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AN INTERNATIONAL E-JOURNAL ON
EMERGING TRENDS IN SCIENCE, TECHNOLOGY AND MANAGEMENT

Analysis and Design of Composite Bridge and there Design Criteria

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Abstract*— In Gadchiroli district, I found out there are village areas such as Krishnar Tola, Vasamundi, Marda, Jaller, Pushtolla, Laheri, Allapalli there is no possible way to transport during the rainy seasons because of high food conditions it affects the transportation of heavy vehicles to village areas. There will be the project which is carried by government of India with the help of Public Work Department of Gadchiroli carried a project which was named 'BAILY BRIDGE' due to this project Krishnar Tola, Vasamundi villages in Gadchiroli District has been helpful for travelling and other possible transportation Solutions by adopting composite bridge structures. In this project, we will discuss those things briefly. Composite structures are nothing but the different kinds of components joint together without disturbing their engineering properties as well as their structural behavior. Composite Bridge is the most innovative idea and Indian Government had been Constructing many Steel sections over Concrete, bituminous roads over concrete, elastic bearings on bridges, trusses in Concrete such kinds of collaboration of two or more structural components/ materials with having their safe load combinations

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Keywords— **Dispersion edge, Tyre imprint / impression, Overlap of dispersion, Deck Slab, Class 'A' Loading, IRC6, Impact Factor, stiffener**

I. INTRODUCTION

The mostly type of composite construction used of steel and concrete material to form steel-concrete composite structures. It is a very well-known information that steel members are susceptible to buckling, while their tensile strength is 200000 pascal . So, plain concrete members cannot break a large intensity of compressive force; however, their tensile strength is minimum.Simultaneously the use of steel and concrete refers the structural designers to take efficiency of steel and concrete and neutralize each material's strengths and weakness by the collaborating of the other material. They are now taking similar standards for high rise buildings, with close to 70 to 80% of the structural systems considered composite ceiling and strut materials. Furthermore, composite wall systems are as well as being developed at a quick rate. Best way to optimism this design of these systems, is the understanding of the local and global buckling properties of these all members.

Though out the mathematicians govern the design of composite materials was developing long time ago, significant advancements in design methodologies of composite materials were first made in the 1960s, driven by the invention of computers. Computers was developing that could manipulate significant amounts of data, analysis and Number of methods were used to design for composite materials. These methods relied on plots of empirically determine materialistic additives. The bridge, which we're going to study, is a composite type of bridge that is constructed in the Gadchiroli district of Maharashtra State. Because of some misconceptions, the project of compensation of bridges by the public works department is considered this project name. Bailey Bridge

The public works department is focusing on changing old criteria that were used before bridges and adopting composite bridge criteria to design bridges because of their advantages. The first bridge in Gadchiroli was constructed on a village road in Potegaon with a 55-metre span and no pair support. We have to analyse this bridge as per seismic load conditions as per the IRC Specifications with moving load analysis in the deck slab.

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II. LOADS ACTS ON BRIDGES

There are major 12 forces acts on the body of bridges-mentioned below

1. Dead Load 2. Live Load 3. Water Pressure
4. Impact Load 5. Buouncy Effect 6.Thermal Effects
7. Wind Load 8. Seismic Forces 9. Longitudinal Force
10. Earth Pressure 11. Centrifugal Forces
12. Deformation Stresses

A. Data and Calculation

In this research we are going to discuss about moving load which is one of the part of Live load acted on the span of the bridge having a 55m span without having Pair Supports, I collected data from the Potegaon Site during construction process mentioned below:

Clear span= 55m
Road Width = 10m
Pathways provided=1.2m
Material Provided= M25 Grade Concrete and
Fe415 Grade Steel

For the designing of the bridge we have to assume some data for check

Slab Thickness (T)= 0.200m= 200mm
Assume Slab thickness = 0.200m = 200mm

Provide 12mm diameter bar with clear Cover 40 mm
{ Cl. 304.3 , Pg No 21 ' IRC 21 }

effective depth of slab (D eff) = D - C/c cover - dia ÷2 =
O. 800 - 0.040- (12÷2) = 793.6 mm

Effective depth of slab (D.eff)= D - C/C distance - dia^2/2
Bearing Width should not less than 800mm < 55m
Thus,
Clear span (Leff) is at least of
clear Span + bearing width = (150×2) + 55000 = 55.300m

III. PAGE DEAD LOAD , BENDING MOMENT & SHARE FORCE

A wearing coat of 60mm is allowed.
① Dead load of slab = Depth of Slab x density Of Concrete
= 800×25
= 20 KN /m.sq/m
② Dead load of wearing Coat = Wearing Coat thickness x density of wearing Coat = 0.062×22 = 1.32 KN

from ①+ ② we get total load = 21. 32 KN/m^2/m

The B.M. occured due to D.L. (BM @ DL) = WL ^ 2 eff / 8
= 21.32 x 55 ^ 2 / 8
= 8061•62 kN/m

IV.

TOTAL LIVE LOAD CALCULATION

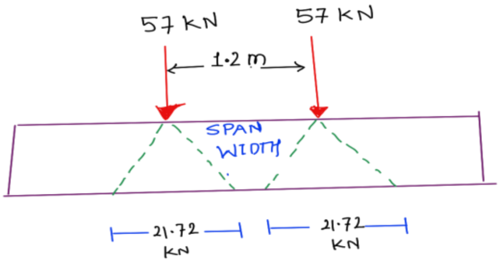
A. Consider section 1-1

The load dispersion of the Tyre imprint / impression Can be considered @ angle of 45° throughout the depth of slab and evaluate by using equation

B eff. = B1 +2 (D + w. c)
= 20+2 (0.8 +0.060)

B eff. @ 1 = 21.72 m

Thus
B eff. @ 2 = 21.72m



Thus position @ bearing is too small nearly equals to 0.04 it Can be Considered to be loaded
Thus
B•eff. = Shoulde/ kerb/ Roadways + B. eff@ (1,2)
= 1.20 + 21.72
= 22.92m

B. Effective Width of Dispersion, Consider Section 2-2

The effective width of a dispersion of a single wheel as per IRC 21:2000, Pg. 52

$$\alpha \cdot x \left(1 - \frac{x}{L_{eff}}\right) + bw$$

$x \rightarrow$ Distance of the Centre of gravity of Concentrated load nearest Support

$L_{eff} \rightarrow$ Effective depth

$\alpha \rightarrow$ Constant depending upon $\frac{L \text{ of Span}}{W \text{ of Span}}$

$bw \rightarrow$ Width of Concentrated load Area

TABLE I

class A vehicle loading

axle load (ton)	ground contact area	
	b (mm)	w (mm)
11.4	250	500
6.8	200	380
2.7	150	200

r B • eff / L . ff = 55.3 / 10 = 5

from IRC-21:2000
Pg. 53 , Table 1

α = 2.60

W. eff = 5×21.72 (1- 21.72)
= 61.71

Now
Bw = 0.5 +2(0.060) = 0.62m

W.eff = 2.60 x 21.72 (1- 21.72 / 55) + 0.62m
= 34.79m

Same as
W.eff ① = W.eff ② = 34.79m
Check for the dispersion overload

It (C/c distance between the axial load) / 2 < W•eff / 2
55/2 > 34.79 / 2
27.5 > 17.40

The overlap is not occurs

C. Impact Factor

for Class 'A' Loading as per IRC6 , Pg.22 and Clauge 211.2 impact factor is given by Equation

I.F.= 4.5 / 6+ L.eff = 4.5 / 6+55 = 0.073

Intensity of distributed load (1) Can be evaluated using following equation
I= I.F. x Axial Load/Area under Influence load

D. Live Load and Share force

To obtain maximum Share force the wheels are adjusted in such a manner that the dispersion edge just touches the support

B.eff ② and ① shall be 1.13 m

I (Intensity) = 1.073 x4×57 / 55.3 x 8.8 = 502.72 KN/m ^ 2 /m
check for the dispersion overlap

It (C/c distance between the axial load) / 2 < W•eff / 2

Dispersion @ bottom of the deck Slab
Here,
W.eff. / 2 = 11.90 / 2 = 5.95
C/c Axial load / 2 = 0-6

W.eff. / 2 > 0.6
It means, there is Overlap Occurred

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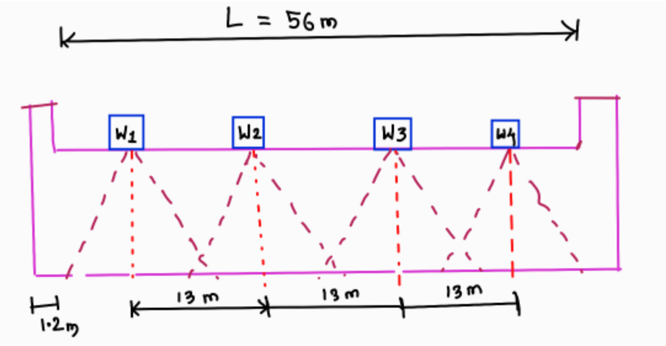

Total effective length = 1-2+13+13+13+1.2 = 41.4 m

# Intensity of Distributed load
I = I.F. X axial load / Area under Influence of load
I = 0.28× (114 x 39) / 2.33 X39
I = 13.69 KN/m ^ 2/m

E. Live load and share force

To obtain maximum share farce the wheel are adjusted in such a way that the dispersion edge just touches the support Support (B.eff @ 1 and 2) shall be 1.13 m

Thus
B-eff. total = 1.13 +1.20 = 2.33 m.
J = 1 - N / 3 = 1- 0.294 / 3 = 0.902

Q= Moment of Resistance Constant

Q = 1.104 $\frac{1}{2} \times N \times J \times \sigma_{cbs}$

Total BM(max) = B.M. (d.l) + B.M.
(I .I) = 8061.62 +65.71 =8127.33 KN / m ^ 2 / m

Total S.F. (max) = S. F @D.L + S. F @ L-
= 586.3 kN+ 1281.34
= 1867.64 KN / m ^ 2 / m

FONT SIZES FOR PAPERS

Sr. No.	Total Research Paper Studied		
	Author Name	**Paper Name**	**Abstract**
1	Amir H. Wadi	**Soil Steel Composite Bridges Research Advantages and Application (2019)**	*Sod-steel composite bridges are regarded as competitive structures since they are a more affordable alternative to concrete bridges with a comparable span. This typically motivates practitioners to push the boundaries of their design and widen the scope of their use, which includes how well they function on sloping terrain. This suggests that the majority of design methodologies are always being improved in an effort to handle new market difficulties and, concurrently, achieve better design and construction. The recent research efforts to increase recognition of the structural performance of soil-steel composite bridges (SSCB) are compiled in this thesis. The performance of SSCB in sloping terrain is examined in the first section of the thesis, where three case studies' behaviour is predicted using numerical simulations. This includes avalanche loads and structural reaction in sloped soils (Paper I).paper II). We became aware of the significance of the soil configuration around the wall conduit and how it affected the structural reaction thanks to the investigation. Although the vulnerability of SSCB with shallow soil cover is highlighted by the presence of surface slopes, deeper soil cover may help to mitigate the effects of steep slopes and avalanche loads. Additionally, it was discovered that the downhill soil structure significantly influences the flexural response. The study's conclusions were also used to develop techniques for*

			providing estimations of the normal forces acting beneath sloped soils and avalanches.
2	Ali Kaveh, Mohammad Mahdi Motesadi Zarandi 1	**Optimal Design of Steel-Concrete Composite I-girder Bridges Using Three Meta-Heuristic Algorithms (2019)**	*Constraints also include all of the standards outlined in the design code of practise. The comparison analysis has demonstrated that the VPS algorithm outperforms CBO and ECBO in terms of performance. 3)Composite Bridge Girder Analysis and Comparative Study (2018) Indian student Patil M.B. PG, SKN Sinhgad College of Engineering, Korti, Pandharpur D.D. Mohite, S.V. Lale, P. Pawar, S.S. Kadam, and C.M. Efforts will be made to use SAP 2000 software to check the analysis of the bridge. The results of the structural analysis using software are contrasted with those from calculations done by hand.*
3	Ricardo Fabeane. Moacir Kripka and Zacarias M. Chamberlain Pravia	**Composite Bridges Study Of Parameter To Optimized Design (2017)**	*An optimization problem that tries to lower the cost of the bridge cross-section by changing the dimensions of the steel girders has been invented to meet the desired goals. The investigated area of simple span bridges with various spans and a variable number of steel girders in their cross-section were used to apply the suggested formulation by developing a design process in MS Excel and using the over-to-find optimism sections.*
4	Ms. Patil M.B. , C.M. Deshmukh , Dr.C.P. Pise, Y.P. Pawar , S .S .K adam , D .D . Mohite, S.V. Lale	**Comparative Study of Girders for Bridge by Using Software (2016)**	*Comparing composite bridges to other types of bridges, the design and analysis of various steel and concrete girders using various software programmes has shown that composite bridges provide the maximum strength. The analysis of the girder will be checked in this project using SAP 2000 software. Pick three girders that will be suitable for the project's composite bridges.*

5	Kazimierz FLAGA, Kazimierz FURTAK	**Application Of Composite Structures In Bridge Engineering. Problems Of Construction Progress And Strength Analysis (2014)**	*Cracow University of Technology's Building Engineering Institute is located in Poland. Steel-concrete composite structure has been employed in bridge construction for many years. This is a result of the sensible application of the strength properties of the two materials. The orthotropic steel plate used in steel bridges is also preferred to the pre-stressed or reinforced concrete deck slab because of its higher bulk, improved vibration dampening, and longer lifespan. Composite girder bridges are the most frequently used, particularly in small and medium-sized highway bridges, however the spans can reach above 200 m. Longer spans are supported by steel truss girders. Additionally, composite bridge structures are used on cable-stayed bridge decks with main girder spans between 600 and 800 metres. The issue is focused on how religious considerations, such asshrinkage and creep of concrete, as well as the effects of temperature on stresses, strains, and internal force redistribution.The purpose of this article is to describe the building process and strength analysis concerns associated with these type of buildings. A lot of consideration is given to the design and computation of the shear connections characteristic for the items under investigation. The authors' primary focus was on the difficulties associated with single composite constructions. The effect of assembly states on the stresses and strains in composite parts is demonstrated. The concerns deal independently with the effects of structural components, such as shrinkage and creep in concrete, as well*

			as temperature influences on stresses, strains, and the redistribution of internal forces.
6	Boxin wang, Chengkui Huang	**Study on Crack Resistance Steel Fiber reinforced self stressing Concrete in old bridge.** **(21-10-2008)**	*Steel fibre reinforced self-stressing concrete (SFRSSC) is a revolutionary type of fibre reinforced composite material. It has a wide range of applications in civil engineering as a result of its well-known remarkable properties, including self-expansive performance and excellent tensile resistance. It is no longer usually recognised as an effective reinforcement for restoring historic bridges, though. This study's major goal is to increase fracture resistance in the areas of the old bridges that experience negative bending moments by using SFRSSC.First, a laptop evaluation of the internal force of continuous t-beams with five spans is provided by this work. The results show that the expansion action of the SFRSSC can successfully lower the internal force in the vicinity of a negative bending moment.*

membership of any professional organization (e.g. Senior Member IEEE).

To avoid confusion, the family name must be written as the last part of each author name (e.g. John A.K. Smith).

Each affiliation must include, at the very least, the name of the company and the name of the country where the author is based (e.g. Causal Productions Pty Ltd, Australia).

Email address is compulsory for the corresponding author.

F. Summery on literature Review

constructions made of a combination of diverse building materials, such as concrete, steel, masonry, and wood. Steel-concrete composite structures, the most popular type of composite construction, are made from steel and concrete. It is a well-known fact that steel members can buckle, despite having a tremendous tensile strength. On the other hand, while plain concrete components may survive significant compressive forces, their tensile strength is quite weak. Because of this, using steel and concrete at the same time enables structural designers to benefit from both materials while balancing out the disadvantages of each. In recent years, composite steel-concrete constructions have gained a lot of popularity. They are currently the system of choice for tall constructions made of a combination of diverse building materials, such as concrete, steel, masonry, and wood. Steel-buildings are the most prevalent form of composite construction, with composite floor and column systems making up over 70% of the structural systems. Additionally, composite wall systems are also progressing quickly. Understanding the local and global buckling behavioral of these elements is essential to the best design of these systems.

i. Why use Composites?

One of the key justifications for using composites rather than traditional products is weight loss.Composite materials are stronger than other materials while still being lightweight.For instance, carbon fibre is appropriate for your design because it is 1/5 the weight and 5 times stronger than 1020 steel. The insulation provided by composites against heat, chemicals, and electricity is another benefit over traditional materials. Contrary to traditional materials, composite materials can possess a variety of qualities that aren't typically present in single materials.Problem Formulation / Identification

ii. *Problems Formulation*

Gadchiroli district, I found out there are village areas such as Krishnar Tola, Vasamundi, Marda, Jaller, Pushtolla, Laheri, Allapalli there is no possible way to transport during the rainy seasons because of high food conditions it affects the transportation of heavy vehicles to village areas. There will be the project which is carried by government of India with the help of Public Work Department of Gadchiroli carried a project which was named 'BAILY BRIDGE' due to this project Krishnar Tola, Vasamundi villages in Gadchiroli District has been helpful for travelling and other possible transportation Solutions by adopting composite bridge structures. in this project, we will discuss those things briefly.

iii. Aims:-

To design and analyse the bridges which are constructed in Gadchiroli district using staad pro software as well as check Seismic Analysis to check how much load it should carry.

iv. Objectives:-

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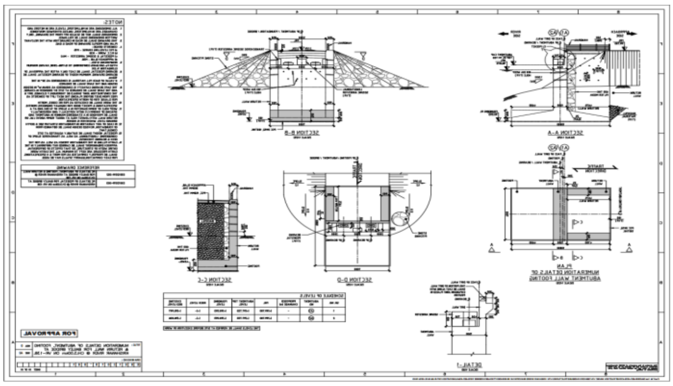
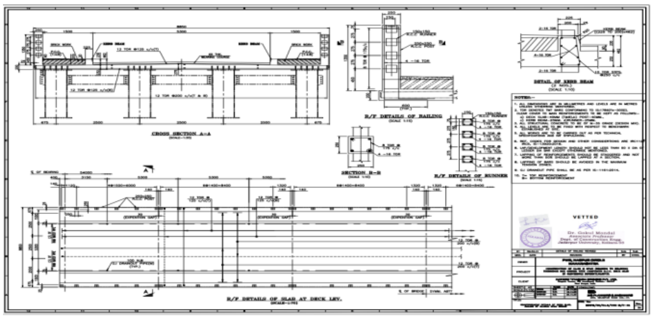
- *To study the method of construction of composite Structure in Bridges.*
- *To Study the elements used in Composite Bridges.*
- *To find out Advantages of composite structures its durability, Maintenance, Design flexibility, Sustainability, Economies as compare to other bridges.*
- *To Design and analyse Longest possible Span without Any Pear Support.*
- *To describe safe Design Criteria for composite bridges using Stadd pro Softwere.*
- *If its not stable according to report then justify the new Design Criteria by which the bridges should be safe.*

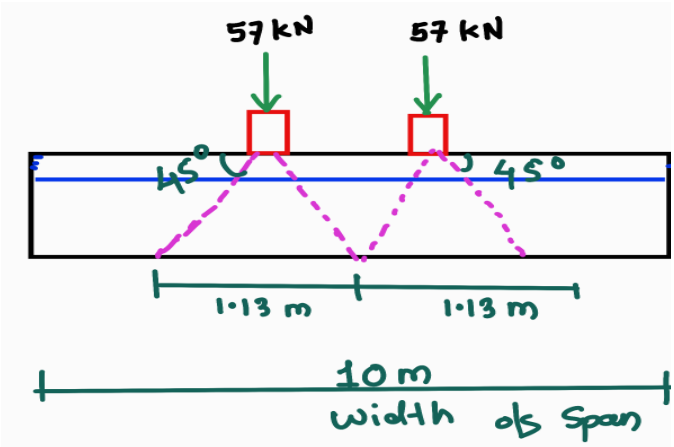
v. *Outline of the Project Work,*

- Collect composed bridge drawings which are completed but not analyse from Public Works Department Gadchiroli.
- Collect the Wind Load, Live load, Seismic Load, Seismic Coefficient and all other theoretical data from Preferred IS Codes.
- Make models in staad Pro Software as per the mentioned dimension of Bridges Drawing.
- Apply the necessary supports, reactions and load case details to the components of bridge such as girders approaches spans and others.
- With the help of staad pro software run the analyse for Response Spectrum, Seismic Coefficient Analysis, Moving Load analysis.
- After analysis all the following criteria prepare report on it and suggest if any corrections require

G. Figures and Tables







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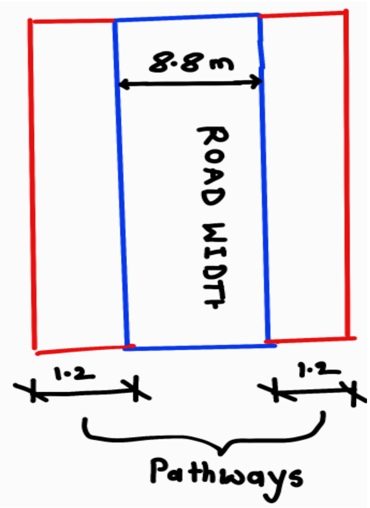

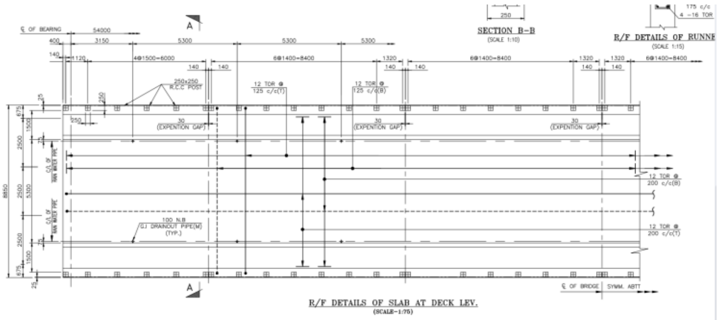

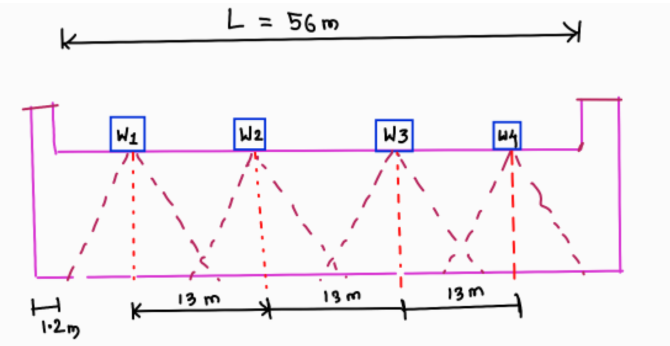

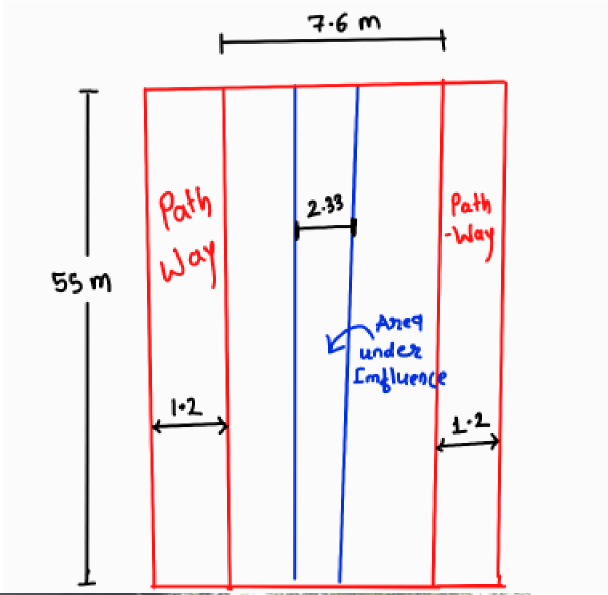

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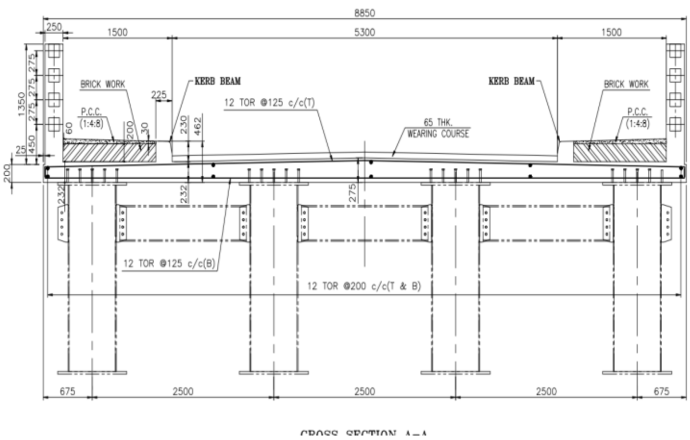

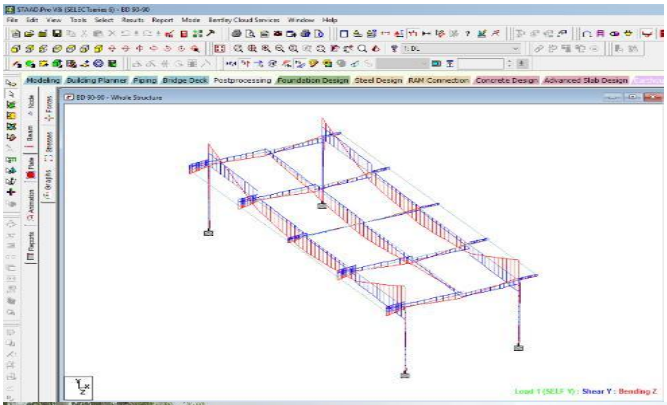

V. CONCLUSIONS

Design Constrains

for M25 Concrete and fe415 steel (from IRC 21)

m = modular ratio = 10 ..... (p.g 18,Table 9Note

N = Nutral Axis Constant = N = 0.294

J = 1 - N / 3 = 1- 0.294 / 3 = 0.902

Q= Moment of Resistance Constant $\frac{1}{2} \times N \times J \times \sigma_{cbs}$

Q = 1.104

Total BM(max) = B.M. (d.l) + B.M.
(I .I) = 8061.62 +65.71 =8127.33 KN / m ^ 2 / m

Total S.F. (max) = S. F @D.L + S. F @ L-
= 586.3 kN+ 1281.34
= 1867.64 KN / m ^ 2 / m

VI. CONCLUSIONS

Slab Design

Effective depth required (D. eff) =

$$\sqrt{\frac{B.M.(max)}{b \times Q}} = \sqrt{\frac{8127.33 \times 10^6}{1200 \times 1.104}}$$

= 219 mm also Considered as 250 mm which is corrected

Area of longitudinal reinforcement(A.st.) =

$$\frac{B.M.(max)}{\sigma_{st} \times j \times d_{eff}(Provided)}$$

B.M. (max) A.St j x dett (Provided)= 8127.33 x 10 ^ 6 / 200 x 0.902 x 250

Ast = 180206.87 mm ^ 2

Distribution Steel should be designed for bending moment

= 0.3 x B.M. @ LL +0.2 x BM@DL
= 0.3 x 65.71 + 0.2 x 8061.62
= 1632.037 KN. m

effective depth available in the width wise direction with 12 mm dia. bar = D.eff. provided - dia. longitudinal bar / 2 - dia. distribution bar / 2

According to the calculated data and given load transformation cross-checked in Staad Pro and we found a Positive response to the Above Calculations.

ACKNOWLEDGMENT

The Authors Are Grateful To The Tulsiramji Gaikwad Patil College Of Engineering And Technology, Nagpur, Maharashtra, India, For Providing Guidance And Resources To Carry Out This Work.

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