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Reinforced Cement Concrete Bridge Deck Design of a Flyover with Analysis for Dynamic Response Due To Moving Loads for Urban Development in Transportation Systems - A Case Study

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Abstract:-- **The present study on Practices in civil engineering for sustainable community development to meet four out of total eight Millennium Development Goals of United Nations have been taken up to improve the quality of life of Global Community by creating awareness in all concerned. This study is also relevant during the United Nations Decade of sustainable development. The four goals related to Civil Engineering are effective irrigation water management, providing safe drinking water, ensuring environmental sustainability and sustainable transportation system. As an inspiration of these goals, this paper is on the study of Reinforced Cement Concrete bridge deck design and its dynamic response to urban development in transport systems.**

A Reinforced Cement Concrete bridge deck is designed using the Indian Roads Congress (IRC) Bridge Code: IRC 21-1987. The bridge deck is designed for IRC Class AA loading tracked vehicle. The design curves by M. Pigeaud, are used to get Moment Coefficients in two directions for the deck slab. The longitudinal girders are designed by Courbon's method. The dynamic response of bridge deck for moving loads is analyzed as per British Standard Code of Practice BSCP-117 Part-II – 1967. This is based on Lenzen's criteria relating the Natural Frequency and Vibration Amplitude. A computer program in C language is developed to design interior slab panels of the Reinforced concrete bridge deck to arrive at the reinforcements and depths for a specified length of the width of slab panel and thickness of the wearing coat with Grade of concrete M-25 and Grade of steel Fe-415 High Yield Strength Deformed (HYSD) bars. The possible Global Partnership for overall development with universities, consulting organizations, government organizations and nongovernmental organizations is also to be discussed.

Index Terms - Courbon's method, Dynamic response, Pigeaud curves, Reinforced Cement Concrete bridge deck.

INTRODUCTION

Bridges may be of Reinforced concrete or steel construction. Reinforced concrete is well suited for the construction of highway bridges in the small and medium span range. Their durability, rigidity, economy and ease with which pleasing appearance can be obtained make them suitable for this purpose. The usual types of reinforced concrete bridges are slab bridges, Girder and slab(T-beam) bridges, Hollow girder bridges, Balanced cantilever bridges, Rigid frame bridges, Arch bridges, Bow string girder bridges.

In INDIA Bridges for road are designed as per the recommendations of the Indian Roads congress (I.R.C). This code classifies bridges and culverts into the I.R.C class A loading, I.R.C class AA loading wheeled vehicle I.R.C class AA loading tracked vehicle and I.R.C class B loading. Apart from these loadings other loads considered are Dead load of structure, Impact load, wind load, longitudinal forces, seismic load, Temperature effect, Settlement, secondary, erection, Centrifugal force, Earth pressure, Drag and tractive force. Flyover is a super structure providing passage of vehicles over an existing road to avoid the unnecessary intersections. Flyovers are also called Road bridges.

Details of flyover project in hyderabad in india:

A flyover is proposed to be constructed near Begumpet in Hyderabad. The construction of foundation and piers is in progress. The bridge deck is yet to be laid out and hence the bridge deck is designed with the available data :
Clear width of road way = 11 m
Span (Centre to centre bearings) = 24 m
Average thickness of wearing coat = 80 mm
Materials : M-25 Grade of Concrete
Fe-415 HYSD bars.

Design of Reinforced Concrete Deck System – Case Study

The practical aspects of bridge design are given in the Technical Hand Books (Panchayath Raj Assistant Executive Engineers Association, Andhra Pradesh 2001 and Association of Engineers, Irrigation and Command area Development Department of Andhra Pradesh 1998). The design procedure for bridge deck slab as per IRC 21-1987 is followed.

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(Krishna raju N-2005, 2004, Johnson Victor.D-1980, Aswani.etal-1985)
A R.C.C Tee beam girder bridge is designed to suit the following data :
Clear width of road way = 11m
Span (center to center of bearings) = 24m
Live load: I.R.C Class AA OR IRC class A whichever gives the worst effect
Average thickness of wearing coat = 80mm
Materials: M-25 grade concrete and Fe-415 HYSD bars.
Four main girders are provided at 2.8m centers.
Thickness of deck slab = 250mm
Wearing coat = 80mm
Width of main girders = 300mm
Kerbs 600mm wide and 300mm deep. Cross girders are provided at every 6m intervals.
Breadth of cross girder = 250mm
Depth of main girders = 2400mm (at the rate of 100mm per metre of span)
The depth of cross girder is taken as equal to the depth of main girder to simplify
computations. The cross-section of the deck and the plan showing the spacing of crossgirders
are shown.

PERMISSIBLE STRESSES

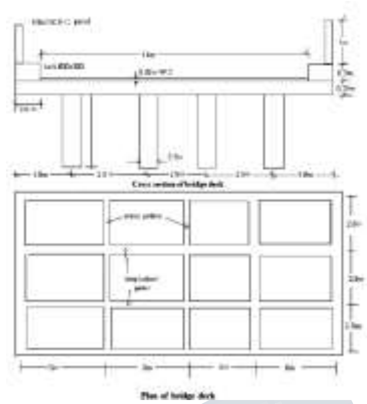
s cb = 8.3 N/mm2 m=10
sst = 200 N/mm2 j= 0.90
Q = 1.1

DESIGN OF INTERIOR SLAB PANELS

Bending Moments:
Dead weight of slab = (1 x 1 x 0.25 x 24) = 6 kN/ m2
Dead weigh of W.C = (0.08 x 22) = 1.76
Total dead load = 7.76 kN/ m2
Live load : Class AA – tracked vehicle. One wheel is placed at the centre of panel
u = (0.85 + 2 x 0.08) = 1.01
v = (3.60 + 2 x 0.08) 3.76 m

$$\frac{u}{B} = \frac{1.01}{2.8} = 0.36$$

$$\frac{v}{L} = \frac{3.76}{6.0} = 0.63$$



Tee-beam and slab bridge deck

$$K = \frac{B}{L} = \frac{2.8}{4.5} = 0.467 \text{ (say k=0.5)}$$

Referring to Pigeaud's curve (Fig. 4.4.2.2)
M1 = 11.2 x 10-2 and M2 = 2.7 x 10-2
MB = W (M1 + 0.15 M2) = 350 (11.2 x 10-2 + 0.15 x 2.7 x 10-2) = 40.6175 kN.m
As the slab is continuous
Design B.M. = 0.8 MB
MB (including impact and continuity factor)
= (1.25 x 0.8 x 40. 6175) = 40.6175kN.m
ML = 350 (2.7 x 10-2 + 0.15 x 11.2 x 10-2) = 15.33 kN.m
Design ML = (1.25 x 0.8 x 15.33) = 15.33 kN.m

SHEAR FORCES

Dispersion in the direction of span = [0.85 + 2(0.08 + 0.25] = 1.51m. For maximum
shear, load is kept such that the whole dispersion is in span, the load is kept at 1.51/
2=0.755m from the edge of beam as shown in Fig. 4.4.3.
Effective width of slab = k . x(1-x/L) +bw
Breadth of cross girder = 250 mm
Clear length of panel = L = 5.75 m

$$\frac{B}{L} = \frac{5.75}{2.5} = 2.3.$$

From Table 4.4.3, k for continuous slab is obtained as k = 2.6
Effective width of slab = [2.6 x 0.755 (1 – 0.755/2.5) + 3.6 + (2x0.08)] = 5.13m
Load/m width = (350/5.13) = 68.23kN
Shear force = 68.23[(2.5-0.755)/2.5] = 47.625kN
Shear force with impact = (1.25 x 47.625) = 59.53Kn

DEAD LOAD BENDING MOMENTS AND SHEAR FORCES

Dead load = 7.76 kN/m2

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Total load on panel = (6x2.8x7.76) = 130.37kN

$\frac{u}{B} = 1$, $\frac{v}{L} = 1$ as panel is loaded with uniformly distributed load.

$k = \frac{B}{L} = \frac{2.8}{6} = 0.47$ and $\frac{1}{k} = 2.143$

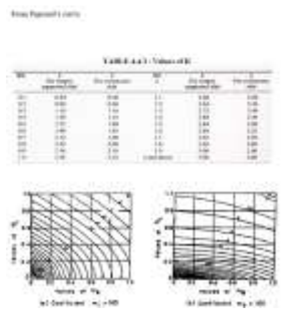


Fig. Moment Coefficients m1and m2 for K = 0.5
M1 = 4.6 x 10-2 and M2 = 0.6 x 10-2 (from pigaued's)
MB = W (M1 + 0.15 M2) = 130.37 (4.6 x 10-2 + 0.15 x 0.6 x 10-2) = 6.114 kN.m
Taking continuity into effect
MB = (0.2 x 6.114) = 1.223 kN.m
ML = 130.37 (0.6 x 10-2 + 0.15 x 4.9 x 10-2) = 1.68kN.m
Taking continuity into effect:

ML = (0.8 x 1.68) = 1.345kN.m

Dead load shear force = $\frac{7.76 \times 2.5}{2}$ = 9.7kN

DESIGN MOMENTS AND SHEARS

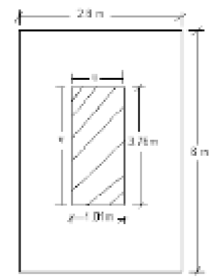
Total MB = 40.6175+1.223 = 41.85kN.m
Total ML = 15.33+1.345 = 16.675kN.m
Total shear force = (59.53+9.7)= 69.23kN
Nominal shear stress = t= V/bd = (69.23 x 103 / 103 x 225) = 0.308 N/ mm2

DESIGN OF SECTION

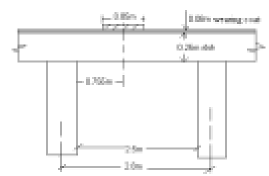
Effective depth = d =√(41.85 x 106/(1.1 x 1000)) =195.05mm
Adopt overall depth = 250mm
Effective depth= d= 225 mm
Ast = [41.85 x 106 /(200 x 0.90 x 225] = 1033.33 mm2
For short span use 16 mm diameter HYSD bars at 150 mm centers (Ast = 1341 mm2)
Effective depth for long span using 10 mm diameter bars is computed as :
d = 225-8-5 = 212 mm
Ast = [16.675 x 106 /(200 x 0.90 x 212] = 437 mm2
For long span adopt 10 mm diameter bars at 150 mm centers (Ast = 524 mm2)

CHECK FOR SHEAR STRESS

Nominal shear stress = t= V/bd = (69.23 x 103 / 103 x 225) = 0.308 N/ mm2
k1 = (1.14 - 0.7x0.225) = 0.9825 > 0.5
k2 = (0.5 + 0.25 x r) where r = 100 As / bd and As = 1341 mm2
r = 100 x 1341 / (1000 x 175) = 0.596
k2 = (0.5 + 0.25 x 0.596) = 0.649 > 1



Position of Wheel load for maximum bending moment



Position of Wheel load for maximum shear

Hence k2 = 1
For M-25 grade concrete ôCO = 0.40N/mm2
ôC = (k1 . k2. ôCO) = (0.9825 x 1 x 0.40) = 0.393 N/mm2 > 0.381 N/mm2
Since ô< ôC, shear stresses are within safe permissible limits.

DESIGN OF LONGITUDINAL GIRDERS

Reaction factors
Using Courbon's theory, the I.R.C. class AA loads are arranged for maximum eccentricity
as shown in Fig. 4.4.7.1
Reaction factor for outer girder is :
RA = 2W1 (1 + 4I x 4.2 x 2.85) = 1.1786 W1
4 2I x 4.22
Reaction factor for inner girder is :
RB = 2W1 (1 + 4I x 1.4 x 2.85) = 2.54 W1
4 2I x 1.42
If W = Axle load = 700kN
W1= 0.5W
RA = (1.1786 x 0.5 W) = 0.5893 W

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RB = (2.54 x 0.5 W) = 1.27W

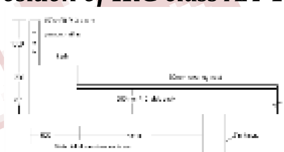
DEAD LOAD FROM SLAB PER GIRDER

The dead load of deck slab is calculated with reference to Fig. 4.4.7.2
1. Parapet railing = 0.700Kn/m
2. Wearing coat = (0.08 x 1.15 x 22) = 2.024
3. Deck slab = (0.25 x 1.15 x 24) = 6.9
4. Kerb = (0.55 x 0.6 x 1 x 24) = 7.92
17.544kN/m
Total dead load of deck = (2 x 17.544 + 7.76 x 8.7) = 102.6 KN/m
It is assumed that the dead load is shared equally by all the girders.
Dead load / girder = 102.6/4 = 25.65kN/m

LIVE LOAD BENDING MOMENTS IN GIRDER

Span of girder = 24 m
Impact factor (for class AA) = 10 %
The live load is placed centrally on the span as shown in Fig. 4.4.7.3.
Bending moment =[6 + 5.1]/2* 700= 3885 KN.m

Transverse Disposition of IRC class AA-Tracked vehicle



Details of deck slab, kerb and parapet

Bending moment including impact and reaction factor for outer girder is
= 3885 x 1.1 x 0.5893 = 2518.37kN.m
Bending moment including impact and reaction factor for inner girder is
= 3885 x 1.1 x 1.27 = 5427.34kN.m

LIVE LOAD SHEAR

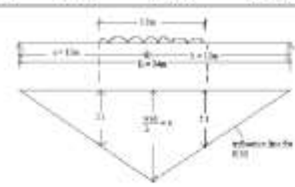
For estimating the maximum live load shear in the girders, the I.R.C. Class AA loads
are placed as shown in Fig. 4.4.7.4
Reaction of W2 on girder B = (350 x 0.75)/2.8 = 93.75kN
Reaction of W2 on girder A = (350 x 2.05)/2.5= 256.25 kN
Total load on girder B = (350 + 93.75) = 443.75kN
Maximum reaction in girder B =(443.75 x 22.2)/24 = 410.47kN
Maximum reaction in girder A = (256.25 x 22.2)/24 = 237.03 kN
Maximum live load shears with impact factors in inner girder
Inner girder = (410.47 x 1.1) = 451.52kN
Outer girder = (237.03 x 1.1 = 260.73kN

DEAD LOAD MOMENTS AND SHEAR FORCE IN MAIN GIRDER

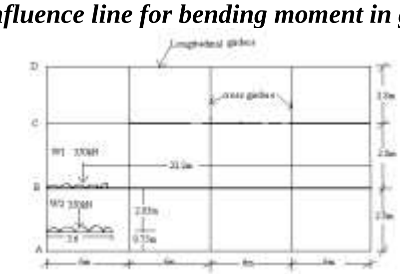
The depth of girder is assumed as 2400 mm (100mm for every metre of span)
Depth of rib = 2.15m, width = 0.3 m
Weight of rib/m = (1 x 0.3 x 2.15 x 24) = 15.48KN/m.
The cross girder is assumed to have the same cross-sectional dimensions of the main
girder.
Weight of cross girder = 1 x 0.25 x 2.15 x 24 = 12.9kN/m
Reaction on main girder = (12.9 x 2.8) = 36.12kN
Reaction from deck slab on each girder = 25.65kN/m
Total dead load/m on girder = (25.65 + 15.48) = 41.13kN/m
Referring to Fig. 4.4.7.5. the maximum bending moments are computed.
Mmax = $(41.13 \times 24^{2)/8}$ + (36.12 x 24)/4 + (36.12 x 24)/4
= 3394.8kN/m
Dead load shear at support = (41.13 x 24)/2 + 36.12 + (36.12)/2 = 547.74kN

DESIGN BENDING MOMENTS AND SHEAR FORCES

B.M	D.L.B.M	L.L.B.M.	Total B.M.	Units
Outer girder	3394.8	2518.37	5913.17	kN.m
Inner girder	3394.8	5427.34	8822.14	kN.m
S.F	**D.L.S.F**	**L.L.S.F.**	**Total S.F.**	**Units**
Outer girder	547.74	260.73	808.47	kN.m
Inner girder	547.74	451.52	999.26	kN.m



Influence line for bending moment in girder



Position of I.R.C. class AA loads for maximum shear

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Dead loads on main girders

Design of sections for maximum B.M and S.F.
Mmax = 8822.14kN.m
Vmax = 999.26kN
The beam is designed as a Tee-section
Assuming an effective depth d = 2100 mm
Approximate lever arm = (2100 – 250/2) = 1975 mm

$$A_{st} = \frac{8822.14 \times 10^6}{200 \times 1975 \times 0.9} = 24816.15\ mm^2$$

Provide 32 bars of 32 mm diameter in five rows (Ast =25735.93mm2)
Shear reinforcements are designed to resist the maximum shear at supports. Nominal
shear stress is computed as :
tv = V/bd = 999.26 x 1000/(300*2100) = 1.586 N/mm2 not greater than 0.07 fck which is
equal to (0.07 x 250) = 1.75 N/ mm2 , Hence safe.
Assuming two bars of 32 mm diameter to be bent at support section, shear resisted by
the bent up bars is given by the relation;
Vs = (ssv x Asv Sin a) = [(200 x 2 x 804 x 1)/(1000 x v2)] = 227kN
Balance shear force = Vb =[V-Vs] = [999.26 – 227] = 772.26kN
Using 10 mm diameter, 4 legged vertical stirrups, spacing is computed as :

$$S_v = \left[\frac{\sigma_{sv} \times A_{sv}\, d}{V_b} \right] = \left[\frac{(200 \times 4 \times 79 \times 2100)}{772.26 \times 1000} \right] = 171.85kN$$

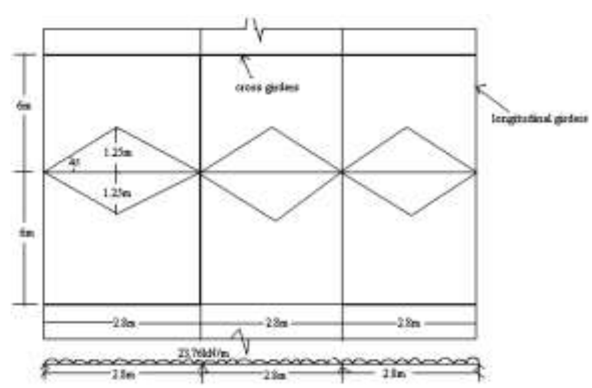
Provide 10 mm diameter 4 legged stirrups at 150 mm centers.

DESIGN OF CROSS GIRDERS

Self-weight of cross girder = 12.9 kN/m
Referring to Fig. 4.4.8.1
Dead load from slab = (2 x ½ x 2.8 x 2.8/2 x 7.76) = 30.42kN
Uniformly distributed load = 20.5/2.8 = 10.86KN/m
Total load on cross girder = 12.9 + 10.86 = 23.76KN/m
Assuming the cross girder to be rigid:
Reaction on each cross girder = (23.76 x 5)/4 =29.7KN
For maximum bending moment in the cross girder, the loads of I.R.C Class AA should be placed as shown.
Load coming on cross girder = 350 (6-1.8/2)/6 = 297.5kN
Assuming the cross girder as rigid, reaction on each longitudinal girder is :
= (3 x 297.5/4) = 223.12kN
Maximum B.M in cross girder under the load = 223.12 x 1.775 = 396.03 kN.m
L.L.B.M including impact = (1.1 x 396.03) = 435.63 kN.m
D.L.B.M at 1.775 m from support = (29.7 x 1.775 – 23.76 x 1.775/2) = 31.63 KN.m
Total design B.M. = (435.63 + 31.63) = 467.26KN.m
Live load shear including impact = (3 x 297.5)/4 x 1.1 = 245.44kN
Dead load shear = 29.7 kN
Total design shear = 245.44 + 29.7 = 275.14 kN
Assuming an effective depth for cross girder as 2250 mm
Ast = (467.26 x 106) / 200 x 2250 x 0.9
= 1153.73 mm2
Provide 4 bars of 20 mm diameter (Ast = 1256 mm2)
Nominal shear stress = ôv = [275.14 x 1000] /250 x 2100 = 0.52 N/mm2 not greater than
(0.07 x 250) = 1.75 N/ mm2 , Hence safe
Spacing Sv=[(200 x 2 x 79 x 2100)]/ (275.14 x 1000) = 241.186mm
Adopt 10 mm diameter 2 legged stirrups at 250 mm centers throughout the length of the cross girder.
The details of reinforcements are shown in the cross section of deck slab and longitudinal section of main girders.

DYNAMIC RESPONSE OF BRIDGE DECKS INTRODUCTION

The dynamic response of bridge deck to a moving load depends on mass stiffness, damping properties of the bridge and dynamic properties of the moving loads resulting in vibrations either at the natural frequency or at the frequency of the applied excited force. The normal range of fundamental frequency of bridges varies between 1 and 20 cycles per second. This may coincide with the range of frequencies of moving vehicles resulting in the possibility of resonance leading to the failure of the bridge deck.



Loads on cross girders

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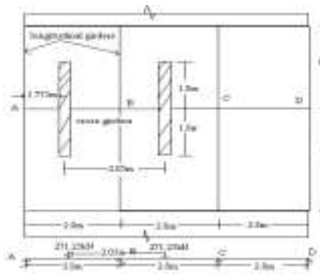


Position of live loads for maximum B.M. in cross girder

The effect of bridge deck vibrations result in

a) Structural damage if not properly designed for vibration effects.

b) Causes unpleasant physiological and psychological reactions on humans, and

c) Develops additional stresses of transient nature which are in addition the static effects. The normal practice generally followed in several national codes to safeguard the bridge deck from the destructive effects of dynamic loads is to provide for impact factors for live loads which amplify the design static loads by a certain percentage. Consequently the bridge deck is rendered more rigid so that the dynamic effects are safely resisted with increased mass and elasticity of the structure.

Design for Dynamic Response Of Bridge- Case Study Of Flyover in Hyderabad

DATA :
Effective span = 24 m
E= 5700Öfck = 5700Ö25 = 28500N/mm2
= 28.50 x 106kN/m2
Sectional properties:- The cross section of Tee beam is shown in Fig. 4.5.5
The second moment of area = I = 0.9723m4
For 4 girders, Effective I= 4 x 0.9723 = 3.8892m4
Flexural Rigidity = EI = 28.50 x 106 x 3.8892
= 110.842 x 106 kN.m2

MAXIMUM DEFLECTION

Maximum deflection at centre of span under a hypothetical concentrated load of 200kN
is computed as

$$\delta = \frac{200 \times 24^3}{48 \times 110.842 \times 10^6} = 0.0005196\text{m} = 0.51966 \text{ mm}$$

DEAD LOAD OF DECK

Self-weight of slab = 0.25 x 1 x 24 x 12.5 = 75kN/m
Weight of wearing coat = 0.08 x 12.5 x 22 = 22kN/m
Weight of 4 girders = 4 x 0.3 x 2.25 x 24 = 64.8kN/m
Weitht of Kerb, parapet railing etc.(L.S) = 8.62Kn/m
Total dead load = wd = 170.42kN/m

NATURAL FREQUENCY OF VIBRATION

$$N_f = \frac{2}{L^2}\sqrt{\left[\frac{EIg}{w_d}\right]}$$

$$= \frac{2}{24^2}\sqrt{\left[\frac{110.82 \times 10^6 \times 9.81}{170.42}\right]}$$

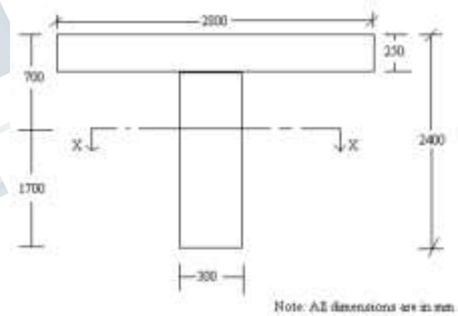
$$= 8.77 \text{ cycles per second}$$

VIBRATION AMPLITUDE

Since Nf >4 cycles per second
D= 0.40 d = 0.40 x 0.5197 = 0.208mm

CHECK FOR DYNAMIC RESPONSE

A = 40 D Nf mm2/sec2
= 40 x 0.208 x 8.772
= 639.91 mm2/sec2
A D = 639.91 x 0.208 = 133.1 mm2/sec2 < 3226 mm2/sec2
Hence safe



Cross section of Tee-Beam

COMPARISON WITH LENZEN'S CRITERIA

Compared with Lenzen's Criteria the vibration characteristic lies between the zone of distinctly to slightly perceptible. The Lenzen's curve is shown.

REINFORCED CONCRETE BRIDGE DECK SLAB DESIGN IN 'C'LANGUAGE

The Flow chart and C programing code are described below

C Program Code For The Design Of Interior Slab Panel Of RCC Bridge Deck Slab.

```
* Program to calculate moment for interior slab panel of a T-beam girder *
* bridge *
#include<stdio.h>
```

```
#include<conio.h> //Header files
#include<math.h>
main()
{
float
spanning_Length,road_Width,thickness,depth,area_of_steel;
float k,k1,k2,M1,M2,u,v,MB,ML,M;
clrscr();
printf("\n\n Please enter the spanning length of the interior
slab panel in
meters:");
scanf("%f",&spanning_Length);
printf("\n please enter the width of interior slab panel in
meters:");
scanf("%f",&road_Width);
printf("\n please enter the thickness of wearing coat in
meters:");
scanf("%f",&thickness);
k=road_Width/spanning_Length;
u=0.85+(2*thickness);
k1=u/road_Width;
v=3.6+(2*thickness);
k2=v/spanning_Length;
printf("\n value of k is %f",k);
printf("\n value of u/B is %f",k1);
printf("\n value of v/L is %f",k2);
printf("\n please refer to the pigeaud's curves based on the
values of k,u/B & v/
L.\n please enter the values of constants M1,M2 with
precision:");
scanf("%f%f",&M1,&M2);
MB=350*(M1+0.15*M2);
ML=350*(M2+0.15*M1);
printf("\n value of Moment along width :%f",MB);
printf("\n value of Moment along length:%f",ML);
if(MB>=ML)
  {
  printf("\n\nDesign moment of given interior slab panel of a
  T-Beam
  girder bridge is: %f",MB);
  M=MB;
  }
  else
  {
  printf("\n\nDesign moment of given interior slab panel of a
  T-Beam
  girder bridge is %f",ML);
  M=ML;
  }
  depth=pow((M*pow(10,6))/(1.1*1000),(1.0/2));
  area_of_steel=(M*pow(10,6))/(200*0.9*depth);
  printf("\nEffective depth of slab:%f",depth);
  printf("\nArea of steel required :%f",area_of_steel);
  printf("\noverall depth of slab:%f",(depth'+25));
  getch();
  }
```

INPUT AND OUTPUT OF C-PROGRAM

Please enter the spanning length of the interior slab panel in meters: 6.0
Please enter the width of interior slab panel in meters: 2.8
Please enter the thickness of wearing coat in meters : 0.08
Value of k is 0.466667
Value of u/B is 0.360714
Value of v/L is 0.626667
Please refer to the pigeaud's curve based on the values of k, u/B, and v/L.
Please enter the values of constants M1 and M2 with precision: 0.112 0.027
Value of Moment along width: 40.617500
Value of Moment along length: 15.330001
Design Moment of given interior slab panel of a T-Beam girder bridge is:
40.617500
Effective depth of slab: 192.158783
Area of steel requires: 1174.303711
Overall depth of slab: 217.158783

RESULTS AND DISCUSSIONS

A Reinforced cement concrete bridge deck slab for a flyover under construction in Hyderabad is designed. The cross girders and longitudinal girders also designed. The interior slab panels are designed using pigeauds curves to arrive at moment t coefficients. The reinforcement details in the deck slab is described in figure and reinforcement details in longitudinal and cross girders are shown in figure. The photographs are taken of the bridge under construction photos explained the various components and stages of construction of the bridge.

A computer program in C-language is developed to design interior slab panels of Reinforced cement concrete deck to arrive at the reinforcements and depth for a specified Length and width of slab panel and thickness of wearing coat with grade of concrete M-25 and Fe-415 HYSD bars. The programming code in 'C' described in paragraph, and the flow chart is described figure . The dynamic response of bridge deck for moving load is analyzed as per British Standard Code of Practice BICP- 117-PART-II-1967. The product of the maximum acceleration (A) is computed to be 133.1 mm2/sec2 which is less than the standar4d value 3226mm2/sec2 (paragraph 4.5.5). The vibrationcharacteristic on the basis of Lenzen's criteria (Fig. 4.5.3) is found to lie between the zone of distinctly to slightly perceptible.

CONCLUSION

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

Flyovers are common in big cities to reduce the traffic congestions. The design of a deck slab for a Reinforced Concrete Bridge as per the bridge code IRC 21- 1987 with analysis for dynamic response due to moving loads is illustrated.

RECOMMENDATIONS

The UN Millennium Development goal of development (Includes Urban Development) through global partnership can be achieved only through sustainable transportations system. It is strongly recommended to construct flyover which reduces be traffic congestion and travel time. It is also recommended for the global partnership for overall development with universities, consulting organization, govt. organization and non-governmental organizations

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