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Roller Compacted Concrete for M30

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ABSTRACT:
Roller compacted concrete for paving is a construction technique that uses zero-slump concrete. This type of concrete is transported, placed, distributed and finally compacted using heavy road-construction equipments. In conventional concrete construction, a minimum quantity of free water is needed for a specified workability that reaches the strength and durability of the concrete. However, in Roller compacted concrete works, the free water content is determined by the field condition. The conditions on the field usually depend on parameters such as the ease of compaction, the process, and the ability of the concrete paste to support the vibrating roller without collapsing or bearing any imprint. Roller compacted concrete for pavements is placed without form, finishing, or surface texturing. Therefore, large quantities of RCC can be placed with minimum cost, compared with conventional concrete. RCC for pavements is stronger and therefore is more durable that asphalt pavements as for mixing, placing and curing both types of concrete is either hot or cold climates, shares the same types of concerns. Therefore, the techniques for handling them under extreme weather are almost the same. However, for RCC, because of the less number of construction joints and therefore large surface area, the care needed and precision procedures involved may be greater. The advantages of Roller compacted concrete techniques over conventional concrete include the lower cost, increased durability with minimum maintenance, and speed of construction.

INTRODUCTION:
Roller compacted concrete is a special blend of concrete that has essentially the same ingredients as conventional concrete but in different ratios, and increasingly with partial substitution of fly ash for Portland cement. Roller compacted concrete is a mixture of cement / fly ash, water sand aggregate or common additives, but contains much less water. The produced mix is drier and essentially has no slump. Roller compacted concrete is placed in a manner similar to paving; the material is delivered by dump trucks or conveyors, spread by small bulldozers or specially modified asphalt pavers and then compacted by vibration rollers. Roller compacted concrete is placed in layers thin enough to allow complete compaction. The optimum layer thickness ranges from 20 to 30 cm. To ensure adequate bonding between the new & old layer are at cold joint, segregation must be prevented and a high plasticity bedding mix must be used at the start of the placement. A compressive strength of above 7 Mpa to 30 Mpa have been obtained.

HISTORICAL DEVELOPMENT:
In the World RCC technique been used to constructed many Dams, in the year

-1985-26% dams in RCC.
-2007-50% dams in RCC.

World achievements over 400 dams constructed with Roller compacted concrete

- Asia- 46.6%
- South & Central America- 16.1%
- Europe - 10.7%
- Africa - 9.4%
- Indian subcontinent - 3.6%

The first RCC dam was taken up during 1978 and completed during 1980 in Japan. A no. of other dams quickly followed. By the end of 1985, seven RCC dams have been completed, and this method of construction technology has been accepted. In the next seven years (1992) the no. of dams constructed by this techniques rose to 96 in 17 different countries mainly in usa, Japan, Spain etc. In the 1960s, a high-production, no-slump mixture that could be spread with bulldozers was used at Alep Geri Dam in Italy (Gentile, 1964) and at Manicouagan I in Canada (Wallingford, 1970). A similar process was used as late as the 1980s at Burdek in Falls Dam in Australia. These mixtures were almost RCC, but they were consolidated with groups of large internal vibrators mounted on backhoes or bulldozers, a procedure that is currently used at times with conventional low-slump mass concrete—for example, at the Tekeze Arch Dam in Ethiopia. "Concrete generally has a higher initial cost than asphalt but lasts longer and has lower maintenance costs". In some cases, however, design or construction errors or poorly selected materials have considerably reduced pavement life. It is therefore important for pavement engineers to understand materials selection, mixture proportioning, design and detailing, drainage, construction techniques, and pavement performance. It is also important to understand the theoretical framework underlying commonly used design procedures, and to know the limits of applicability of the procedures.

ENGINEERING PROPERTIES:

The main engineering properties of the Roller compacted concrete are

- High flexural strength
- High compressive strength
- Modulus of elasticity
- High shear strength
- High density, low absorption
- Low water content
- Low water cement ratio
- Hard , durable, light coloured surface

Compressive Strength:

The relationship between water-cement ratio and compressive strength is the same for RCC as for conventional mass concrete.

Normally, for durability reasons, the RCC mix will be designed to provide a minimum strength of 2,000 psi; however, for seismic reasons higher compressive strengths are often required to achieve the desired tensile and shear strength. The compressive strength at seismic strain rates will be 15 to 20 percent greater than that at the quasi-static rates used during laboratory testing (ACI Committee-439 1969); however, compressive strength is never the governing factor in seismic design.

RCC Limitations:

- RCC is poor in Aesthetics.
- It has Rougher Surface Texture.
- It Limits the speed of the traffic, traffic is allowed at low-speeds
- Travelling on RCC pavement makes to experience a bumpy ride.

RCC Applications:

RCC pavements used mainly in areas like

- Ports /heavy industry
- Light industrial access roads
- Airports
- Local & residential streets
- Arterial streets
- Shoulders/widening
- Base for Highways & inlays of Highways
- Fast-track, high-volume intersections

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WORKABILITY TESTS:

MATERIALS:

The constituent materials and their physical properties are given below.

Cement

Coarse aggregate

Fine aggregate

Fly ash

GGBS

Super Plasticizer

CASTED MEMBERS:

MIX DESIGN:

Work in designing the mix proportion for conventional and RCC consists of a material testing and boundary gradation. The aggregate sizes are almost identical in both cases, except that for RCC, the maximum size of the aggregate is generally smaller. Aggregate sizes in the RCC depend very much upon factors such as the lift's thickness, project requirements, and the cost involved. For conventional concrete mix design, having a specific W/C (water-cement ratio) and compressive strength for the 28-day age, along with the available mix-proportion charts and tables, would give a good estimate of the proportion in the designed mix. To achieve the required pavements for concrete, such as its compressive strength, the procedure may need some trial and error samples to be prepared in the laboratory for standardization. RCC mixtures are proportioned at low water-cement ratios, ranging from 0.2 to 0.4. The mixture of RCC must be dry enough to support the weight of a vibratory roller and wet enough to allow adequately uniform distribution of the concrete paste throughout the entire mass during the mixing and compaction process. As for the conventional concrete mix designs, many methods are available for the RCC mix design also. These methods are usually classified into the following two major groups -Mixture proportioning techniques for RCC to meet the special limits of consistency.

PLACING AND COMPACTION:

RCC PLACED AND COMPACTED

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Experimental work on various combinations of materials:

CODE	Combination of the Materials
FA-R	Partial Replacement of Cement with fly ash and River Sand as Fine Aggregate (20%, 40% and 60%)
GG-R	Partial Replacement of Cement with GGBS and River Sand as Fine Aggregate (10%, 20%, 30%, 40%, 50% and 60%)
SP-A	Addition of SP and River sand as Fine Aggregate (2.5 ml, 5 ml, 7.5 ml)

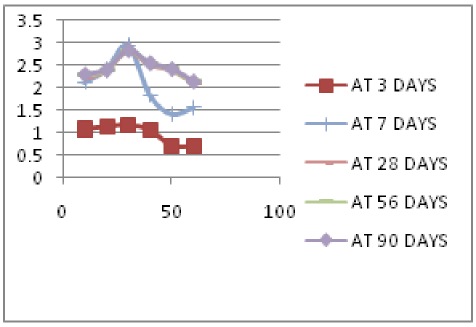
- Finally the cement is partially replaced by Admixtures and strength's were found. Graph is drawn between %replacements of cement to that of the respective strength. Hence the peak point in any Graph represents the optimum level of an Admixture that should be replaced in place of cement to get max strength.
- Using the obtained proportions we use to find the strength's like
- Flexural strength
- Compressive strength
- Split tensile strength

FLY ASH:

Fly ash is a fine, glass powder recovered from the gases of burning coal during the production of electricity. Fly ash is a heterogeneous material. SiO_2, Al_2O_3, Fe_2O_3 and occasionally Cao are the main chemical components present in fly ashes. Fly ash particles are generally spherical in shape and range in size from 0.5 µm to 300 µm. It mainly lowers the heat of hydration and allows thicker placements. As it is used in concrete it contributes more strength to the concrete at later stage due to its pozzolanic reactivity. By usage of fly ash it not only increases the durability of concrete it also reduce the environmental pollution

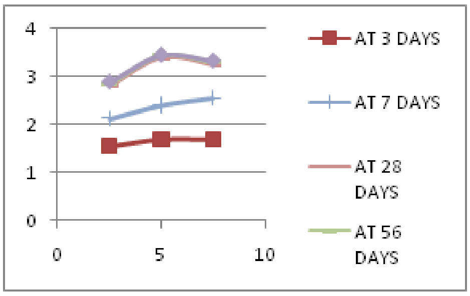
GGBS:

Ground granulated blast furnace slag (GGBS) is a by-product from the blast-furnaces used to make iron.It mainly consists of silicates and aluminates of calcium and other bases. The molten slag is rapidly chilled by quenching in water to form a glassy sand like granulated material. The granulated material when further ground to less than 45u will have specific surface of about 400 to 600Sq.m/kg.



SUPER PLASTICIZER:

These are also known as high range water reducers, are chemicals used as admixtures. The addition to concrete or mortar allows the reduction of the water to cement ratio, not affecting the workability of the mixture, and enables the production of self-consolidating concrete and high performance concrete.



Conventional mass concrete versus RCC:

The principal difference in the two is the mixture consistency and the method of compaction. Internal compaction using immersion-type vibrators is used for conventional concrete, while external compaction with spreading equipment and vibratory rollers is used for RCC. The controls placed on mixture ingredient selection for conventional mass concrete will apply to RCC also.

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RCC mixture proportioning procedures are also similar to conventional concrete; however, RCC mixtures will normally contain less water and more fly ash / sand to limit segregation. Heat of hydration studies as required for conventional mass concrete work, are also required for RCC.(For more details please refer fig. No. 1) RCC has been used as a construction material in the following applications Concrete dams: RCC has been used to construct new gravity dams and arch dams worldwide and has been the most widely used application for this technology. RCC has also been used to raise concrete dams and to provide stability berms for static and seismic requirements. II. Embankment overtopping protection and spillways: RCC has been used to armor embankment dams for overtopping flows. The armored embankment essentially functions as an auxiliary or emergency spillway. RCC has also been used to construct some service spillways that operate infrequently. Pavements: RCC has been used in pavement construction. But, unlike soil-cement used in pavements, the RCC is exposed and typically not covered with another wearing surface.

Typical thickness of the RCC pavement is 150– 200 mm but thicker layers have been used. Where thickness greater than 300 mm ~12 in. is required to accommodate heavy loads, multiple layers of RCC are used. IV. Slope protection: The use of RCC for slope protection is similar to that of soil-cement, except some of the material requirements may be different. Foundation stabilization: As with soil-cement, RCC can be used to provide stabilized foundations in the form of mass concrete. [2] The main advantage of RCC pavement is 1. Fast construction with minimum labor, 2.High load carrying ability, 3.Early strength gain, 4.Durable, 5.Low maintenance, 6.Economical, 7. Special forms not required, 8.No reinforcing Steel. [3] RCC dams compared to embankment type dams, RCC usually gains an advantage when spillway and river diversion requirements are large, where suitable foundation rock is close to the surface, and when suitable aggregates are available near the site.

Another advantage is reduced cofferdam requirements because, once started, an RCC dam can be overtopped with minimal impact and the height of the RCC dam can quickly exceed the height of the cofferdam.

CONCLUSION:

RCC is a stiff, zero-slump concrete mix that has the same ingredients as conventional concrete, Because of its low W/C ratio, RCC products usually high strengths similar or even greater than conventional concrete. Usually, RCC, when used in pavement construction, is placed without forms, finishing, or surface texturing.

- Roller compacted concrete has many times cost benefits over conventional concrete. The low cement content and use of fly ash causes less heat to be generated while curing than Conventional concrete.
- Initially roller compacted concrete was used for back fill, sub-base and concrete pavement Construction, but increasingly it has been used to build concrete gravity dams. It can be used to any type of pavements that is subjected to heavy loads.
- The roller compacted concrete can be used in parking areas, low speed broad ways and storage. Skid resistance to the vehicles can be easily achieved.
- The amount of labour required is significantly less than conventional p.c. c pavement of the same thickness this also results in low cost.
- Roller compacted concrete can be placed without form work, finishing or surface texturing. So that large quantities of concrete can be placed rapidly with minimum labour & equipment.
- As the water cement ratio is low the consumption of cement also decreases when compared to Conventional concrete. Hence it reduces the cost of construction.
- As roller compacted concrete has zero slumps it is hard durable, offers resistance towards rutting & avoids the formation of pot holes.
- It will not deform under heavy & concentrated loads and will not deteriorate under weathering actions of climate. Roller compacted concrete pavements will not soften under high temperatures

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and its construction is fastest, easiest & most economical.

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