Pavement Design for Concrete Parking Lots

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Abstract—*Concrete parking lots are provided in shopping mall parking lot, school, and church, commercial or industrial parking lot. They are used to provide maneuvering areas and access for delivery vehicles. The design of slabs of concrete parking lots has many similarities with the design of highways but they also have some very distinct features. By considering these different features in the design, this can result in economical design of concrete parking lots. As Indian Roads Congress does not provide any separate guidelines for the pavement design of concrete parking lots, the design guidelines for the design of rigid pavements for roads are used for the design of parking lots as well. This paper describes the comparison and pavement design of concrete parking lots using ACI 330-R and IRC 58:2011.*

Keywords: *thickness; joints; dowel bars; tie bars;*

1. INTRODUCTION

Parking lots are provided to serve specific type of traffic such as light vehicles or heavy delivery vehicles, not for mixed traffic conditions. In parking lots load is imposed in interior part of slab but in case of highways, loads are along or across the free edges, so highways are subjected to greater deflection and stresses. In highway pavements water drained towards edges but in case of parking lots, water is stored internally and it is conveyed away through underground system. Generally, speed of vehicles on parking lots is less, so fatigue stresses are less as compare to highway pavement. Provision should be considered for parking appurtenances such as lighting standard, drainage structure, traffic islands and landscaped area in design of jointing system and layout of construction of parking lots.

2. LITERATURE REVIEW

2.1 ACI Committee Guidelines

ACI Committee Guidelines [1] recommend pavement thickness for concrete parking lots on the basis of average daily truck traffic (ADTT) and on the basis of CBR values of sub grade support. Generally, ADTT varies from 1 to 700 and corresponding variation in CBR values is from 2 to 50. Pavement thickness values are obtained from graphs provided by ACI 330-R. Pavement thickness of concrete parking lots varies from 90 mm to 230 mm. Spacing of joints varies from

24 to 30 times of the pavement thickness. Depth of joint is one fourth of the pavement thickness. Width of joint in pavement of concrete parking lots is 2.5 mm to 3 mm. Distributed steel reinforcement is required when transverse joints are spaced more than 30 times of the pavement thickness. Dowel bars are not provided for light traffic. It is recommended only in case of heavy traffic. Size of dowel bars varies from 16 mm to 29 mm and spacing is kept 300 mm.

2.2 Indian Roads Congress Guidelines

Indian Roads Congress Guidelines [4] provides guidelines for the design of concrete pavement for highways and the same guidelines are also used for the design of concrete parking lots pavement. Design period of these pavements is generally 30 years. Pavement thickness of parking lots varies from 200 mm to 350 mm. Longitudinal joints in slabs is required for width of slab greater than 4.5 m and joint spacing varies from 4500 mm to 5000 mm depending on thickness of pavement of concrete parking lots. Spacing of dowel bars is kept 300 mm and diameter of dowel bars varies from 250 mm to 380 mm. Dowel bars are not provided for thickness less than 200 mm. Generally, diameter of tie bars varies from 8 mm to 16 mm and their spacing is kept between 330 mm to 910 mm.

3. METHODOLOGY

I will explain design of slab for parking lots here using two different approaches

1. Using IRC-58:2011 (Use in India)

2. ACI -330R-01 (Use in America)

3.1 Methodology of IRC 58:2011

1. Stipulate design values for various parameters.

2. Decide types and spacing joints.

3. Select a trial thickness of pavement slab.

4. Compute the repetition of loads of different magnitude during design period.

5. Calculate stresses due to single and tandem axle load and determine cumulative fatigue damage (CFD).

6. If CFD>1, select higher thickness and repeat all above 5 steps.

7. Compute temperature stresses at edges and if addition of temperature stresses and flexural stresses is greater than modulus of rapture then select higher thickness and repeat all above 6 steps.

8. Design pavement thickness on basis of corner stresses if no dowel bars are provided and there is no load transfer due to lack of aggregate interlock.

9. Finally design of joints done.

3.2 Methodology of ACI 330R-01

I calculated all design parameters like pavement thickness, size of dowel bars and size of tie bars using 20 year design tables provided by ACI 330R-01

It also provided some graphs to calculate flexural stresses and cumulative damage factor using these we can calculate pavement thickness of concrete parking lots.

4. CALCULATIONS

For calculating pavement thickness for concrete parking lot, same parameter like Effective CBR of compacted subgrade and strength of concrete in both case is consider same. Using this data we design both types of pavement for concrete parking lots.

Using IRC-58:2011 (Use in India)

Effective CBR of compacted subgrade = 136 MPa/m (Assumed data)

Strength of concrete= 40 MPa (Assumed data)

Vehicular traffic ADTT (Average daily truck traffic) = 700 CVs (Assumed data)

Thickness of slab with dowel bars = 0.27 m (Calculate using excel sheet based on IRC 58:2011)

Transverse spacing of joints = 4.5m (7.1.6 IRC 58:2011)

Dowel bar detail

Diameter of dowel bar = 38mm (Using Excel Sheet Calculation for Design of Dowel bar Based on IRC58:2011)

Spacing of bars = 300 mm (Using Excel Sheet Calculation for Design of Dowel bar Based on IRC58:2011)

Length of bar 500 mm (Using Excel Sheet Calculation for Design of Dowel bar Based on IRC58:2011)

Design of tie bar

These bars are provided in accordance with recommendation of IRC: 15.

For Plain bars

Diameter of dowel bar = 12mm (Using Excel Sheet Calculation for Design of Tie bar Based on IRC58:2011)

Spacing of bars = 323 mm (Using Excel Sheet Calculation for Design of Tie bar Based on IRC58:2011)

Length of bar= 580 mm (Using Excel Sheet Calculation for Design of Tie bar Based on IRC58:2011)

For Deformed bars

Diameter of dowel bar = 12mm (Using Excel Sheet Calculation for Design of Tie bar Based on IRC58:2011)

Spacing of bars = 517 mm (Using Excel Sheet Calculation for Design of Tie bar Based on IRC58:2011)

Length of bar= 638 mm (Using Excel Sheet Calculation for Design of Tie bar Based on IRC58:2011)

ACI -330R-01 (Use in America)

Modulus of subgrade reaction, k = 500 pci (Assumed data)

Flexural stress of concrete = 650 psi (Assumed data)

Vehicular traffic = 700 CVs/day (Assumed data)

Thickness of pavement for concrete parking lots = 0.17 m (Table 2.4 ACI 330R)

Spacing of joints = 4.5m (Table 2.5 ACI 330R)

Design of Dowel bars

Diameter of bar = 22mm (Table 2.6 ACI 330R)

Total length of bar = 360mm (Table 2.6 ACI 330R)

Spacing of bars = 300mm (Table 2.6 ACI 330R)

Design of Tie bars

Tie bar size = 13mm*610mm (Table 2.7 ACI 330R)

Spacing of bars = 760mm (Table 2.7 ACI 330R)

NOTE: - Tie bar are not required in interior of joints because they are supported by surrounding slab.

5. CONCLUSION

Presently India has no standard code for the design of pavement of concrete parking lots. In the absence of such a standard, the guidelines for the design of rigid pavement for highways are used for the design of pavement for concrete parking lots. The present study shows that conditions such as vehicular loading, vehicular speed, and fatigue etc for pavement of concrete parking lots are different from pavement of highways. The pavement thickness for concrete parking lots designed by using guidelines for rigid pavements for highways results in higher and uneconomical thickness of pavement for the parking lots. There is a need to develop separate guidelines for the design of pavement of concrete parking lots.

REFERENCES

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[3] **IRC: 57-2006.** Recommended practice for sealing of joints in concrete pavements, New Delhi.

[4] **IRC: 58-2011.** Guidelines for design of plain jointed rigid pavements for highway, Indian Roads Congress, New Delhi.