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# An Experimental Investigation of Partial Replacement of Cement with Metakaolin and Coarse Aggregates with Construction and Demolition Waste in Concrete Pavements

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**A B S T R A C T**

Global production of construction and demolition waste has significantly increased over the last few decades, causing environmental problems due to its uncontrolled disposal. The use of recycled materials has been on the rise during the same period, primarily for the purpose of sustainable development and protecting the environment. Construction waste management (CWM) has become a major environmental concern in most of the Indian municipalities. The aim of this project is analyzing the mechanical performance of concrete with recycled aggregates (RA) from construction and demolition waste (CDW) from various locations in Puttaparthi. The cement is also replaced with metakaolin. First the characteristics of the various aggregates (natural and recycled) used in the production of concrete were thoroughly analyzed. The coarse aggregate partially replaced with recycled aggregates in the percentage of 10%,15%,20% and cement replaced with metakaolin in the percentage of 5%,10%,15%. The composition of the RA was determined and several physical tests(specific gravity, water absorption) of the aggregates were performed. In order to evaluate the mechanical performance of concrete, compressive strength (in pavement blocks) were performed. The analysis of the mechanical performance allowed concluding that the use of RA were seen, most of the properties tested, especially when coarse RA are used. In this research pavement blocks were made with water cement ratio of 0.5 by using of M20 grade of concrete. The pavement blocks are taken of size 250 mm x 125mm x 90 mm. The main purpose of this research study was to observe the properties of concrete blended with replacement of construction and demolition waste.

***Keywords***: C&D Waste, Metakaolin, Compressive strength.

## 1. Introduction

### CURRENT SCENARIO OF CDW IN INDIA

Construction waste management (CWM) has become a major environmental concern in most of the Indian municipalities as the CW generated in India is 150 MT and accounts for 35%–40% of the global C & D waste annually. Currently in India the development alternatives projected a massive amount of 750 million tones of C&D waste generation annually. From materials flow analysis, that the generation of C&D waste in India could range between 112 and 431 million tones. CSE (Center for Science and Environment)estimated that, India recycles just 1% of its C & D waste that is being generated.

### C&D WASTE GENERATION AND IT'S SOURCES

CDW is generated whenever a building, road, bridge, industrial structure or a manufacturing facility is constructed, repaired or rehabilitation or demolished. Majority of RCA material comes from building renovations and demolition. The construction and demolition is a continuous process, which seemingly will continue forever. The world needs to address a judicious management of the solid waste that it generates from construction and demolition processes.

## 2. LITERATURE REVIEW

**Ms.Medina et al. (2014)** had studied on analysing the viability of producing 30 MPa concrete using coarse RA from CDW with a high content of asphalt and floating matter. They found that the use of 50% of these RA caused a 28-day compressive strength loss up to 18%.

**Mr.Poon et al. (2007)** had studied the influence of the replacement of coarse NA with coarse RA on the mechanical strength. They used RA from CDW from a recycling plant and produced concrete mixes with 10%, 20%, 50%, 80% and 100% replacement ratios, keeping the w/c ratio constant. They found that full replacement of the coarse NA led to compressive strength losses of 24%, 16%, 19% and 10% at 3, 7, 28 and 90 days.

**Mr.Kou et al. (2004)** had studied on concrete with coarse RA from CDW, at 0%, 20%, 50% and 100% of the overall mass of the coarse NA. They analysed the concrete compressive strength at 7, 28 and 90 days and, for full replacement, obtained losses of 33%, 37% and 31%.He also evaluated the 28- and 90-day modulus of elasticity of concrete with coarse RA from CDW at 0%, 20%, 50% and 100% of the overall mass of the coarse aggregates. For full replacement of the coarse NA they obtained losses of 40% and 28% at 28 and 91 days.

**Mr.Barra (1996)** had found that concrete with coarse RA from concrete need greater cement content to reach the compressive strength of a conventional concrete. For mixes with strengths of 45 MPa and 57.5 MPa, increases of 7.2% and 17.3% of the cement content were necessary.

## 3. OBJECTIVES

- To collect the CDW material from Puttaparthi
- To collect the raw materials of project like cement , metakolin , fine aggregate & coarse aggregate
- To recycle the construction and demolition waste into aggregate
- To Study the feasibility of using recycled aggregate from Construction & Demolition Waste (CDW) in concrete paves blocks to reduce consumption of natural resources
- To analyze the physical properties of recycled CDW aggregate such as specific gravity, water absorption test.
- To determine the durability properties of concrete blocks such as compression strength.

## 4. METHODOLOGY

### A. Materials

The following materials were used in our project.

- Cement
- Fine aggregate
- Coarse aggregate
- Water
- Metakaolin
- Construction and demolistion waste

**1.Cement**

A cement is a binder, a chemical substance used for construction that sets, hardens and adheres to other materials to bind them together opc 43 grade is a premium quality cement manufactured from world renowned narzi limestone Opc 43 grade cement shall conform to IS:812-1989 and the designed strength of 28 days shall be minium 43 Mpa or 430 kg/sqcm Even though 43 grade cements early strength is less as compared to that of 53 grade with time it will attain the same ultimate strength as that of 53 grade cement.

**2.Fine Aggregates (F.A)**

Fine aggregates used were available on site and are tested, the results are as per Indian Standards BIS: 383:1970. Use of fine aggregate improves the compressive strength of concrete. Use of fine aggregates provides better bonding or interlocking of both fine and coarseAggregates. The test conducted on fine aggregate are specific gravity, water absorption and Sieve analysis.

**3.Coarse Aggregates (C.A)**

The aggregates used were 20mm nominal maximum size and are tested as per Indian standards and the results are within permissible limits (BIS: 10262, BIS: 383). The aggregates used were locally available quarry in the region of beedupalli, puttaparthi. The test conducted on coarse aggregate are specific gravity, water absorption, flakiness index, elongation index, impact test and abrasion test.

**4.Metakaolin**

Metakaolin in concrete tend to reduce the size of pores which consequently lead to obtain more strength, higher density, and more resistance acid.Metakaolin is partially replaced with the cement in the percentage of 5%, 10%, 15%.

**5.C&D Waste**

The aggregates used were 20mm nominal maximum size and are tested as per Indian standards and the results are within permissible limits (BIS: 10262, BIS: 383). The aggregates used were locally available quarry in the region of beedupalli, puttaparthi. The test conducted on coarse aggregate are specific gravity, water absorption, flakiness index, elongation index, impact test and abrasion test.

**6.Water**

The Water required for curing and casting was being available on site and does satisfy as per IS456:2000 pH value of water used as 7.3.

## 5. RESULT AND DISCUSSION

**Table 4.1 : Cement Tests**

| S.NO | PROPERTIS | RESULT |
|---|---|---|
| 1. | Fineness of Cement | <10 |
| 2. | Standard Consistency of Cement | 26-38% |
| 3. | Initial Setting Time | >30 |
| | Final Setting Time | >600 |

**Table 4.2 : Fine Aggregate Tests**

| S.NO | PROPERTIS | RESULT |
|---|---|---|
| 1. | Specific gravity | 2.60 |
| 2. | Water absorption | 1.4% |

**Table 4.3 : Corase Aggregate Tests**

| S.NO | PROPERTIES | RESUTLS |
|---|---|---|
| 1. | Specific gravity | 2.63 |
| 2. | Water absorption | 0.5 % |

**Table 4.4 : Metakaolin Properties**

| S.NO | PROPERTIES | RESULT |
|---|---|---|
| 1. | Fineness | 6 % |
| 2. | Colour | White |
| 3. | Particle Shape | Powder form |

**Table 4.5: Compressive strength for 7 days of Replacement Pavement blocks**

| Mix | Experimental Trails | Metakaollin (%) | C&D waste (%) | Compressive strength(7 days) KN/mm2 | Conventonal pavements Compressive strength(7 days) KN/mm2 |
|---|---|---|---|---|---|
| Mix I | M1 | 5 | 10 | 25.64 | 15 KN/mm2 |
| | M2 | | 15 | 23.4 | |
| | M3 | | 20 | 22.43 | |
| Mix II | M4 | 10 | 10 | 24.12 | |
| | M5 | | 15 | 21.32 | |
| | M6 | | 20 | 18.58 | |
| Mix III | M7 | 15 | 10 | 14.42 | |

| | | | | | |
|---|---|---|---|---|---|
| | M8 | | 15 | 15.25 | |
| | M9 | | 20 | 12.98 | |

**Table 4.6: Compressive strength for 14 days of Replacement Pavement blocks**

| Mix | Experimental Trails | Metak aolin(%) | C&D waste (%) | Compressive strength(14 days) KN/mm2 | Conventonal pavements Compressive strength(14 days) KN/mm2 |
|---|---|---|---|---|---|
| Mix I | M1 | 5 | 10 | 30.44 | 19 KN/mm2 |
| | M2 | | 15 | 22.75 | |
| | M3 | | 20 | 25.32 | |
| Mix II | M4 | 10 | 10 | 25.64 | |
| | M5 | | 15 | 26.92 | |
| | M6 | | 20 | 19.23 | |
| Mix III | M7 | 15 | 10 | 15.06 | |
| | M8 | | 15 | 20.43 | |
| | M9 | | 20 | 18.76 | |

**Table 4.7: Compressive strength for 28 days of Replacement Pavement blocks**

| Mix | Experimental Trails | Metak aolin(%) | C&D waste (%) | Compressive strength(28 days) KN/mm2 | Conventonal pavements Compressive strength(28 days) KN/mm2 |
|---|---|---|---|---|---|
| Mix I | M1 | 5 | 10 | 27.24 | 22.4 KN/mm2 |
| | M2 | | 15 | 23.47 | |
| | M3 | | 20 | 24.32 | |
| Mix II | M4 | 10 | 10 | 23.4 | |
| | M5 | | 15 | 22.5 | |
| | M6 | | 20 | 20.3 | |
| Mix III | M7 | 15 | 10 | 19.34 | |
| | M8 | | 15 | 21.45 | |
| | M9 | | 20 | 19.42 | |

## 5. CONCLUSIONS

From the test results, the following conclusions can be drawn:

1)From the tests performed, it is observed that there is remarkable increment in the properties of concrete on replacement of cement by metakaolin and replacement of coarse aggregates with C&D waste .

2) When the metakaolin and C&D waste was added to concrete by replacing cement & coarse aggregate up to 20% in M20 concrete, it is found that there is considerable increase in workability and increase in compressive strength, when compared with plain cement concrete of M20 grade.

3) It can be concluded that the optimum amount of MK and C&D waste replacement for cement and coarse aggregate for M20 grade of Concrete is 5% of metakaolin and 10% of C&D waste.

4) When the cost comparison of plain cement concrete of M20 grade and concrete with 5%

of MK and 20% of C&D waste replacement of cement and coarse aggregate by MK and C&D, it is found that there is a significant reduction in cost for one cubic metre of concrete.

5) In the case of 15% MK observed that the compression strength is reduced.

## 6. REFERENCES

Evangelista, L., de Brito, J., 2010. Durability performance of concrete made with finerecycled concrete aggregates. Cem. Concr. Compos. 32 (1), 9e14.

Gomes, M., de Brito, J., 2009. Structural concrete with incorporation of coarserecycled concrete and ceramic aggregates: durability performance. Mater.Struct. 42 (5), 663e675.

Hansen, T., 1992. Recycling of Demolished Concrete and Masonry. E & FN SPON, RILEM report 6, London, United Kingdom, p. 305.

Kou, S., Poon, C., Chan, D., 2004. Properties of steam cured recycled aggregate fly ash concrete. Use of recycled materials in buildings and structures. In: International RILEM Conference, Barcelona, Spain, pp. 590e599.

LNEC E-397, 1993. Determination of Elasticity Modulus in Compression. National Laboratory of Civil Engineering (LNEC), Lisbon, Portugal (in Portuguese).

Matias, D., Brito, J. de, Rosa, A., Pedro, D., 2013. Mechanical properties of concrete produced with recycled coarse aggregates e influence of the use of superplasticizers. Constr. Build. Mater. 44, 101e109.

Medina, C., Frías, M., Sanchez de Rojas, M.I., 2012. Microstructure and properties of recycled concretes using ceramic sanitary ware industry waste as coarse aggregate. Constr. Build. Mater. 31, 112e118.

Medina, C., Rojas, M., Frías, M., 2013. Freeze-thaw durability of recycled concrete containing ceramic aggregate. J. Clean. Prod. 40, 151e160.

Mehta, P., Monteiro, P., 2006. Concrete: Microstructure, Properties and Materials, third ed. McGraw Hill, New York, United States of America.

Merlet, J., Pimienta, P., 1994. Mechanical and physic-chemical properties of concrete produced with coarse and fine recycled concrete aggregates. In: Demolition and Reuse of Concrete and Masonry, RILEM Proceedings 23, Odense, Denmark, pp. 343e353.

Neville, A., 1995. Properties of Concrete, fourth ed. United Kingdom, London, p. 844. NP EN 206e1, 2013. Concrete. Specification, Performance Production and Conformity. IPQ, Lisbon, Portugal.

Oliveira, M., Assis, C., Wanderley, A., 2004. Study on compressed stress, water absorption and modulus of elasticity of produced concrete made by recycled aggregate. In: Use of Recycled Materials in Buildings and Structures, International RILEM Conference, Barcelona, Spain, pp. 636e642.

Pacheco-Torgal, F., Jalali, S., 2010. Reusing ceramic wastes in concrete. Constr. Build. Mater. 24 (5), 832e838.

Park, S., Lee, B., Kim, J., 2004. Studies on mechanical properties of concrete containing waste glass aggregate. Cem. Concr. Res. 34 (12), 2181e2189.

Pereira, L., Jalali, S., Aguiar, J., 2004. Construction and demolition waste management. In: Workshop Integrated Management Systems for Specific Waste Streams, Lisbon, Portugal