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# Use Of Various Recycled Materials In Repairing In Rigid Pavement

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**Abstract:** Use of recycled materials in pavement construction as a filler material is an innovative step towards sustainable development. Waste or recycled materials like plastic, fly ash and recycled aggregates are used as components of concrete to produce a cementous material, which is used to fill road patches. With the evolution of the road industry and growing traffic on roads, construction materials have also been evolved. The scarcity of conventional natural materials and the jeopardized environment which have underpinned the tendency materials resources to be incorporated in the road industry. Several waste by-products and materials have been investigated, assessed, evaluated for utilizations, and practiced in the field. Depending on the attributes of the characteristics of the recycled material, the inclusion varies. Some recycled materials have been proven to possess preferable properties over the other and have performed satisfactorily in the field as a filler material.

**Keywords** : Concrete, potholes, repair work, recycled materials, plastic, fly ash, sustainable development

## 1. Introduction:

The purpose is to be addressing the ongoing problems of potholes in India. The reason that the potholes are such a problem is because of rapid weather change in India.

Potholes are holes in the roadway that vary in size and shape. They are caused by the expansion and contraction of ground water after the water has entered the ground under the pavement. As the weight of cars and trucks pass over the weak spot in the road, pieces of the roadway material weaken, which will cause the material to be displaced or broken down from the weight, creating the pothole. Potholes are such a big problem which can easily damage your vehicle and even they could harm the lives passengers.

Various efforts have been conducted by researchers to arrive at some alternatives that are able to significantly reduce high energy consumed and environmental impacts during fabrication process of cement, including implementing the concept of industrial ecology and green chemistry as well as nano-engineering for achieving higher performance.

The innovation solution to fix the problem is to repair the potholes with concrete having different waste or recycled material such as recycled material, plastic aggregate, and fly ash as a filler material in concrete design.

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing materials, water aggregate and sometimes admixtures in required proportions. Fresh concrete or plastic concrete is freshly mixed material which can be moulded into any shape hardens into a rock–like mass known as concrete. Concrete has high compressive strength and low tensile strength. To overcome this shortcoming, steel reinforcements are used along with the concrete. This type of concrete is called reinforced cement concrete (RCC). When waste or recycled materials are added to this concrete, it is called green concrete. In other words when the materials of concrete contain one or more waste products, it is called Green Concrete. It is an innovative step towards sustainable development as concrete now-a-days is one of the most used manmade resources.

## 2. Literature Review:

Number of research papers and case studies were analysed for the selection of waste materials which can be used in concrete practice. Several waste by-products and materials have been investigated, assessed, evaluated for utilizations, and practiced in the field. Depending on the attributes of the characteristics of the recycled material, the inclusion varies. Some recycled materials have been proven to possess preferable properties over the other and have performed satisfactorily in the field as a filler material.

**Materials:**

**Cement:**

Cement, one of the most important building materials, is a binding agent that sets and hardens to adhere to building units. Here OPC 53 grade cement (satisfying the requirements of IS : 12269) is used for this project.

| | | | |
|---|---|---|---|
| 1 | Cement | Grade & Brand | Grade 53 |
| 2 | | Specific Gravity | 3.15 |
| 3 | | Standard consistency | 34% |
| 4 | | Initial setting time | 80 minutes |
| 5 | | Final setting time | 480 minutes |
| 6 | | Bulk density | 1431 Kg/Cum |


**Fig. 1 - Portland Cement**

**Fine Aggregate:**

Fine aggregates are small size filler materials in construction. River sand confirmed to zone-II as fine aggregates (satisfying the requirements of IS : 383) are used.

| | | | |
|---|---|---|---|
| 1 | Fine Aggregates | Natural river sand | Zone-II |
| 2 | | Bulk density | 1750 Kg/Cum |
| 3 | | Water absorption | 1 % |

**Fig. 2 – Natural River Sand**

**Coarse Aggregate:**

Coarse aggregates are larger size filler materials in construction. Here, granite stones as a coarse aggregates of max size 12mm (satisfying the requirements of IS : 383) are used.

| | | | |
|---|---|---|---|
| 1 | Coarse Aggregates | Natural aggregates | Granite |
| 2 | | Bulk density | 1730 Kg/Cum |
| 3 | | Water absorption | 0.7 % |

**Fig. 3 – Natural Aggregates**

**Fly ash:**

Various tests were done to find out the physical and chemical properties of fly ash which is illustrated in table below.

| Parameters | Observed value | Permissible value as per IS ; 3812 - 2003 |
|---|---|---|
| Specific surface area | 340-360 $m^2$/Kg | >250 $m^2$/kg |
| Particle retained on 45 micron sieve | 28.9% | <35% |
| Compressive strength at 28 days | 44-48 N/$mm^2$ | >39-43 N/$mm^2$ |
| Soundness | 0.014 to 0.0018% | <8% |
| Silica + alumina + iron oxide content | 88-91% | >70% |
| Silica | 58 – 60% | 35% |
| Sulfur as $SO_3$ | 0.26 – 0.32% | <0.3% |
| MgO | 0.26 – 0.34% | <0.5% |
| Loss on ignition | 0.9 – 1.05% | <1.5% |
| Available Alkalies as $Na_2O$ | 0.16 – 2% | 1.5% |

**Fig. 4 – Fly ash**

**Handmade Plastic Aggregates:**

Different types of plastic (hard plastic, water bottles, polythene, etc.) which was disposed in the environment as a waste were collected, cleaned to removed dust and dirt, further cut to smaller size, then it has been carried to burning flame of approximately 600ºC . Care was taken such that plastic would reach melting point. When the plastic is taken towards burning flame, the molten plastic was passed through a sieve of required size, directly into water for cooling and hardening.

**Fig. 5 – Plastic Aggregates**

**Recycled Aggregates:**

Recycled aggregates consist of crushed, graded inorganic particles obtained from the materials that have been used in constructions. Recycled aggregates were obtained from nearby roads and bridges which were demolished.

**Fig. 6 – Recycled Aggregates**

**Mix Design:**

Depending upon the waste material, various mix designs of different proportions were calculated according to IS methods. The mix designs prepared were:

Concrete having Plastic aggregates (10% of Course aggregate)
Concrete having Plastic aggregates (20% of Course aggregate)
Concrete having Recycled Concrete aggregates (10% of Course aggregate)
Concrete having Recycled Concrete aggregates (20% of Course aggregate)
Concrete having Fly ash (20% of Cement content)
Concrete having Fly ash (25% of Cement content)

## 3. Laboratory Testing:

Various tests were performed related to road and transportation technology. Some of the most important tests were:

Field tests of cement
Cement soundness test
Aggregate abrasion value test
Aggregate impact value test
Aggregate crushing value test

## 4. Test Results:

**Aggregate**

| Test | Values | I.S. Requirements |
|---|---|---|
| Impact Value Test | 28.6 % | 30% |
| Crushing Value Test | 26.4 % | 30% |
| Los Angeles Abrasion value Test | 29.2 % | 30% |

Fig. 7 - Impact Testing Machine

Fig. 8 - Compressive Testing Machine

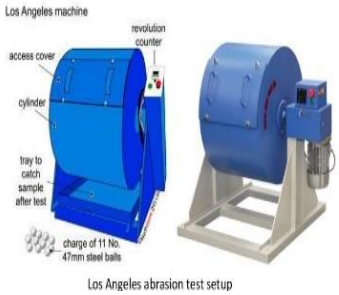


Fig. 9 - Los Angles Abrasion Testing Machine

**Concrete with Plastic Aggregate**

| % Replaced | Strength after 28 days(in N/mm²) |
|---|---|
| 10 % | 41.29 |
| 20 % | 43.06 |

**Concrete with Recycled Aggregate**

| % Replaced | Strength after 28 days(in N/mm²) |
|---|---|
| 10 % | 42.89 |
| 20 % | 40.75 |

**Concrete with Fly-ash**

| % Replaced | Strength after 28 days(in N/mm²) |
|---|---|
| 20 % | 39.97 |
| 25 % | 42.16 |

## 5. Conclusion:

The test results for compressive test of concrete with plastic aggregates results as 41.29 N/mm2 and 43.06 N/mm2 for 10 % and 20 % of Plastic aggregate content respectively.

For concrete with recycled aggregates the strength for 10% Recycled aggregate content is 42.89 N/mm2 and for 20% recycled aggregate content is 40.75 N/mm2.

Lastly, on replacing 20% cement with fly ash, the strength after 28 days is 39.97 N/mm2 and on replacing 25%, the strength after 28 days is 42.16 N/mm2.

The cost of concrete production is also reduced significantly. And in case of plastic aggregates, density of concrete is also reduced. Therefore, with the research above, we can conclude that,

Recycled aggregates are cheaper than the naturally mined aggregates

Fly ash is cheaper than Cement,

Plastic aggregates are light in weight than natural coarse aggregate.

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