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EXPERIMENTAL ANALYSIS OF ABRASION RESISTANCE IN PAVER BLOCKS WITH NANO-PARTICLE ADDITIVE

Ms.S.Bharathi[1], Mr.S.Manikandan[2]
[1] *Assistant professor,CivilEngineering,Sethu Institute of Technology,Kariapatti*
[2] *Final Year M.E Student, Department of Structural Engineering, Sethu Institute of Technology ,Kariapatti*
Corresponding Author Orcid ID : https://orcid.org/0000-0002-8096-6045

ABSTRACT
The abrasion resistance of paver blocks containing nano-particles for pavement is experimentally studied. Both nano-TiO2 and nano-SiO2 are, respectively, employed to be as the additives. For comparison, the abrasion resistance of plain paver block and the paverblock containing polypropylene (PP) fibers is also experimentally studied in this work. The test results indicate that the abrasion resistance of concretes containing nano-particles andPP fibers is significantly improved. However, the indices of abrasion resistance of paver block containing nano-particles are much larger than that of paver block containing PP fibers. The abrasion resistance of paver block containing nano-TiO2 is better than that containing the same amount of nano-SiO2. The enhanced extent of the abrasion resistanceof paver block decreases with increasing content of nano-particles. Finally, the relationship between the indices of abrasion resistance and compressive strength of concrete, water absorption test will find out.
Keywords—Cylinder block, Nano-TiO_2, design, analysis

1. Introduction

The history of Concrete Paving Block dates back to 19th Century when paving stones were used in European countries for construction of roads serving as footpaths and tracks for steel-wheeled vehicles. Concrete Block Pavement (ICBP), an environment friendly and labor-intensive technology, has been developed at CRRI, for providing pavements in areas where conventional types of construction are less durable due to many technical and environmental constraints. Concrete paver blocks were first introduced in Holland in the fifties as replacement of paver bricks which had become scarce due to the post-war building construction boom. These blocks were rectangular in shape and had more or less the same size as the bricks. A concrete mix of 40 (cement: sand: stone chips) by volume may be used for cement concrete paving blocks with water to cement ratio of 0.60. The concrete mix should not be richer than 1:6 by volume of cement to combined aggregates before mixing. Fineness modules of combined aggregates should be in the range of 3.6 to 4.0. All the raw materials are placed in a concrete mixer is rotated for 15 minutes. Till now Indian standard has not given any specification on cement concrete paving blocks.
However, the specification laid down in IS 2185 (Part1) specification for concrete masonry units: Part 1 for Hollow and solid concrete blocks, may be used as general guidelines for meeting the quality parameters. Quality parameters like actual proportion of the individual raw materials, ratio of coarse aggregates to fine aggregates, water to cement ratio, good finish, accuracy in size and shape, and compression strength after curing are the some of the important parameters that should be checked periodically to ensure good quality of the product. Concrete pavers act as a zipper in the

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pavement. When the need arises to make underground repair, interlocking concrete pavement can be removed and replaced using the same materials. Unlike asphalt or poured-in- place concrete, paving blocks can be opened and closed without jack hammers and with less construction equipment. The process of reusing the same paving units is called reinstatement. Location of the block in the production process could play an important role, and should be controlled in future experiments.

2. Experimental Methods or Methodology

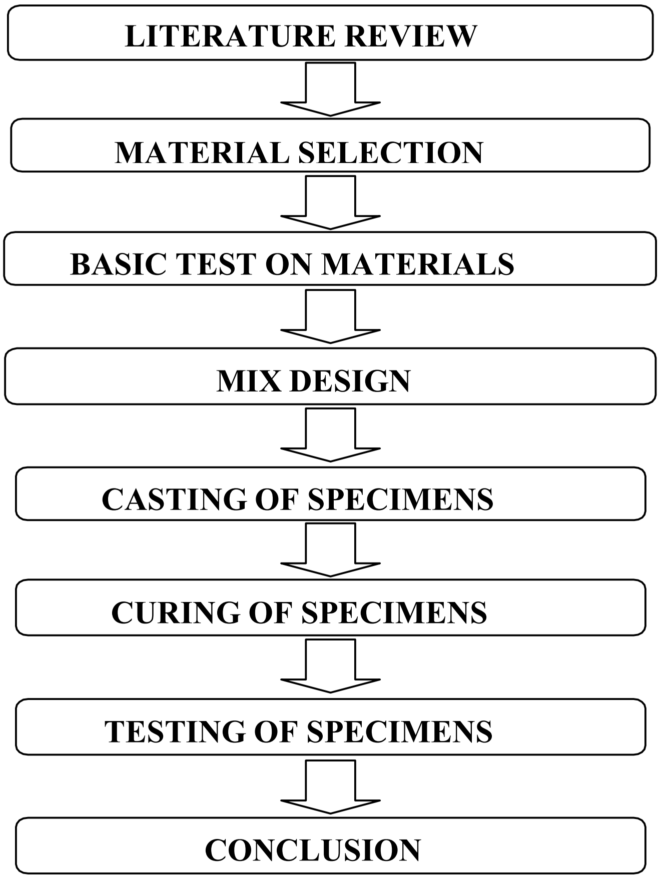

Fig 2.1 Methodology

2.1 Material selection

Cement a key to infrastructure industry and is used for various purposes and also made in many compositions for a wide variety of uses Cements may be named after the principal constituents, after the intended purpose, after the object to which they are applied or after their characteristic properties. Cement used in construction are sometimes named after their commonly reported place of origin, such as Roman cement, or for their resemblance to other materials, such as Portland cement, which produces a concrete resembling the Portland stone used for building in Britain. The term cement is derived from the Latin word Cacmentum, which is meant stone chippings such as used in Roman mortar not-the binding material itself Cement, in the general some of the word, described as a material with adhesive and cohesive properties, which make it capable of bonding mineral fragments in to a compact whole. The first step of reintroduction of cement after decline of the Roman Empire was in about 1790,when an Englishman, J. Smeaton, found that when lime containing a certain amount of clay was burnt, it would set under water. This cement resembled that

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which had been made by the Romans. Further investigations by J. Parker in the same decade led to the commercial production of natural hydraulic cement.

Fig 2.2 Cement

2.2 Water

Water is a key ingredient in the manufacture of concrete. Water used in concrete mixes has two functions: the first is to react chemically with the cement, which will finally set and harden, and the second function is to lubricate all other materials and make the concrete workable. Although it is an important ingredient of concrete, it has little to do with the quality of concrete. One of the most common causes of poor- quality concrete is the use of too much mixing water. Fundamentally "the strength of concrete is governed by the nature of the weight of water to the weight of cement in a mix, provided that it is plastic and workable, fully compacted, and adequately cured".

2.3 Aggregate

Aggregates were first considered to simply be filler for concrete to reduce the amount of cement required. However, it is now known that the type of aggregate used for concrete can have considerable effects on the plastic and hardened state properties of concrete, they can form 80% of the concrete mix so their properties are crucial to the properties of concrete. Aggregates can be broadly classified intofour different categories: these are heavyweight, normal weight light weight and ultra-lightweight aggregates. However, in most concrete practices only normal weight and lightweight aggregates are used. The other types of aggregates are for specialist use such as nuclear radiation shielding provided by beach concrete.Classification of aggregates of good quality concrete, is to obtain. The alternative used in the manufacture the aggregate in at least two size groups, i.e.Fine aggregate often called sand not larger than 5mm in size. Coarse aggregate, which comprises material at least 5mm in size:

On the other hand, there are some properties possessed by the aggregate but absent in the parent rock: particle shape and size, surface texture, and absorption. All these properties have a considerable influence on the quality of the concrete, either in fresh or in the hardened state. It has been found that aggregate may appear to be unsatisfactory on some count but no trouble need be experienced when it is used in concrete.

2.4 Fine Aggregate

Fine aggregate or material passing through an IS sieve that is less than 4.75mmas a fine aggregate Locally available sand is gauge usually natural sand is used as fine aggregate that places where natural sand is not available crushed stone is used as fine aggregate in the conventional concrete. River sand zone II was used in this study. The various results of testing carried out for fine aggregate is provided in table. According to 383: 1970 the fine aggregate is being classified into four different zone, that is Zone-l. Zone-II, Zone- III, Zone- IV. There is no chemical formula for the sand. By default, sand formula treated as sio2, Sand is a mixture of multiple different minerals.

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sand has a variety of color depending on the location sand is a mixture of Silica (SiO2), Calcium Silicate (Casi04), Calcium Nitride (Ca3N2), Silicon Nitride (Si3N4), Aluminium Nitride (AIN3), Alumina (A1203). Borazone "Boron Nitride" (BN), Magnesium Oxide (Mgo), Silicon Oxysulfide (SiOS), Lithium Silicate (Li2Si04) and other oxides/nitrides of a multitude of metals.

Fig 2.3 Fine Aggregate

2.5 Coarse Aggregate

The shape and particle size distribution of the aggregate is very important as if affects the packing and voids content, water absorption, grading and variation in fines content of all aggregate should be closely and continuously monitored order to produce constant quality. Coarse aggregate of maximum size 20mm was used in this experimental study.

2.6 Nano Silica Fume:

Silica fume is also known as micro silica. It is an ultrafine powder collected as a byproduct of the silicon and ferrosilicon alloy production and consists of spherical particles of with an average particle diameter of 150nm. The main field of application is as pozzolanic material for high performance concrete.

Fig 2.4 Nano Silica Fume:

2.7 **Metakaolin:**

Metakaolin is a dehydroxylated form of the clay mineral kalonite.Metakaolin is commonly used in the production of ceramics,but is also used as cement replacement in concrete.Metakaloin has smaller particle size and higher surface area compared with Portland cement,but larger particle sizethan SF.

Fig 2.5 Metakaolin Powder

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3. Results and Discussion

3.1 COMPRESSION TEST

Apply the load increasingly at a rate of 140 kg/cm² per minute until the cube collapse. Note down the maximum load applied to the specimen and any other unusual activities at the time of failure.

Day	**Conventional concrete[MPa]**			**nS concrete[MPa]**		
	1	**2**	**3**	**5%**	**10%**	**15%**
7	10.5	11.31	12.33	20.8	22.5	21.67
14	16.78	16.93	17.11	26.54	27.6	25.45
28	27.33	27.9	27.66	37.45	40.45	38.33

Table 3.1 Comparative compression test

3.2 SPLIT TENSILE STRENGTH TEST ON CYLINDER

The bearing surfaces of the supporting and loading rollers shall be wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers. Record the maximum applied load indicated by the testing machine at failure. Note the type of failure and appearance of fracture.

Day	**Conventional concrete[MPa]**			**nS concrete[MPa]**		
	1	**2**	**3**	**05%**	**10%**	**15%**
7	0.93	0.98	1.01	1.9	2.40	2.25
14	1.18	1.36	1.38	2.30	2.75	2.43
28	1.97	2.12	2.33	2.85	3.18	3.09

Table 3.2: Comparative split Tensile Test:

3.3 WATER ABSORPTION TEST

For water absorption test, the specimen was weighed before and after immersion in water for predetermined duration of time. Water absorption was then determined as the difference in the weight of the specimen before and after immersion in water relative to the weight of specimen before immersion in water, expressed in percentage

Duration	**Conventional Concrete**	**%increase**	**nS concrete**	**% increase**
0	8.310	0	8.614	0
30 min	8.320	0.12	8.619	0.06
60 min	8.330	0.24	8.619	0.06
1 day	8.344	0.40	8.623	0.10
2 days	8.347	0.44	8.624	0.11
3 days	8.348	0.45	8.625	0.12

Table 3.3 Comparative Water absorption Test:

CONCLUSION

Depending upon certain considerations, a suitable interlocking block has been designed. Interlocking blocks were cast successfully as per the code 2185:2005 (part 1).
Optimum value of cement by silica fume replacement was found as 20% through trials. Block density and water absorption tests were satisfactory.
Compressive strength of interlocking block was found greater than that of ordinary clay block .
Because of the pattern of interlock, it provides better matrix strengthening, wall stability, disallows movements and reduces mortar.
Therefore, the interlocking block masonry can be adopted as a suitable substitute for traditional masonry. And in conclusion, interlocking masonry can be recommended for housing projects as an alternative method that is cheaper than the conventional.

References

1. Bharathi S “Strengthening and Crack Prevention of Conventional Rc Structure by Retrofitting Technique” International Research Journal on Advanced Engineering Hub (IRJAEH).
2. Bharathi S“An experimental investigation on utilisation of red soil as replacement of fine aggregate in concrete” Psychology And Education 58 (2), 8398-8403.
3. Bharathi S “Feasibility Study on Utilization of Red Soil as Replacement of Fine Aggregate in Concrete” International Journal of Creative Research Thoughts 6, pp 149-156.
4. Bharathi S “Stabilization of Black Cotton Soil Using Polypropylene Fibre” International Journal of Creative Research Thoughts 6, pp 805-815.
5. Patel Abhiyan S. , RathodHirenA. Neeraj SharmaD.3,2013, An Overview on Application of Nanotechnology in Construction Industry, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue11,6094- 6098, ISSN: 2319-8753
6. Aaduolar, 2011, nano materials and nanotechnologies for civil engineering, construcţii. Arhitectură, 109-117
7. Yazdani, Vinoth Mohanam, 2014, Carbon Nano-Tube and Nano-Fiber in Cement Mortar: Effect of Dosage Rate and Water-Cement Ratio, International Journal of Material Science, Volume 4 Issue 2, 45-52
8. Somnath Ganguli, Vikas Julius Ganesh, P. Shenick Jain, Manoj Nallanathel, S.Needhidasan, 2015, Nanotechnology in Civil Engineering Present Scenario with Practical Application, INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH, volume -4 issue -5, 3-7, ISSN No 2277 – 8179
9. Surinder Mann, 2006, Nanotechnology and Construction, EuropeanNanotechnology Gateway, 1-55
10. A.A. Maghsoudi, and F. ArabpourDahooei, 2009, application of Nanotechnology in self compacting concrete design.
11. B. B. Das and ArkadeepMitra, 2014,Nanomaterials for ConstructionEngineering-A Review, International Journal of Materials, Mechanics andManufacturing, volume-2 No-1,41-46
12. B. Karthikeyan ,G.Dhinakaran ,2014, Effect of Grinding on Physico- MechanicalProperties of Ultra-Fine Micro-Silica, Asian Journal of Applied Sciences,182-193 , ISSN 1996-3343
13. Saloma, AmrinsyahNasution, Iswandi Imran and Mikrajuddin Abdullah, 2013,Mechanics Properties of nano-silica material concrete, International Journal of Engineering & sciences
14. Syed Sabihuddin, 2014, Application of Nanotechnology in Civil Infrastructure,Int. Journal of Engineering Research and Applications, Vol. 4, Issue 3(Version1), 92-95, ISSN: 2248-9622.