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“DESIGN OF CEMENT CONCRETE PAVEMENT: A REVIEW”

Sanjay Patidar¹, Shashikant B. Dhobale²

¹PG Scholar, Civil Engineering Dept., JIT, Borawan, (M.P.), India

²Assistant Professor, Civil Engineering Dept., JIT, Borawan, (M.P.), India

ABSTRACT

The design and construction of the roadbed for any pavement structure is key to its longterm performance and smoothness over time. A roadbed is characterized by the layer(s) that provide the foundation for the riding surface. For concrete pavement, the foundation is typically comprised of a subbase layer on top of the subgrade soil. A variety of engineered subbase materials and subgrade treatment methods exist for use with concrete pavement. Careful attention to the design and construction of sub grades and subbases is essential to ensure the structural capacity, stability, uniformity, durability, and smoothness of any concrete pavement over the life of that pavement. Of utmost importance is the uniformity of the foundation. This bulletin publication discusses each essential factor and provides the necessary background information for the proper selection and application of subbases and the appropriate consideration of subgrade variables for concrete pavements used for streets, roads, and highways.

KEYWORDS: *Pavement structure, Concrete structure, Soil, Foundation , Granular subbase.*

I. INTRODUCTION

The factors governing design of cement concrete pavement have been discussed below: i) Wheel Load: Heavy vehicles are not expected on rural roads. The maximum legal load limit on single axle with dual wheels in India being 100KN, the recommended design load on dual wheels is 50 KN having a spacing of the wheels as 310 mm centre to centre. ii) Tyre Pressure: For a truck carrying a dual wheel load of 50 KN the tyre pressure may be taken as 0.80 MPa and for a wheel of tractor trailer, the tyre pressure may be taken as 0.50 MPa. iii) Design Period: The design period is generally taken 20 years for cement concrete pavement. iv) Characteristics of the Sub-grade: The strength of sub-grade is expressed in terms of modulus of sub-grade reaction (k). Since, the sub-grade strength is affected by the moisture content, it is desirable to determine it soon after the monsoons. v) Sub-base: A good quality compacted foundation layer provided below a concrete pavement is commonly termed as sub-base. It provides the concrete pavement a uniform & firm support and acts as a leveling course below the pavement. vi) Concrete Strength: Since, concrete pavement fails due to bending stresses, it is necessary that their design is based on the flexural strength of concrete. vii) Modulus of Elasticity (E) and Poisson's Ratio (μ): The Modulus of Elasticity of concrete and Poisson's ratio may be taken as 30,000 MPa and 0.15 respectively. viii) Co-efficient of Thermal expansion (α) The co-efficient of thermal expansion of concrete may be taken as 10×10^{-6} per $^{\circ}\text{C}$.

II. LITERATURE SURVEY

Narender Singh, 2015 state that India is an agriculture based country and more than 70 percent of the population is residing in the rural areas. The rural traffic consisting mostly agricultural tractors/trailers, goods vehicles, buses, animal driven vehicles, autorickshaws, motor cycles, bi-cycles, light or medium trucks carrying sugarcane, quarry material etc. The road passing through a village/built-up area usually found damaged due to poor drainage of water. Therefore, flexible pavement in the built-up area is to be substituted with the concrete. pavement to make it durable and to avoid wastage of nation money on repeated treatments. The different aspects of design of concrete pavement should be taken care prior to construction for making the same durable and cost effective. 11 The guidelines contained in IRC: SP: 62-2014 are applicable for low volume roads with average daily traffic less than 450 Commercial Vehicles per Day (CVPD).

Surender Singh, Dr.S.N.Sachdeva state that The main factors affecting the thickness of the cement concrete pavement are subgrade strength axle load repetitions, type of sub-base and shoulders". Well-designed and maintained shoulders are an important part of cement concrete pavement. They do not only give lateral support to the pavement slab but also protect the edges of high volume highway pavements by reducing the edge flexural stress. Moreover, this widened part can be used by vehicles as an extra lane, thereby maintaining the Level of service and can be used for parking in populated urban areas and if rough texture is provided to it, will bring in additional safety to vehicles, particularly during night hours. This will also cut the economy of the future project as this widened part itself can be extended to make a new lane. The subgrade strength in case of cement concrete pavement is expressed in terms of modulus of subgrade reaction, which is determined by plate load test. As conducting the plate load test involves a number of complexities, it will be usual to indirectly check the modulus of subgrade reaction from the CBR value of soil using the relationships between CBR and k value given in IRC: 58. The design of rigid pavement follow guidelines given in IRC: 58-2011.

The design has been carried out for different subbase such as dry lean concrete of 100 mm thickness, granular subbase of 150 mm thickness and cement treated subbase of 100 mm thickness with tied and untied shoulders and CBR value of subgrade varying from 2% to 10% and then selecting the best possible subgrade soil, subbase material and shoulders that can support the pavement effectively and economically.

A design life of 30 years is considered in this study. The total traffic in the year of completion of construction is taken as 2000 commercial vehicles per day in each direction. The traffic growth rate is taken as 7.5 percent. The percentage of front single axle, rear single axle, rear tandem axle and the rear tridem axle are taken as 45%, 15%, 25% and 15% respectively. The percentage of commercial vehicles with spacing between the front axle and the first rear axle less than 4.5m is taken as 55% and it is assumed that 50% of the vehicles travel during the night hours. Design flexural strength of concrete is taken as 4.95 mPa with a unit weight of concrete as 24kN/m³ and elastic modulus as 30000 MPa. Table 12 shows the category wise design axle load repetitions for both bottom up and top down cracking's analysis.

Narender Singh, 2015 said that A large proportion of India's villages has been connected with all-weather roads and has low volume of traffic. The main composition of such roads is granular layer with or without thin bituminous surfacing. The common problem to rural roads is that their maintenance is neglected because of paucity of funds and poor institutional set up, and the road asset created at a great cost is lost. Cement concrete pavement offer an alternate to the flexible pavements especially when the soil strength is poor, the aggregates are costly and drainage conditions are bad. Concrete pavements have now been constructed for low volume of traffic because of their durability even under poor drainage conditions.

Rural roads connecting major roads are sometimes required to carry diverted traffic which may damage the concrete pavement slabs. Such factors may be considered while arriving at thickness of concrete pavements. It is well established that the concrete pavements demand a high degree of professional expertise at the design stage as the defective design may lead to concrete failure even if the construction is done with great care. Indian Roads Congress has issued the first revision of IRC: SP: 62 in 2014 for design and construction of concrete pavement for low volume of roads. In this paper, efforts have been made to elaborate the different design aspects of concrete pavement for rural roads which will be helpful for the young engineers and research scholars.

The concrete pavement for rural roads perform well under poor drainage conditions and thus avoid wastage of resources on repeated treatment of flexible pavement. The proper design of concrete pavement will definitely help to make it durable and

cost effective. The technical institutions should enforce the design aspects of concrete pavement for the optimum benefit of young engineers and research scholars.

Nagesh Tatoba Suryawanshi, 2012 state that Fly ash is generated in huge quantities every day in major thermal power stations of Maharashtra. The safe disposal of this fly ash is the major socio-economic problem before the authorities and is becoming a costly affair for them. Conventional method of concrete road construction consumes the natural resources like stone metal, sand, murum etc. and hence causes ecological imbalance. The use of fly ash in concrete road construction will save such resources. The cement is also costly ingredient of concrete. A part of cement and sand can be replaced by good quality fly ash to the extent of 10-30 percent and 5-15 percent respectively. This would results in lowering cost of resultant concrete without any loss in strength. The use of fly ash will solve the disposal problem and automatically reduce the construction cost. Hence this paper is aimed to describe the use of fly ash in rigid pavement construction. Because of the use of fly ash, rigid pavement behaves as a semi rigid pavement causing substantial reduction in cost of construction. If the fly ash is utilized on large scale for road construction, the infrastructure development can be completed at lesser cost and will also help for environmental protection of our country. This paper also deals with techno-economic analysis of fly ash reinforced cement concrete over the flexible and rigid pavements.

It was concluded that Fly ash is the fine, waste product produced in thermal power plants. The safe disposal is the major problem for fly ash. The disposal problem is too hazardous that neighboring climate is polluted by suspended fly ash in air and causes nullification of plants. Human beings also have to face bronchial and lungs diseases. Due to this problem and storage difficulties, it is available abundantly in the thermal power plants. As the fly ash increases the pozzolanic properties of cement concrete, it can be used for replacing the cement in various percentage. Now a day's fly ash is also used as ingredient in cement production. It has been found that fly ash cement concrete does not gain appreciable strength in the initial 7-14 days. But in 28 days cement constituents and pozzolanic reaction results in rapid hardening properties. The study of graphs of compressive strength v/s percentage replacement and flexural strength v/s percentage replacement shows that optimum results are obtained at 25 percent replacement of cement by fly ash. Using this replacing percentage in experimental work it has been found that after 28 days the results on ordinary concrete and fly ash concrete are nearly same. It is also observed that fly ash mixed simply reinforced cement concrete pavement proves economical over convention flexible pavements and rigid pavements. For medium traffic and 2% CBR, it is observed that initial construction cost of flexible pavement and rigid pavement with fly ash and reinforcement is nearly same; it has also been concluded that construction of rigid pavement with fly ash saves rupees one lakh per km and proves economical over rigid pavements. It has been concluded that adoption of fly ash in road construction works will result in the less depletion of naturally available stone metal, gravel, sand and soil. Use of fly ash in rigid pavement construction will save cement, which is the costliest ingredient will lead to reduction in construction cost. It will also help to solve the problem of safe disposal of the fly ash. However to achieve this objective, proper characterization of fly ash is necessary. With adequate knowledge on performance of fly ash based road pavements, a huge demand can be expected from the road sector to use fly ash for construction purposes.

III. CONCLUSION

There is a general perception that stronger the subgrade lesser would be the thickness required for the pavement or conversely weaker the subgrade more is the thickness of cement concrete pavement required. Many a time, the existing soil is either replaced with soil having a higher California bearing ratio or stabilized to enhance the CBR value of using it in the subgrade. There is a general trend that with an increase in the slab thickness, stresses tended to decrease, but according to IRC: 58-2011, "if there is zero temperature differentials, the flexural stresses decrease with increase in effective modulus of subgrade reaction (k-value) for all the thicknesses. But for almost all the positive temperature differential, the warping stresses are high for thicker slabs and it results in higher flexural stresses in slabs while flexural stresses are lower for higher values for thinner slabs.

REFERENCES

1. Narender Singh, Design Aspects of Cement Concrete Pavement for Rural Roads in India, International Journal of Engineering Research and General Science Volume 3, Issue 4, July-August, 2015, ISSN 2091-2730.
2. Surender Singh and Dr.S.N.Sachdeva, Thickness Requirement of a Rigid Pavement with varying Conditions of Subgrade, Sub-Base and Shoulders, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), National Conference on Advances in Engineering, Technology & Management PP 52-57.
3. Nagesh Tatoba Suryawanshi, Use of Eco-Friendly Material like Fly Ash in Rigid Pavement Construction & It's Cost Benefit Analysis, International Journal of Emerging Technology and Advanced Engineering, Volume 2, Issue 12, December 2012.
4. Dr. R. Kumar, Scientist, Rigid Pavements Division, CRRI, "Design and Construction of Rigid Pavements/Cement Concrete Roads (ppt)".
5. Pandey, B.B., "Warping Stresses in Concrete Pavements- A Re-Examination", HRB No. 73, 2005, Indian Roads Congress, 49-58.
6. Westergaard, H. M. (1948), "New Formulas for Stresses in Concrete Pavements of Airfield", ASCE Transactions, vol. 113, 425- 444.
7. Srinivas, T., Suresh, K. and Pandey, B.B., "Wheel Load and Temperature Stresses in Concrete Pavement", Highway Research Bulletin No. 77, 2007, 11-24.