A Study on Manual Design And Analysis of Cantilever Bridge

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Abstract- *This project study represents Analysis and Design of Cantilever bridge using Staad Pro software, while analysing the cantilever bridge to check the maximum loading effects act on the structural components of the bridge structure, such as shear forces, bending moments, stress concentration centres etc. . This project looks on the work of analysis and design of bridge deck and girder on software staad pro v8i. The bridge model is taken of a particular span and carriageway width the bridge is subjected to IRC loadings like IRC Class AA tracked loading etc. In order to obtain maximum bending moment and shear force from the analysis it is observed and understand the behavior of bridge deck and girder under different loading condition and comparing the result. The different codes of design will be use in this project they are IRC 5-2015, IRC 6-2016, IRC 112-2011, IRC 21-2000. In this study bridge slab is design by pigeauds method and longitudinal and cross girders is design by courbon's method and IRC class AA tracked loading and class A loading will be used.*

Keywords- shear forces, bending moments, stress concentration centres,Class AA tracked loading,bridge deck and girder

I. INTRODUCTION

DEFINITION:

A bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for a road, railway, pedestrian, a canal or a pipeline. The obstacle to be crossed may be a river, a road, railway or a valley.

COMPONENTS OF A BRIDGE:

The main of abridge structure are:

1) Decking, consisting of deck slab, girders, trusses etc.;
2) Bearings for the decking;
3) Abutments and piers;
4) Foundations for the abutments and piers;
5) River training works, like revetment for slopes for embankment at abutments, and aprons at river bed level;
6) Approaches to the bridge to connect bridge proper to the
7) roads on either side and

Some of the components of a typical bridge are shown below:

a) The components above the level of bearings are grouped as superstructure.
b) While the parts below the bearings level are classed as the substructure.
c) The portion below the bed level of a river bridge is called the foundation.
d) The components below the bearing and above the foundation are often referred as substructure.

CLASSIFICATION OF BRIDGES:

1) Function
2) Material of construction
3) Form
4) Inter-span relations
5) Position of the bridge to the superstructure
6) Method of connections
7) Method of clearance
8) Length of bridge
9) Degree of redundancy
10) Type of service

Bridges may classify in many ways as below:

1) **FUNCTI0N**: According to function as aqueduct (canal over a river), viaduct (road or railway over a valley), pedestrian, highway, railway, road-cum-rail or a pipeline.

2) **MATERIAL OF CONSTRUCTION**: According to the material of construction of the superstructure as timber, masonry, iron, steel, reinforced concrete, pre-stressed concrete, composite or Aluminum Bridge.

3) **FORM:** According to the form or type of the superstructure as slab, beam, truss, arch, cable stayed or suspension bridge.

4) **INTER -SPAN RELATIONS**: According to the inter-span relations as simple continuous or cantilever bridge.

5) **POSITION OF THE BRIDGE TO THE SUPERSTRUCTURE**: According to the position of the bridge to the superstructure as deck, though, half-through or suspended bridge.

6**) METHOD OF CONNECTIONS**: According to the method of connections of the different parts of the superstructure, particularly for the steel construction as pin connected, riveted or welded bridge.

7) **METHOD OF CLEARANCE**: According to the method of clearance for the navigation as high-level, movable-bascule, movable-swing or transporter bridge.

8**) LENGTH OF BRIDGE**: According to the length of bridge as culvert (<6m), minor bridge (6to60m), majorbridge (>60m) or a long span bridge when the main span of the major bridge is above 120m.

9**) DEGREE OF REDUNDANCY**: According to the degree of redundancy as determinate or indeterminate bridge.

10**) TYPE OF SERVICE**: According to the anticipated type of service and duration of use as permanent, temporary, military bridge.

II. LITERATURE REVIEW

ARDRA M R et al (2019) the investigation paper presented an assessment of a bent adjusted cantilever connect an aspect of the Kochi Metro. The advancement begins from the enduring docks and proceeds reasonably to mid-extend. The examination of the extension model direct during advancement mastermind when presented to the dead load and working stage when presented to live load, specifically, the live burden was performed. From IS 456, compelling moment worth was resolved, and differentiated and second worth got from the STAAD assessment.

Results communicated those qualities acquired from the examination were inside this limit. For essentially maintained shaft limit state of functionality has given the limit for preoccupation as length/250. the qualities were found safe under the range.

Anjani Kumar Shukla and P R Maiti (2019) the investigation paper inspected the cantilever footbridge connect retrofitted by a steel coat to check the preoccupation and stress limit of the expansion and results communicated that the platform was secured. The exhibiting and assessment of the enlargement were done using Staad.Pro V8i.

Convincing information expressed that the most extreme resultant displacing was 9.526 mm, which was on the sliding side. The Maximum Horizontal Displacement in the X heading was 4.957 mm. The Maximum Axial Compressive Stress was - 9.227 N/mm2 in both steel shaft which was fix with the essential help of the extension and between center 22-26 and 3-10. The Maximum Axial Tensile Stress was 21.824 N/mm2 in Both steel bar which was fix with the guideline support of the Bridge and between Node 17-28 and 12-14.

III. METHODOLOGY

Here examination on a cantilever connects with three unique ranges is shown in the examination program in which joints interface is checked and improved, and IRC Class AA and seismic load are considered.

Three cases have been considered for near examination:

❖ Cantilever Bridge 80.00 m length.

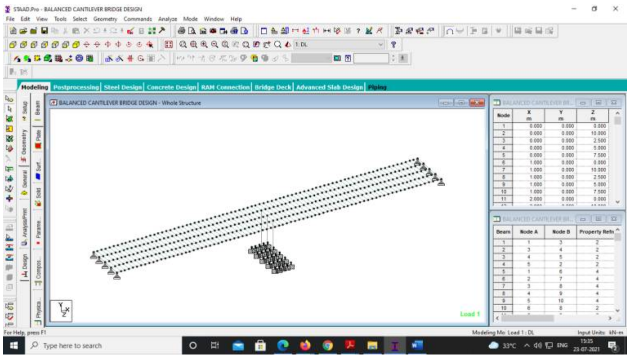
The accompanying three cases must be examined and contrasted with set up a near report

a. Planning of calculation and sectional properties
b. Relegating sections according to Indian standard steel.
c. Allotting loads as IRC Class AA and seismic Provisions.
d. Arrangement of results and post-processing outputs.

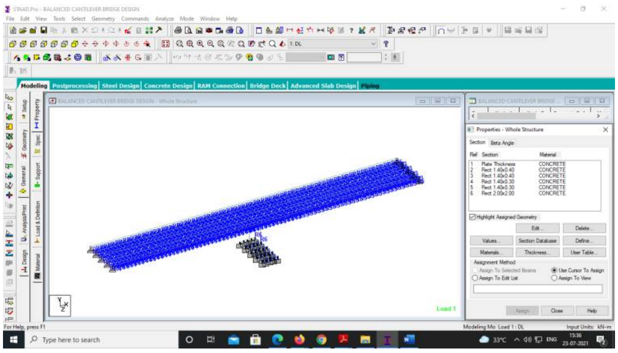
Following steps are considered for completion of this project are as follows:

To design the bridge in the Staad pro we have to complete the following procedure.

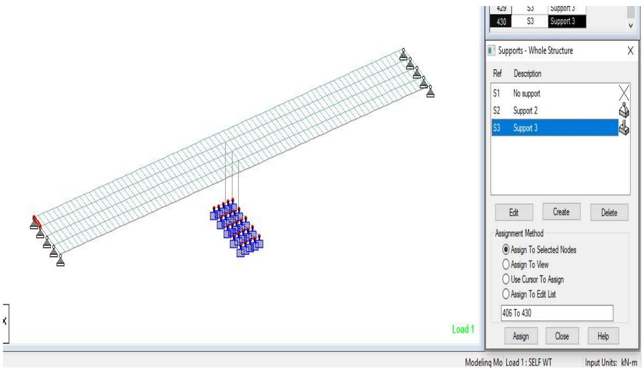
First we have to complete the bridge structure diagram by using different geometrical methods in the Staad pro. And create the plate to the bottom road way. Now, we can very clearly observed bridge diagram as shown in below.



After the completion of geometry we have to go for the properties and then select section data base option and then choose suitable profile to the steel members, and also go for the thickness and enter the plate element thickness as 0.2m and assign to the particular members as shown in below.



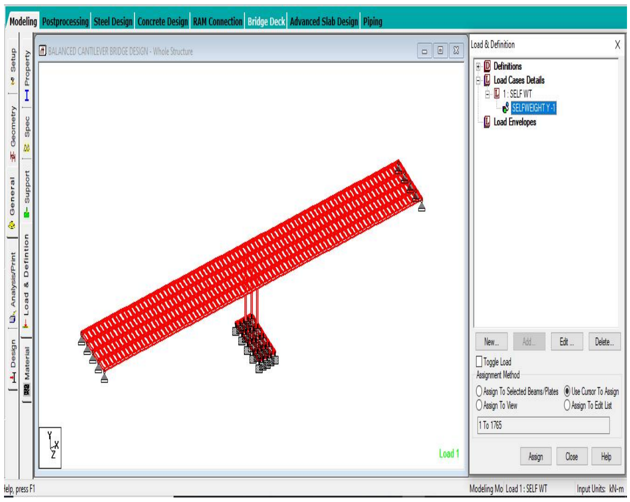
After the completion of properties we have to go for the supports option and then click on fixed and add and also create pinned and click on add. The fixed support assign to the one end and also we have to assign pinned support to the other end.



Generally in more cases of bridge designs we have to be consider gravity loads and also provide ductility property to the entire bridge. Now, in this we have to consider DL load case only and the dead load calculation are clearly observed as below.

DEAD LOAD CALCULATIONS:

For any type of bridges, we have to be consider self-weight



After the completion of analysis stage, we have to go for the Design stage and design the steel members as well as concrete members is also well.

After the completion of analysis stage, we must go for the Design stage. In this we must select material as concrete and then select code as IS: 456-2000, then go for the "define parameters" such as,

FC 30000 KN/M^2 (grade of concrete M30)
FY MAIN 415000 KN/M^2 (grade of steel Fe 415)
FYSEC 415000 KN/M^2 (grade of steel Fe 415)
RATIO 4 %(As per the clause 33.2 of IS: 456-2000 the ratio of longitudinal percentage is considered as 1 to 4%)
RFACE 4(The arrangement of reinforcement in along four direction's)
TRACK 0(Beam and column minimum details are printed)

All the above parameters we can assign to the entire structure by using option assign to view. Then we have to go for the "commands" option and then select,

DESIGN BEAM (Assign to the along X&Z direction members only)
DESIGN COLUMN (Assign to the along Y direction members only)
DESIGN SLAB/ELEMENT (Assign to the plates only)
TAKE OFF (It will assign automatically).

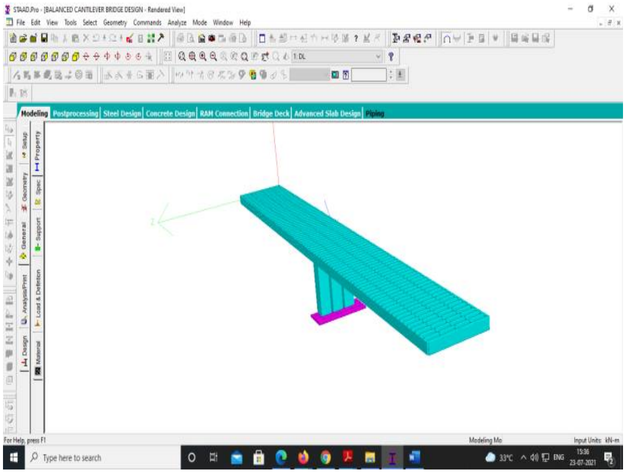


Table of Dead Load Shear Forces and Bending Moments

Section	x from left ( )	h ( )	V (kN)	M (kNM)
A	0	40	27.40	0.00
B	8	40	18.32	182.84
C	16	40	9.24	293.04
D	24	40	0.16	330.59
E	32	41.2	-9.00	295.21
F	40	44.8	-18.46	185.39
G	48	50.8	-28.51	-2.48
H	56	59.2	-39.47	-274.39
I (L)	64	70	-51.62	-638.72
I (R)	64	70	51.78	-638.72
J	72	59.2	39.62	-273.14
K	80	50.8	28.67	0.00
L	88	44.8	18.61	189.10
M	96	41.2	9.16	300.16
N	104	40	0.00	336.78

Table of Live Load Shear Forces and Bending Moments

Section	x_x ( )	V (kn)	M (knM)
K	0	42.99	0.00
L	8	34.10	272.78
M	16	25.20	403.24
N	24	16.81	432.89

Section	VDL (k)	VLL+IMP (k)	VD	MDL (k)	MLL+IMP (k)	MD^+ (k)	MD^- (k)
A	27.40	45.59 -10.75	72.99	0.00	0.00	0.00	0.00
B	18.32	38.92 -10.75	57.24	182.84	311.33 -85.99	494.17	0.00
C	9.24	32.24 -10.75	41.48	293.04	515.91 -171.97	808.95	0.00
D	0.16	25.57 -12.23	25.73	330.59	624.13 -257.96	954.72	0.00
E	-9.00	18.90 -18.90	-27.90	295.21	646.37 -343.94	941.58	-48.75
F	-18.46	-25.57	-44.03	185.39	624.13 -429.93	809.52	-244.24
G	-28.51	-32.24	-60.75	-2.48	515.91 -515.91	513.43	-518.39
H	-39.47	-38.92	-78.39	-274.39	311.33 -601.90	36.94	-876.29
I(L)	-51.62	-45.59	-97.21	-638.72	-687.88	0.00	-1326.60
I(R)	51.78	51.89	103.67	-638.72	-687.88	0.00	-1326.60
J	39.62	47.93	87.55	-273.14	-343.94	0.00	-617.08
K	28.67	42.99	71.66	0.00	0.00	0.00	0.00
L	18.61	34.10	52.71	189.10	272.78	461.88	0.00
M	9.16	25.20	34.36	300.16	403.24	703.40	0.00
N	0.00	16.81	16.81	336.78	432.89	769.67	0.00

Table of Combination of DL & LL+IMP to get VDesign and MDesign

IV. STAAD PRO OUTPUT RESULTS

C O L U M N D E S I G N R E S U L T S

M30 Fe415 (Main) Fe415 (Sec.)

LENGTH: 10000.0 mm CROSS SECTION: 2000.0 mm X 2000.0mm
COVER: 40.0 mm
** GUIDING LOAD CASE: 1 END JOINT: 408 SHORT COLUMN
DESIGN FORCES (KNS-MET)

DESIGN AXIAL FORCE (Pu) : 9274.2

		About Z	About Y
INITIAL MOMENTS	:	10.05	1598.56
MOMENTS DUE TO MINIMUM ECC.	:	803.77	803.77

TOTAL DESIGN MOMENTS : 803.77 1598.56

REQD. STEEL AREA : 5545.14 Sq.mm.
REQD. CONCRETE AREA: 693142.12 Sq.mm.
MAIN REINFORCEMENT : Provide 28 - 16 dia. (0.14%, 5629.73 Sq.mm.)
(Equally distributed)
TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties @ 255 mm c/c

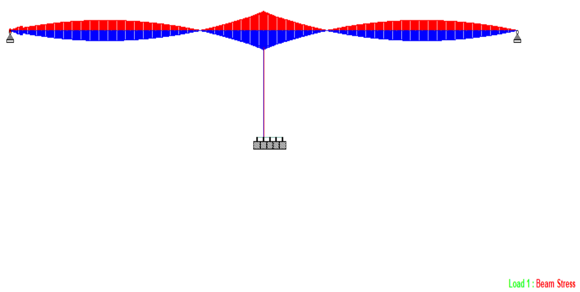
SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)

Puz : 55651.07 Muz1 : 9236.97 Muy1 : 9236.97

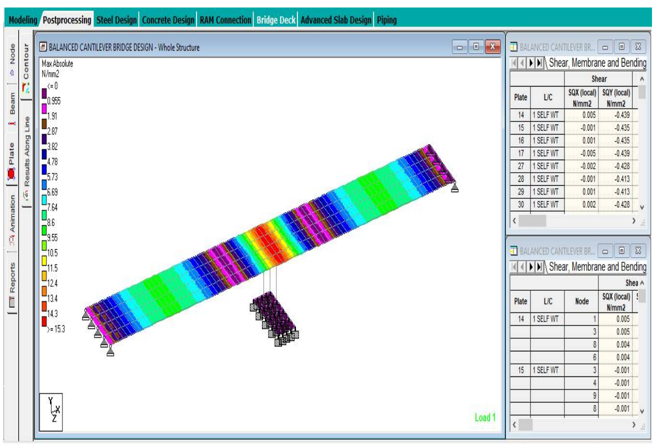
INTERACTION RATIO: 0.26 (as per Cl. 39.6, IS456:2000)

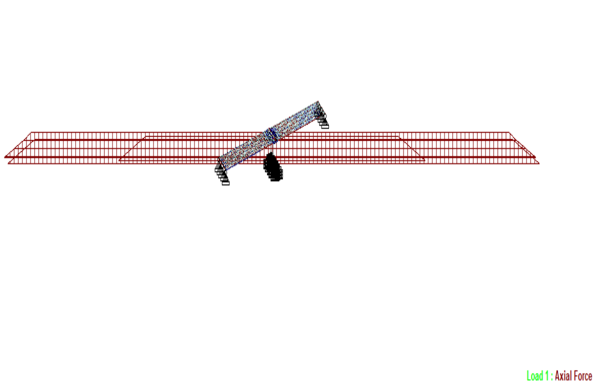
SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)

WORST LOAD CASE: 1
END JOINT: 205 Puz : 55676.25 Muz : 8662.04 Muy : 8662.04 IR: 0.49

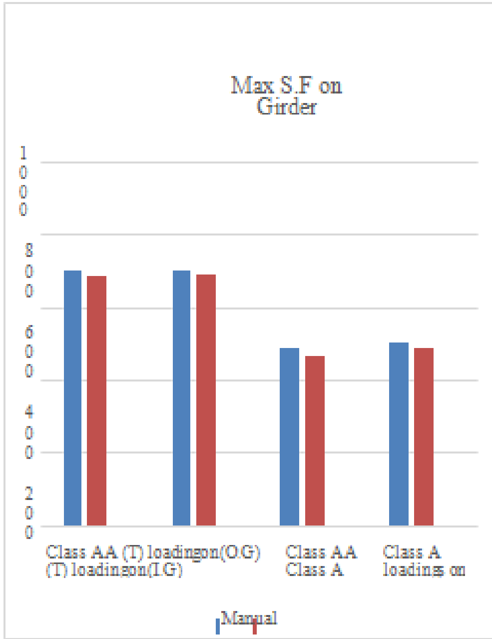


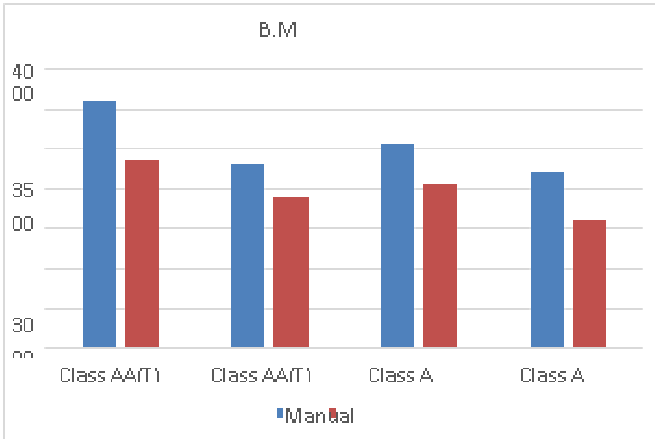
BEAM STRES DIAGRAM





Axial force diagram





V. CONCLUSION

1. The specified reinforcement and spacing for the bridge are going to be figure out by analysis the value from staadpro.

2. This will give the entire study and behavior of bridge Structure under different IRC loadings condition on staadpro.
3. The software are very helpful for constructing the economically bridge structure.
4. It's observed that the design mixture of concrete taken in the staad pro is M30, manually design by M35
5. Maximum BM occurs within the class AA Tracked loading vehicle so this loading is the most crucial case for maximum BM in longitudinal girder
6. The bending moment value occur in the outer girder is above the bending moment value occur within the inner girder.
7. The shear force value occur within the inner girder is more than the shear force value within the outer girder.
8. Maximum SF occurs for class AA Tracked vehicle loading so class AA Tracked vehicle loading case is the most crucial case for optimum Shear force in longitudinal girder.
9. With in the design of slab panel, Maximum shear force and the maximum bending moment value occur in the in the class AA tracked loading hence class AA tracked vehicle case is the most crucial case in the term of maximum shear force and bending moment.
10. According to the courbon's method, the very best importance given to the Outer Girder and Second for Inner Girder.
11. Here we will clearly see the effect of the pigeauds method over the effective width method within the slab panel where the pigeauds method will be used for higher span, and use for two-way slab also.
12. Thestaadproresultnearlyreachesthevaluesobtainedbycourbon'smethodforclassAAtrackedvehicleandforclassAloading ,for class AA Tracked and class A loadings the staad pro result is reduced by 5% to 10% as compared to courbon'smethod.

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