver block. Maximum compressive strength was obtained for 44.25N/mm<sup>2</sup> (15% granite powder by weight of cement and 0.75% coir fibre by weight of cement). Conventional concrete paver block compressive strength 41.50N/mm<sup>2</sup>.
- The flexural strength obtained for the tested paver blocks is greater than the conventional paver block. Maximum flexural strength was obtained for 12.10N/mm<sup>2</sup> (15% granite powder by weight of cement and 0.75% coir fiber by wt of cement). Conventional concrete paver block flexural strength at maximum 9.32N/mm<sup>2</sup>.
- The use of granite powder in concrete to help in reduction environmental pollution.

#### REFERENCES

1. Ritesh Mall, Sharda Shrama and R.D. Patel (2014) "Studies of the Properties of Paver Block using Fly Ash" IJSRD - International Journal for Scientific Research & Development, Vol. 2, Issue 10.
2. Som Nath Sachdeva, Vanita Aggarwal, S. M. Gupta (2014) "High Volume Fly Ash Concrete for Paver Blocks" International Journal of Civil, Architectural, Structural and Construction Engineering, Vol: 8 No: 3.
3. Rama Mohan Rao, P. Sudarsana Rao, H. and Sekar, S. K. (2010) "Effect of Glass Fibers on Fly ash Based Concrete" International journal of civil and structural engineering Volume 1, No 3.
4. V. M. Sounthararajan and A. Sivakumar (2013) "Reinforcing efficiency of glass fibers in low volume class F fly ash concrete" JCECT Vol. 4(6), pp. 184-191.
5. G. Navya, J. Venkateswara Rao. (2014) "Experimental Investigation on Properties Concrete Paver Block with the Inclusion of Natural Fibers" IJERA, ISSN: 2248-9622, Vol. 4, Issue 8 (Version 6), pp. 34-38.
6. G. Navya, J. Venkateswara Rao. (2014) "Influences of polyester fiber on concrete paver blocks" IOSR, ISSN: 2278-1684 Volume 11, Issue
7. IS 516-1959, "Indian Standard code of Practice Method of Test For Strength of concrete", India Standard Institute 1959. IS 1199-1959, "India Standard Method of Sampling And Analysis", India standard Institute, New Delhi 1959.
8. IS 383-1963, "Indian Standard Specification For Coarse And Fine Aggregates From Nature Source For Concrete", Pg 9-11.
9. IS 2385-1963 Part 3 "Method of Test of Aggregate For Concrete Specific gravity density, voids, absorption And Bulking, Indian Standard Institution", New Delhi = 1963
10. "Bhandari. P.S", "Tajne. K.M", "Use of waste glass in cement mortar". international journal of civil and structural engineering, Volume 3, No 4, 2013
11. "C. Meyer, N. Egosi and C. Andela", (2001) "Concrete with Waste Glass as Aggregate". International Symposium Concrete Technology Unit of ASCE
12. "M. Iqbal Malik, Muzafar Bashir, Sajad Ahmad, Tabish Tariq, Umar Chowdhary", Study of Concrete





- Involving Use of Waste Glass as Partial Replacement of Fine Aggregates, Vol. 3, Issue 7 (July. 2013), V6/ PP 08- 13.
13. “ R. C. Yeole<sup>1</sup>, Dr. M. B.Varma<sup>2</sup>”, Comparison of Mix Designs of Paver Blocks using Waste Rounded Steel Aggregates and Rubber Pad, IJETAE (Volume 4, Issue 10, October 2014)
  14. “Shayan and A. Xu”, “Value added utilization of waste glass in concrete”, Cement and Concrete Research, vol-34, pp.81-89, Jan. 2004.
  15. “Sunny O. Nwaubani<sup>1</sup> and Konstantinos I. Poutos<sup>2</sup>”, The Influence of Waste Glass Powder Fineness on the Properties of Cement Mortars, IJAIEM, Volume 2, Issue 2, February 2013.
  16. “Tomas U. Ganiron Jr”, Use of Recycled Glass Bottles as Fine Aggregates in Concrete Mixture, Vol. 61, (2013).