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Analytical Study of R C C Deck Slab Bridge with Variable Parameters

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Abstract:- Bridges ware always proved to be the key elements for the infrastructural development of country .While designing the bridges ,three major aspects were always to be considered. These three factors were strength , stability and cost effectiveness .It was observed that cost economy was based on width to span ratio of bridge. Another important aspect of economics of bridge was the thickness of deck slab. The length/span of bridge was kept constant and magnitude of width was selected as variable parameter. Four different width to span ratio were taken as 0.75,1, 1.5 and 2.0 respectively. Keeping the same width to span ratios , design calculations were carried out for 0.6 m and 0.7 m deck slab thickness Design was carried out for Mix M-30 and steel as Fe -415. Total eight cases were studied to observe an economy of deck slab bridge Four cases were considered for different parameters of design of deck slab . For all the four width to span ratios ,mentioned above for 0.6 m deck slab thickness and four cases for 0.7 m deck slab thickness were attempted. It was concluded that for width to span ratio=1.0 , was suitable for minimum cost . The results thus obtained were shown in tabular form .The results thus shown were useful for optimizing the design of deck slab bridges . This analysis is extremely useful to civil engineers, practicing engineers, contractors, research scholars and budding engineers.

Keywords:- *I R C -6 , Deck Slab, Median ,Crash Barrier, AA Class Track Loading , Wearing Coat .*

I. INTRODUCTION

Development of any country is based on infrastructural development in every part of nation . Development includes construction of roads , bridges , dams , airports etc. Important aspects of development were related to the stability , strength and economic aspect also Construction of bridges need three major considerations' These considerations were strength , stability and cost effectiveness. Huge amount of concrete and steel were required for the construction of bridges .The cost of materials were piling up every day . Hence economical design of all types of bridges should . be considered. During the design of deck slab bridge ,,it was observed that width to span ratio plays a vital role to achieve an economy . For the design of R C C deck slab bridge , concrete mix as M- 30 and steel as Fe -415 ,were considered As per the I R C -6 norms , AA class loadings and 75 mm wearing coat thickness were considered .For AA class tracking loads I R C -6 – 2000 was adopted The span length of deck slab bridge was adopted as 8.0 m (Constant). Design of deck slab bridge was considered for four different width of bridge as 6.0 m ,8.0 m , 12.0m , 16.0 m ,keeping the span length constant as 8.0 m The span to width ratio were adopted as 0.75 ,1.0,1.5, 2.0 (Total four span to width ratio) . For all eight cases (four for deck slab thickness =0.6 m and four for 0.7 m slab thickness) moments , shear force , area of steel ,area of centering and weight t of concrete were calculated ,All the results thus obtained were shown in tabular form .While designing the deck slab for all the eight cases ,it was considered that the structure was considered in seismic zone II . Similarly during the design of deck slab bridge ,wind effect was also not taken into account. .No median and crash barrier were considered. While designing the deck slab bridge ,as boundary condition ,both the ends were considered as simply supported . All the design parameters through all the eight cases were shown in tabular form.

II. METHODOLOGY

The design of bridges were carried out on the basis of types of loads .The major loads were dead load ,wearing coat load , live load etc .The design was carried out as per the specifications of IRC -6 .As a boundary condition ,the deck slab bridge was design considering it as simply supported . The deck slab thickness was taken as 600 mm and 700 mm . For both the deck slab thickness , the thickness of eearing coat was taken as 75 mm . The span length was taken as 8.0 m .As per norms of I R C, A class track loading as live load was considered.

For each slab thickness , the width was adopted as 6.0 m,8.0 m,12.0 m,and16.0 m. For each width to span ratio ,as per code , design was carried out In all total eight cases were considered for design requirements. For all the eight cases maximum bending moments , maximum shear force , required area of steel ,quantity of steel , quantity of concrete ,area of shuttering ,were obtained .For the design of R C C structure ,IS Code 456-2000 was considered . Quantity of main steel as well as quantity of distribution steel were also found out for consideration of economic aspect of bridge.

For design calculations, as per the requirements of code, concrete M-30 and steel Fe-415 were selected. The results thus obtained were analyzed and the outcome of the result were shown in tabular form.

Most economical results were observed for the width to span ratio was 1.0

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III. OBSERVATIONS

Total eight cases were studied .Details of all the cases are as under.

- **Case I** : Slab thickness **: 700 mm** .Width to span ratio :0.75 , Wearing coat :75 mm
- Case II : Slab thickness : 700 mm , Width to span ratio : 1.0 Wearing coat: 75 mm
- Case III : Siab thickness : 700 mm , Width to span ratio : 1.5 Wearing coat : 75 mm
- Case IV : Slab thickness : 700 mm Width to span ratio : 2.0 Wearing coat : 75 mm
- **Case V** : Slab thickness **:** 600 mm .Width to span ratio : 0.75 , Wearing coat :75 mm
- Case VI Slab thickness : 600 mm , Width to span ratio : 1.0 Wearing coat: 75 mm
- Case VII: Slab thickness : 600 mm , Width to span ratio : 1.5 Wearing coat : 75 mm
- Case VIII : Slab thickness : 600 mm Width to span ratio : 2.0 Wearing coat : 75 mm

Comparative statement was prepared ,in tabular form , showing parameters of structural elements for 700 mm deck slab thickness .Magnitude of bending moments for dead loads and live loads were shown in Table 01.

Table 1 : Showing Bending Moment due to Live Load for 0.7 m Slab Thickness

Case No Moment	**Case I**	**Case II**	**Case III**	**Case IV**
Dead load B M	176.4 KNM	176.4 KNM	176.4 KNM	176.4 KNM
Live load B M	187.95KNM	156.28KNM	147.83 KNM	144.15 KNM

Comparative statement was prepared ,in tabular form ,showing parameters of structural elements for 600 mm deck slab thickness .Magnitude of bending moments for dead loads and live loads were shown in Table 02.

Table 2 : Showing Bending Moment due to Live Load for 0.6 m Slab Thickness

Case No Moment	**Case V**	**Case VI**	**Case VII**	**Case VIII**
Dead load B M	149.94 KNM	149.94 KNM	149.94 KNM	149.64 KNM
Live load B M	161.7 KNM	15 9.0 KNM	150.78 KNM	146.58 KNM

Comparative statement was prepared ,in tabular form ,showing parameters of structural elements for 700 mm deck slab thickness .Magnitude of steel in MT for dead loads and live loads were shown in Table 03

Table 3 : Showing Qty of steel in MT for deck slab thickness 700 mm

Case No Qty of steel	**Case I**	**Case II**	**Case III**	**Case IV**
Main steel	**1**.3 MT	1.129 MT	1.121 MT	1.121 MT
Dist Steel	0.546 MT	**0.473 MT**	0.449 MT	0.449 MT
Total steel	1.846 MT	1.602 MT	1.57 MT	1.570 MT

Comparative statement was prepared ,in tabular form ,showing parameters of structural elements for 600 mm deck slab thickness .Magnitude of steel in MT for dead loads and live loads were shown in Table 04

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Table :4 Showing magnitude of steel in MT for slab thickness 600 mm

Case No Wt of steel	**Case V**	**Case VI**	**Case VII**	**Case VIII**
Main steel	1.337 MT	1.315 MT	1.188 MTMT	1.166 MT
Dist steel	0.583 MT	0.522 MT	0.51 MT	0.498 MT
Total steel	1.920 MT	1.837 MT	1.698 MT	1.664 MT

Quantity of concrete in Cu M was calculated for slab thickness as 700 mm The result thus obtained were shown in table no 05

Table :5 Showing magnitude of concrete in Cu M of for slab thickness 700 mm

Case Qty	**Case I**	**Case II**	**Case III**	**Case IV**
Concrete in Cu M	33.6	44.8	67.2	89.6

Quantity of concrete in Cu M was calculated for slab thickness as 600 mm The result thus obtained were shown in table no 06

Table :6 Showing magnitude of concrete in Cu M of for slab thickness 600 mm

Case Qty	**Case V**	**Case VI**	**Case VII**	**Case VIII**
Concret in Cu M	28.8	38.4	57.6	76.8

Area of centering in square meter was calculated for slab thickness as 700 mm The result thus obtained were shown in table no 07

Table :7 Showing magnitude of centering in Sq M for slab thickness 700 mm

Case Area	**Case I**	**Case II**	**Case III**	**Case IV**
In Sq M	67.6	86.4	124	161.6

Area of centering in square meter was calculated for slab thickness as 600 mm The result thus obtained were shown in table no 08

Table :8 Showing magnitude of centering in Sq Mof for slab thickness 600 mm

Case Area	**Case V**	**Case VI**	**Case VII**	**Case VIII**
In Sq M	64.8	83.2	120	152

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IV. RESULTS

- Live load bending moment for 0.7 m slab thickness and width to span ratio as 0.75 ,subsequently decreases by 16.0 % , 21.2 % , 22.16 % .
- Live load bending moment for 0.6 m slab thickness subsequently decreases when compared with 0.75 width to span ratio by 2.0 % ,6.7 % ,and 9.3 % respectively .
- Quantity of steel for deck slab thickness as 0.7 m , decreases when compared with 0.75 width to span ratios and with other subsequent ratios as 0.75 1.0 , 1.5 , 2.0 , by 15.0 %
- Quantity of steel for the deck slab thickness as 0.60 m ,decreases when compared with 0.75 width to span ratio by 4.3 % ,14.56 % ,13.33 % .for all respective three ratios .
- Quantity of concrete increases for 0.6 m depth of deck slab , when compared with 0.75 width to span ratio width other subsequent ratios , observed to be increases as 104.25 % 206.38 , 308.510% .. Quantity of concrete increases for 0. 7 m depth of deck slab , when compared with 0.75 width to span ratio with other subsequent ratios , observed to be increases as 33.3 % ,100.00 %, and 166.66 % .
- Dead load bending moment ,when compared to 0.6 m deck slab thickness with 0.70 m ,it was observed that the magnitude for all the span to depth ratio ,increases by 17.4 % .
- Area of shuttering for all the width to span ratio with 0.6 m deck slab thickness was found to be increased for the 0.70 m depth by 4.1 % ,4.7 % ,3.2 & ,and 5.90% .
- For the 0.75 , width to span ratio , the quantity of concrete observed to be increased by 14.28 % for all the ratios of 0.6 m and 0.7 m deck slab thickness .

V. CONCLUSION

While designing the R C C deck slab bridge ,for fixed span of bridge , when span to width ratio exceeds two then as per table no 7 of IRC -21,the value of constant “ K “ is constant .Hence it was concluded that the design of deck slab with width to span ratio exceed 2.0 , is not economical .

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