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Development Of Bond Strength Of Pavement Quality Concrete

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ABSTRACT
The pavement is a multi-layered component of the road that is arranged one layer on top of the other. Every pavement layer is designed to withstand the weight and strain of moving vehicles. In addition to bearing the abrasive force of moving wheels, the top layer of pavement must be able to sustain weights and pressures from moving cars. Materials or unlimited material may be used to create the pavement's layers. In order to address the primary causes of the rigid pavement section's failure, including inadequate base support, subterranean water seepage, and frost action, dry-lean concrete (DLC) is placed underneath the rigid pavement section's wearing course. Modern rigid pavement incorporates Dry Lean Concrete (DLC) as a significant component. Large aggregate-to-cement ratios, which are below the stiff pavement section's wearing course, are often used in the manufacturing of DLC. Pavement Quality Concrete (PQC) is concrete that has been poured over a dry, lean concrete sub-base and is constructed in compliance with IRC guidelines using large-size aggregates, or 32mm. Because of its ability to support large loads, this structure is only used for concrete runway pavements on highways. The objective of this research is to provide significant perspectives on how to optimize PQC formulations for increased bond strength, which will aid in the creation of robust and environmentally friendly road infrastructure. The conclusions of this study provide engineers and other interested parties with useful advice for building and maintaining PQC pavements. In this study, standard concrete and M35 dry concrete were tested without the use of fly ash. Concrete performance, adhesion strength, uniform strength distribution, tensile strength and compressive strength are measured. After seven, fourteen and twenty-eight days of curing, DLC and PQC strengths were determined.
Key words: *fly ash, PQC, Dry lean concrete, M35 grade, bond strength,*

1.Introduction

A pavement is a section of a road that is composed of many layers stacked one on top of the other. Every pavement layer is designed to withstand the weight and strain of moving vehicles. In addition to bearing the abrasive force of moving wheels, the top layer of pavement must be able to sustain weights and pressures from moving cars. Materials or unlimited material may be used to create the pavement's layers. Generally speaking, the pavement should be able to endure the strains of traffic loads, weather-related degradation, and the grinding action of wheels for a certain amount of time. Pavements are divided into the following categories based on the material used and how they behave under load:

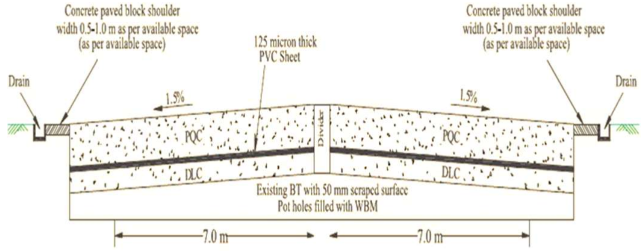


Fig 1: Typical cross-section of the concrete road

1.1 Dry Lean Concrete(DLC)

It is a crucial component of contemporary stiff pavement. It is a basic concrete that is often used as a basis or sub-base of stiff pavement and has a higher aggregate to cement ratio than conventional concrete (Central Road Research Institute, 2010). The following is a discussion of the IRC standard materials used in dry lean concrete (MORTH section 600). Dry lean concrete, often referred to as roller compacted concrete, is characterized as being lean and having a low weight-to-cement ratio. As roller-compacted concrete with minimal workability, according to ACI 207.5R-89. When being compacted, the newly built concrete layer has to be strong enough to hold a roller.

1.2 Pavement Quality Concrete:

Pavement Quality Concrete (PQC) is often used to provide a smooth asphalt surface with a hard base. PQC is also used in airport construction to reduce the critical impact of the wheel at ground level. Conventional concretes are not well suited for PQC preparation; Therefore, it is recommended that you score M30 and above to meet PCQ requirements. Because lower water/cement concentration is believed to provide greater strength, the quality of is generally lower than that of conventional cement of the same quality. Except cement particles, all elements play an important role in increasing the strength of PQC. Before PQC is established, both FA and CA are selected and released from each database. Hard, clean CA with a maximum size of 20-25 mm is ideal for PQC production.

2. Literature Review

Mohammad Jalaluddin (2017) The use of plastic in civil construction has changed due to research on "use of plastic waste in construction and new design materials (environmentally friendly)". Methods used in this transformation range from small plastic tubs and hangers to large plastic items used for flooring, wall coverings, electrical wiring and waterproofing. Plastic usage in the building of roads has shown a similar level of confidence as utilizing plastic trash, such as in the creation of paver blocks and plastic roadways. He claimed that plastic would raise bitumen's melting point. Rainwater won't get through due to the plastic included in the tar. Thus, less road repairs will be necessary as a consequence of this technique.
A.I. Essawy a, A.M.M. Saleh b, Magdy T. Zaky c, Reem K. Farag b, A.A. Ragab b (2013) This research paper on 'Environmentally Friendly Road Construction' shows that reusing polymer waste is an attractive way to reduce environmental pollution and save money on road construction and maintenance. Certain industrial byproducts, such as polyester and polypropylene fibers, may be used to make ecologically friendly hot mix asphalt (HMA) for paving.

3. MATERIALS AND MIX RATIOS USED IN THE STUDY

3.1 Materials used for the study

3.1.1 Cement

Throughout the experiment, ordinary Portland cement (OPC) of 53 Grade from a single lot was employed. It had no lumps and was fresh. The following table lists the tests that were used to establish the cement's physical characteristics in accordance with Indian Standard IS: 8112:l1989. To avoid its qualities being compromised by moisture, cement is kept with great care.

Fig 2:OPC 53 Grade concrete

3.1.2 Coarse aggregates

Two crushed stone samples that were readily accessible locally and held on 10 mm while passing through 12.5 were combined to create the coarse aggregate. After being cleaned to get rid of dust and dirt, the aggregates were dried until they were surface dry.

Fig 3: Coarse aggregate

3.1.3 Fine aggregates

Filling the gaps with coarse aggregate and serving as active material are the two most important tasks of successful installation. Fine aggregate can be classified as fine sand, coarse sand or fine sand according to its size. IS: 383-1970 divided fine aggregates into four classification categories (classes I to IV) based on size distribution.

3.1.4 Fly ash

Fly ash, commonly known as "oil ash" in Britain, is a by-product of the combustion of coal, consisting of small fuel particles known as particulate matter, emitted from coal-fired boilers and flue gases. Bottom ash is the ash that accumulates at the bottom of the boiler. Fly ash is captured by electrostatic precipitators or other particulate filters in modern coal-fired power plants before the flue gases reach the stacks. The coal ash is called and the bottom ash is removed from the bottom of the furnace.

Fig 4: Fly ash

3.1.5 Water

It is generally advised to mix and cure concrete using potable water. Therefore, concrete is made using this drinkable water. The water may be used in the concrete mixture since it is mostly devoid of harmful pollutants.

3.2 Mix proportioning

- Cement 365 kg/m3
- Water 165 kg/m3
- Fine aggregate = 776.5kg / m * 3
- Coarse aggregate = 1167.8kg / (ln(3))
- w/c ratio =0.45

RATIO= 1:2.12:3.19

3.3 Mix trials used in the study

For cubes

1. Mix 1 -75mm dry lean concrete
2. Mix 2 – 75mm PQC concrete
3. Mix 3 - 75mm dry lean concrete + 20% FA
4. Mix 4 – 75mm PQC concrete+20% FA

For cylinders

1. Mix 1 -60^0 angle dry lean concrete
2. Mix 2 – 60^0 angle PQC concrete
3. Mix 3 - 60^0 angle dry lean concrete + 20% FA
4. Mix 4 – 60^0 angle PQC concrete+20% FA

For prism specimens

1. Mix 1 -75mm dry lean concrete
2. Mix 2 – 75mm PQC concrete
3. Mix 3 - 75mm dry lean concrete + 20% FA
4. Mix 4 – 75mm PQC concrete+20% FA

Bond strength

1. Mix 1 -75mm dry lean concrete with 12mm bar at 100 mm embedded length
2. Mix 2 – 75mm PQC concrete with 12mm bar at 100 mm embedded length
3. Mix 3 - 75mm dry lean concrete + 20% FA with 12mm bar at 100 mm embedded length
4. Mix 4 – 75mm PQC concrete+20% FA with 12mm bar at 100 mm embedded length

5. EXPERIMENTAL STUDY

To evaluate the strength and strength of concrete structures using dry concrete and PQC for M35 concrete, we need to use the grid, rollers and prisms to compare the compressive strength, uniform strength distribution, specific strength and bond strength at different cure times

4.1 Batching

The process of gathering the amount of supplies needed for the job is called batching. Two techniques are often used to measure the amount of material: weight batching and volume batching. I used weight batching to measure the amount of materials in the current investigation.

4.2 Mixing of the Concrete

I blended the items according to the trails after calculating the amount of each ingredient. To produce a uniform mix, we must first mix the coarse and fine aggregates for a while. Then, we must add the cement and fly ash, and mix the combination once more for a little while longer to get the same mix throughout the material. Finally, add the water in accordance with the mix design calculations to create newly mixed M35 grade concrete

Fig 5: Mixing of concrete

4.3 Casting Of Specimens

To test the strength and endurance of the concrete, we must cast specimens such as cubes, cylinders, and prisms once the components have been mixed.

Fig 6: Cube specimens

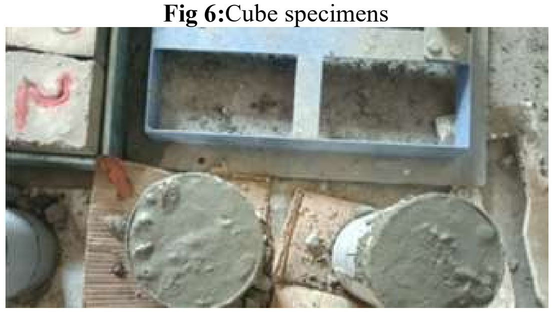


Fig 7: Cylinder specimens

4.4 Curing Of the Specimens

To examine compressive strength, tensile strength and tensile strength, samples should be cured with five test mixtures for seven, fourteen and twenty-eight days. But to test the service life, we need to at least subject the samples to acid and alkali tests.

4.5 Tests to be conducted on concrete

4.5.1 Slump cone test

One of the most important features of a well-designed innovation is functionality. In this study, slump factor and slump cone tests were used to determine the performance of concrete mixtures. The figure below shows the collapse equations for various factors.

Fig 8: Slump cone test of concrete

4.5.2 Compressive strength of concrete

Using a universal testing machine (UTM), the compressive strength of concrete after curing is determined for tests 1 to 5. The compressive strength of concrete after 7, 14 and 28 days of curing is shown in the figure below.

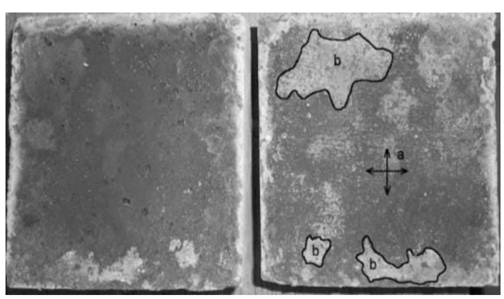


Fig 9: Failure of specimen after testing

4.5.3 Split tensile strength of concrete

Cylinder samples are used to compare the tensile strength of M35 class concrete mix tests from test 1 to test series. The dimensions of the cylinder were determined to be 300 mm long and 150 mm in diameter. The difference in strength after 7, 14 and 28 days is shown in the graph below.

4.5.4 Flexural strength of concrete

Flexural strength of M35 Grade concrete is measured for both PQC and DLC during the 7-, 14-, and 28-day curing periods.

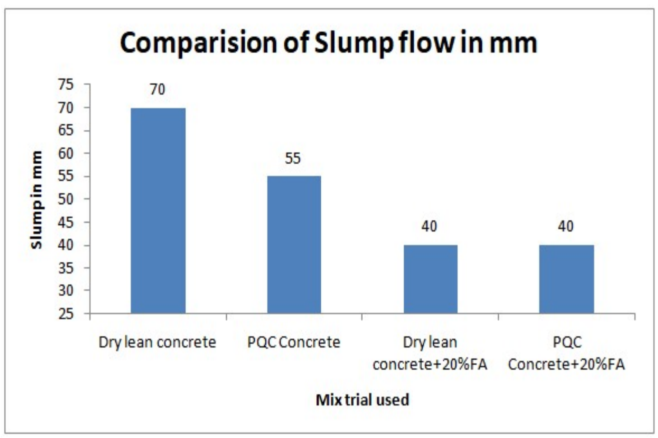
4.5.5 Bond strength of concrete

In order to verify the effectiveness of the above formula and the suitability of concrete and steel strength, fourteen tensile tests were conducted to determine the relationship between concrete strength and tensile strength. Each sample was processed on the same day at the University of Wollongong laboratory. The industry produced large amounts of concrete used in construction. The nominal sizes of the steel, consisting of a total of 500, steel grades, were 12, 16, 20, 25, 28, 32 and 36 mm. Two concrete sizes (diameter 240 and 300 mm) were measured per size.

Fig 10: Testing of bond strength of concrete

5 RESULTS AND ANALYSIS

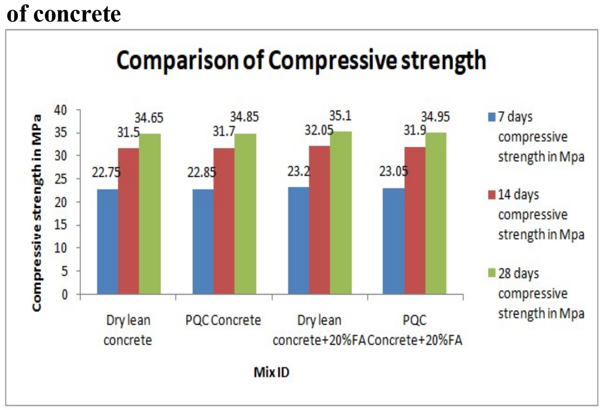
5.1 Workability of concrete



Graph 1: Comparison of slump cone test results

It can be seen from the above table and graph that when the 20% fly ash is used, the value of slump drops. Slump values were found to be lowest in PQC with 20% fly ash and to be greatest in dry lean concrete. The slump cone value decreases from dry lean to PQC with 20% fly ash as a result of the extra water content that is detected by rice husk ash in the concrete mix.

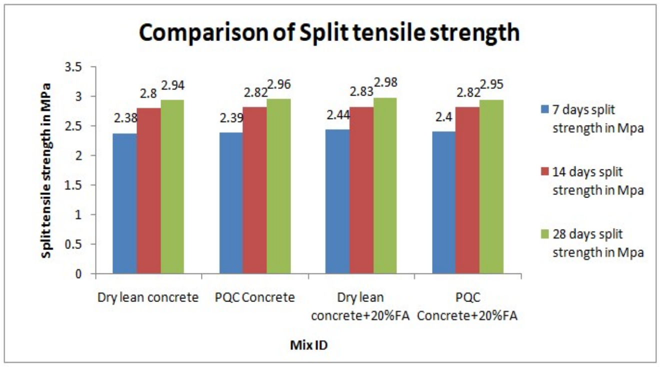
5.2 Compressive strength of concrete



Graph 2: Comparison of compressive strength

According to the aforementioned discovery, dry lean concrete with a 20% fly ash concentration had higher compressive values after 7 days, 14 days, and 28 days than the other mix trails. The compressive strength value improves as the amount of fly ash in mix 3 increases. However, the strength value progressively drops at mix 4 because of an improper mix at mix 4.

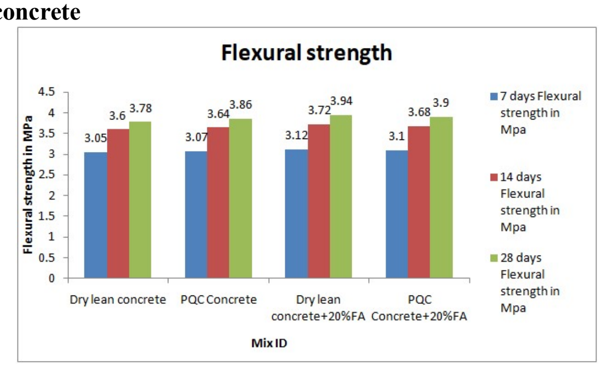
5.3 Split tensile strength of concrete



Graph 3: Comparison of split tensile strength

The graph above compares the split tensile strength after 7 days, 14 days, and 28 days for various mixes, including mix 1, mix 2, mix 3, and mix 4. In every instance, mix 3 yielded the greatest tensile strength.

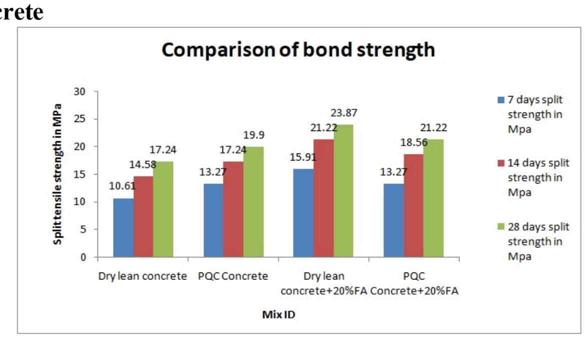
5.4 Flexural strength of concrete



Graph 4: Comparison of flexural strength of concrete

The comparison of flexural strength across all mixes and cure times (7, 14, and 28 days) is shown in the above observation. Mix 3 has the strongest findings overall.

5.5 Bond Strength of concrete



Graph 5: Comparison of bond strength of concrete

The bond strength of the test specimens that were left for seven days, fourteen days, and twenty-eight days are compared in the table above. Based on the plots, it was determined that the ideal bond strength of M35 grade concrete was found when the concrete was dry, lean, and included 20% fly ash.

6 CONCLUSIONS

The above research results yielded the following results.

1. When comparing DLC and PQC, the sleep value seems lower. In the M35 concrete mix, the values decrease from mix 1 to mix 4.

2. Compared to other mixtures, PQC without fly ash provides better compressive strength. As fly ash increases, the compressive strength of concrete decreases.
3. PQC without fly ash had better force distribution and dynamic values than other mixtures. As the size of fly ash increases, the compressive strength of concrete decreases.
4. A cylindrical sample of 100 mm in diameter and 12 mm in diameter is used to calculate the bond strength.
5. From DLC to PQC without fly ash, the initial tensile strength increases and the subsequent tensile strength decreases for PQC with fly ash.
6. Therefore, we will choose PQC instead of fly ash in M35 concrete when developing the coating.

REFERENCES

[1]. Wang, S.K, Sergious, M. and Cheung, Y.K., (1972) “Advanced Analysis o[14] Joseph O. Afolayan, Stephan A. Alabi “Investigation On The Potentials Of Cupola Furnace Slag In Concrete” International Journal of Integrated Engineering– 2013, Volume 5, pp. 59-62.

[2]. Mohammed Nadeem and Arun D. Pofale “Experimental Investigation Of Using Slag As An Alternative To Normal Aggregate (Coarse And Fine) In Concrete” International Journal of Civil And Structural Engineering– 2012, Volume 3, pp. 117-127

[3]. Hebhoub H., Aoun H., Belachia M., Houari H. and Ghorbel E. (2011), Use of waste marble aggregates in concrete, Construction and Building Materials, Vol. 25, pp. 1167– 1171.

[4]. R.Balaraman and S. Anne Ligoria “ Utilization of cupola slag in concrete as fine and coarse aggregate” International Journal of Civil Engineering and Technology (IJCIET)-Aug 2015, Volume 6, pp. 06-14.

[5]. Gameiro F, Brito J. d and Silva C.D., (2014) “Durability performance of structural concrete containing fine aggregates from waste generated by marble quarrying industry”, Engineering Structures, Vol. 59, pp. 654–662.

[6]. Soliman N. M., (2013) “Effect of using Marble Powder in Concrete Mixes on the Behavior and Strength of R.C. Slabs”, International Journal of Current Engineering and Technology, Vol. 3, No. 5.

[7]. Best, J. F., and Lane, R. O. (Oct. 1980) “Testing for Optimum Pump ability of Concrete,” Concrete International, V. 2, No. 10, pages 9 to 17.

[8]. Carette, G.G., & Malhotra, V.M, (1990) “Studies on Mechanism of Development of Physicaland Mechanical Properties of High-Volume Fly Ash-Cement Pastes”. Cement and Concrete Composites, vol. 12 & 4, pp 245-25.

[9]. Ghosh, R.S. and Timusk, J. (Sep-Oct. 1981) "Creep of Fly Ash Concrete", ACI Journals, Vol.78, No. 5, , pages 351 to 357.

[10]. Malhotra, V.M, (1990) “Durability of Concrete Incorporating High-Volume of Low- calcium (ASTM Class F) Fly Ash”. Cement and Concrete Composites, vol. 12 & 4, pp 271-277.

[11]. Marceau, M.L., Gajda, J., and VanGeem, M.G., (2002) “Use of Fly Ash in Concrete: Normaland High Volume Ranges”, PCA R&D Serial No. 2604, Portland Cement Association, Skokie, Illinois.

[12]. Malhorta, V.M. and Mehta, P.K. (2002) “High-Performance, High-Volume Fly Ash Concrete”. Supplementary Cementing Materials for Sustainable Development, Inc., Ottawa,

[13]. Canada. Naik, T.R., B.W. Ramme, R.N. Kraus, and R. Siddique. (2003) “Long Term Performance of High-Volume Fly Ash Concrete Pavements.” ACI Materials Journal 100(2), pp. 150-155

[14]. Pattnaik, S.C, Sabat, A.K, (2010) “A study of NALCO fly ash on Compressive Strength for effective use in High Volume Mass Concrete for a Sustainable Development”. Ravina, D., & Mehta, P.K., (1986) “Properties of Fresh Concrete Containing Large Amountsof Fly Ash”. Cement and Concrete Research, vol. 16, pp. 227-238.