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DESIGN OF SLAB PANEL BY PIGEAUD'S CURVES USING IRC: 21-2000 AND IRC: 112-2011

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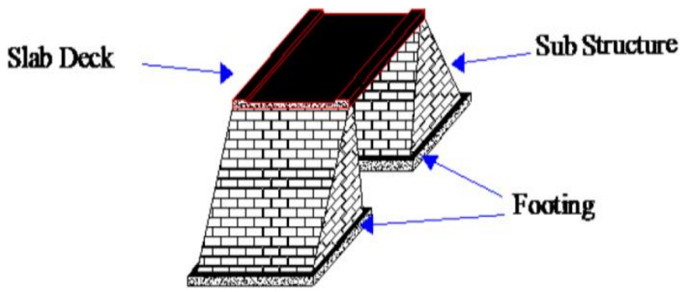
ABSTRACT

Bridges are the connecting structures they are used to connect two land masses separated by a valley or a water body. In India, till now RC road bridges are designed and constructed according to Indian road congress guidelines as per IRC: 21-2000 code in which working stress method is used. Recently Indian road congress has introduced another code IRC: 112-2011 for design of prestress and RCC bridges using limit state method.

In regards to this, present study has been performed to know how design of IRC-112 differs from IRC-21. Present study is performed on design of RC slab panel by working stress method using IRC: 21-2000 and limit state method using IRC: 112-2011 code specifications. Quantity of materials required in limit state method is compared with quantity of material required in working stress method. On comparison for slab panel, concrete can be saved up to 30 to 35% using limit state method. It can be concluded that concrete can be saved by adopting limit state method in design of bridge in comparison to working stress method.

Keywords: Bridge Deck, Pigeaud's curves, IRC Codes.

I. INTRODUCTION



Bridges are the connecting structures. They are used to connect two land masses separated by a valley or a water body. They ease the transportation in complicated regions. Bridges also eradicate the fillings in the construction

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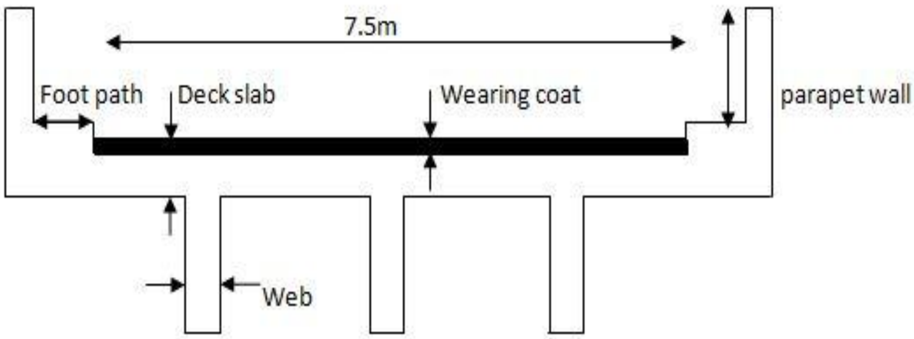
of roadways. Bridges are allowed to shorten the distance between the two places. Bridges are used to curtail traffic jam in densely populated areas.

A bridge deck or slab panel is the roadway, or the pedestrian walkway, surface of a bridge, and is one structural element of the superstructure of a bridge. It is not to be confused with any deck of a ship. The deck may be constructed of concrete, steel, open grating, or wood.

The primary function of a bridge deck is to support the vehicular vertical loads and distribute these loads to the superstructure. The deck is typically continuous along the span of the bridge and continuous across the width of the span. In most applications, the bridge deck is made composite with the superstructure through positive attachment to the girders, such as using shear connecters to attach the concrete deck slabs to girders. In such cases, the deck serves as part of the top flange in the composite section and can be utilized for strength and stiffness. The deck is subjected to local flexural bending of the slab spanning over the girders in the transverse direction caused by the vehicle wheel loads. When the deck is made composite, it is also subjected to longitudinal stresses caused by flexure along the span. The deck, when positively attached to the girders, provides continuous bracing of the top flange in the finished structure, and provides stability to the overall bridge system. The deck will also act as a horizontal diaphragm that is capable of transferring lateral loads, such as wind or seismic loads, to the supports.

II. METHODOLOGY



a) Calculation of live load bending moments is taken same for working stress method and limit state method, only 1.5 is multiplied for final moments in case of limit state method.

u = contact width of wheel + 2× thickness of wearing coat

v = contact length of wheel + 2× thickness of wearing coat

Calculate ratios (u/B) and (v/L) and K=(B/L) based on these note down the moment coefficient values m_1 and m_2 from Pigeaud curves and finally calculate the B.M in the long and short span directions using following formulas.

$$\text{Short span moment } M_B = W (m_1 + 0.15\, m_2)$$

$$\text{Long span moment } M_L = W (m_2 + 0.15\, m_1)$$

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b) Calculation of Dead load bending moments remains same for working stress method and limit state method, only 1.5 is multiplied for final moments in case of limit state method.

u = contact width of wheel + 2× thickness of wearing coat

v = contact length of wheel + 2× thickness of wearing coat

Assume ratios (u/B) = 1 and (v/L) = 1 and note down moment coefficient m_1 for K=(B/L), and m_2 for (1/K) values from Pigeaud's curves. Finally calculate the B.M in the long and short span directions using following formulas.

$$\text{Short span moment } M_B = W\,(m_1 + 0.15\,m_2)$$

$$\text{Long span moment } M_L = W\,(m_2 + 0.15\,m_1)$$

(c) Design of section is done using respective formulas in limit state and working stress method.

III. RESULTS

Design of interior slab panel is done by working stress method as per IRC-21:200 and limit state method as per IRC-112:2011 and finally checked which effective depth holds good for all class of loading separately for working stress method and limit state method and corresponding percentage of steel can be adopted.

For spans 12m, 16m, and 20m same panel size of 4m × 2.5m, for 14m 3.5m × 2.5m and for 18m 3m × 2.5m panel sizes are considered for analyses.

3.1 Working stress method:

1. Tracked vehicle

Span in m	Effective depth in mm	% of steel	Volume of concrete in m^3
12	175	0.612	2
14	167	0.601	1.75
16	175	0.612	2
18	153	0.55	1.5
20	175	0.612	2

2. Trained vehicle

Span in m	Effective depth in mm	% of steel	Volume of concrete in m^3
12	136	0.369	2
14	135	0.362	1.75

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16	136	0.369	2
18	131	0.341	1.5
20	136	0.369	2

3. Wheeled vehicle

Span in m	Effective depth in mm	% of steel	Volume of concrete in m^3
12	165	0.54	2
14	163	0.527	1.75
16	165	0.54	2
18	175	0.586	1.5
20	165	0.54	2

3.2 Limit state method:

1. Tracked vehicle

Span in m	Effective depth in mm	% of steel	Volume of concrete in m^3
12	125	1.078	1.5
14	120	1.059	1.225
16	125	1.078	1.5
18	112	1.007	1.015
20	125	1.078	1.5

2. Trained vehicle

	Effective depth in mm	% of steel	Volume of concrete in m^3
12	100	0.976	1.3

14	100	0.918	1.09
16	100	0.976	1.3
18	100	0.866	0.95
20	100	0.976	1.3

3. Wheeled vehicle

	Effective depth in mm	% of steel	Volume of concrete in m^3
12	120	1.011	1.4
14	115	1.098	1.225
16	120	1.011	1.4
18	125	1.026	1.125
20	120	1.011	1.4

IV. CONCLUSIONS

1. From results it is clear that depth required by working stress method of design is more than limit state method of design.
2. With comparison of tracked, trained and wheeled vehicle loads by working stress method of design an 175mm holds good for all class of loadings.
3. By working stress method of design an in general steel required is 0.612% for all class of loadings.
4. From tables it is clear that volume of concrete required by limit state method is 30% less than working stress method.
5. It is also observed that % steel required by limit state method is double than working stress method of design.
6. With comparison of limit state method results generally an effective depth of 125mm holds good for all class of loading and corresponding percentage of steel 1.078% can be provided.

V. ACKNOWLEDGEMENTS

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