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Construction of rigid pavement with comparative study of conventional concrete and fly ash

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ABSTRACT- In a developing nation like India, the construction and improvement of high quality roads plays an important role. In this research paper, the comparison between conventional concrete of grade M20 and M25 with Fly ash can be performed to study different parameters for designing rigid pavements. Study of compressive strength with eco-friendly material like fly ash is carried out in rigid pavements. This experiment study aimed to investigate the physical, chemical and mechanical properties of fly ash cement concrete for road construction. This studied proved that percentage replacement of fly ash with cement has a better performance. Characteristics compared to the standard requirements conformable code. Moreover, the use of fly ash would result in reduction of the cost of materials in construction and the reduction of greenhouse gas emission. High strength of concrete can be make and the fusion of admixture as substitute to improve the properties of concrete. Test result of specimens indicates the workability, and bonding strength of properties, and different reaction when the water ratio a change its content. Slump test having an appropriate workable mixing the slump of a concrete, gave sufficient compressive strength. Presently large amount of fly ash is generated in thermal power plants as a waste material with an improper impact on environment and humans. Fly ash is difficult to deteriorate, by using fly ash is a major step towards sustainable development. Also, Cement industry is one of the major contributors to pollution by releasing carbon dioxide. So by partially exchanging cement with eco friendly material such as fly ash, the cement industry can serve both the purposes of meeting the demands of construction industry and at the same time providing a green and clean environment. This can not only improve the various properties of concrete -both in its fresh and hardened states, but also can contribute to economy in construction costs. This research work is to investigate the behavior of concrete pavement while replacing fly ash in different proportions. The cement can be added in the range of 10%, 20% and 30% by weight of M20 and M25 grade concrete. Concrete mixtures were produced, tested and compared in terms of compressive strength, to traditional concrete. These tests were carried out to evaluate the mechanical properties for 3, 14 & 28 days.

KEY WORDS- rigid pavement design, rigid pavement construction, instrumentation, Dynaflect, Falling Weight Deflectometer Concrete pavement, Long-life pavement rehabilitation strategy, joint plain concrete (JPCP)

1. INTRODUCTION

In India now a days, the concept of smart city is growing very faster. As the main emphasis is ongreen and sustainable development. Infrastructure is the basic arm and smart material is essential to achieve that feat properly. Smart material is a one which gives better results in low economy. Considering fly ash as a smart material, it is a waste material obtained from coal combustion in electric power generating thermal plants. Using this smart material (fly ash) in construction of concrete pavements as a admixture improves the properties. By replacing the cement with fly ash accordingly in the range of 10%, 20%, 30% by weight of cement in M20 and M25 grade of concrete.

A. Fly Ash & its Significance

Chemically, fly ash is a pozzolan. When mixed with lime (calcium hydroxide), pozzolans combine to form cementitious compounds. Concrete containing fly ash becomes stronger, more durable, and more resistant to chemical attack. Mechanically, fly ash also pays dividends for concrete production. Because fly ash particles are small, they effectively fill voids. Because fly ash particles are hard and round, they have a "ball bearing" effect that allows concrete to be produced using less water. Both characteristics contribute to enhanced concrete workability and durability. Finally, fly ash use creates significant benefits for our environment. Fly ash use conserves natural resources and avoids landfill disposal of ash products. By making concrete more durable, life cycle costs of roads and structures are reduced. Furthermore, fly ash use partially displaces production of other concrete ingredients, resulting in significant energy savings and reductions in greenhouse gas emissions.

2. LITERATURE REVIEW

Arora (2003) has reported that the Westergaard's analysis is used for design of rigid pavements. The stresses in the concrete slab are determined using Westergaard's theory. Westergaard considered the rigid pavement as a thin elastic plate resting on soil subgrade. The upward reaction at any point is assumed to be proportional to the deflection at that point. The slab deflection depends upon the stiffness of the subgrade and the flexural strength of the slab. Thus the pressure-deformation characteristics of a rigid pavement depend upon the relative stiffness of the slab and the subgrade.

Punmia et.al (2005) have described the development of a design procedure for rigid highway pavement by Portland Cement Association based upon formulae developed by Pickett. The design charts for protected and unprotected corners, based on the formulae by Pickett for the design of highway pavement have been developed. The pavement thickness is obtained based on magnitude of wheel load and given value of modulus of subgrade reaction.

Razouki and Al-Muhana (2005) developed stress charts for the quick determination of maximum bending tensile stresses for the case of a concrete pavement slab on a Winkler foundation. The maximum bending moment in the concrete pavement represented by a Westergaard slab on Winkler foundation was obtained analytically by extending the known solution for the case of a uniformly loaded circular segment to the case of multiple circular contact areas. The paper reveals that the effects on the maximum bending tensile stress are quite significant due to the modulus of subgrade reaction, modulus of elasticity of concrete and slab thickness.

3. MATERIALS AND METHODOLOGY

2.1 MATERIALS

A. Fly Ash: Size of particle of fly ash is 0.1µm -150 µm. The fly ash was collected from Brick industry,chikhli.
B. Cement: Ordinary Portland Cement(OPC)of 43 grade (UltraTech cement) was used.
C. Aggregate: Aggregate are the important constituent in concrete. It acts as a body to the concrete, reduces shrinkage and effect economy. For producing good workable concrete, well graded aggregate are required.

1. Coarse Aggregate: The aggregate passing from 20mm sieve and retained on 4.75mm sieve are termed as coarse aggregate. The mixture of 20mm and 12mm size aggregate are used.
2. Fine Aggregate: The aggregate passing from 4.75mm sieve and retained on 150µm sieve are termed as fine aggregate. The Kanhan sand is used as a fine aggregate.

1.2 Methodology :

1.2.1 Compressive strength

4.RESULT

Table no.1 Compressive strength of conventional concrete of grade M20 and M25

Sr.no.	Grade of concrete	3 Days Strength N/mm2	7 Days Strength N/mm2	28 Days Strength N/mm2
		Average of Three samples		
1	M20	12.94	24.21	35.01
2	M25	14	26.09	37.36

Table no.2 Compressive strength of conventional concrete of grade M20 with percentage of fly ash

Sr no.	Cube sample name	Fly ash percentage	3Days Strength N/mm2	7Days Strength N/mm2	28Days Strength N/mm2
1	C10	10%	11.92	21.68	34.91
2	C20	20%	10.34	19.11	30.92
3	C30	30%	9.12	17.65	25.77

Table no. 3 Compressive strength of conventional concrete of grade M25 with percentage of fly ash

Sr no.	Cube sample name	Fly ash percentage	3 Days Strength N/mm2	7Days Strength N/mm2	28Days Strength N/mm2
1	C10	10%	12.32	23.81	39.23
2	C20	20%	11.01	24.34	37.78
3	C30	30%	10.51	19.11	31.46

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6. CONCLUSION

The workability of concrete decreases with the increase in fly ash, theparticles of Fly ash reduces the amount of water required to produce a given slump. The circular shape of the fly ash particles and its dispersive ability provide water reducing characteristic.The compressive strength and flexural strength increases with the increase of fly ash in concrete up to 30% replacement with cement in conventional mix, however the compressive strength increases more as compared to flexural strength, the values are acceptable as per IRC.Mixing of fly ash in concrete conventional mix has resulted in considerable variation in the properties of fresh concrete. Integration of fly ash in concrete increased the cohesiveness of the mix, prohibited segregation and resulted in reduced bleeding. Higher percentages of fly ash can cause a change in color of the mix.
Incorporation of fly ash in concrete can save the coal & thermal industry disposal costs and produce a „greener" concrete for construction.The research can be conducted further on higher grades of concrete or integration of such waste material by which more impact can be created improvement of strength.

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