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Relative Study of RCC T-Beam Bridge Superstructure using IRC Codes and AASHTO Code

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Abstract: Bridges are the structures which are built to associate the route isolated by stream or valley. In India, there are various codes which are utilized to design bridges. Each code have distinctive structural design provisions and methods. This examination incorporates two Indian Road Congress (IRC) codes which are utilized to design bridges those are IRC: 21-2000 and IRC:112-2011. IRC: 21-2000 code of design rest upon the working stress technique and limit state technique of design is utilized to frame IRC: 112-2011 code. In this study, three single span of T-beam girder bridge of 15m, 20m and 25m length are planned and designed according to both IRC codes and American Association Of State Highway Transportation Officials (AASHTO) code and STAAD PRO V8i Software is utilized to dissect the model. Two examinations are made. The primary examination is in between the design and analysis results by IRC: 21-2000 working stress technique with the results of AASHTO and another correlation is in between IRC 112-2011 limit state technique with the consequences of AASHTO and it will be inferred what examination have pretty much similitudes and furthermore the most ideal structural design technique or code for RCC T-beam bridge.

Keywords: IRC:21-2000, IRC: 112-2011, AASHTO(LRFD)

I. INTRODUCTION

Engineers in India have been utilizing IRC 21-2000 for structuring bridges which has been set up according to working pressure technique for design, additionally IRC:112-2011 for RCC and prestressed spans has been presented by Indian road congress which has been set up according to limit state technique. Both the codes have various rules for structuring bridges. In working pressure technique, it has been seen that 13 is the permissible length and depth proportion while 20 is the most preferable length and depth proportion in limit state technique. 30 to 35% decrease in cost of cement is conceivable utilizing limit state technique as collated with working pressure strategy. This investigation is performed on RCC T-pillar connect. The bridge span is designed by utilizing IRC:21-2000, IRC:112-2011 code and AASHTO(LRFD) and dissected by utilizing STAAD Pro.. The results by both the codes are collated with the results of design and analysis of same span of RCC-T Beam Bridge by AASHTO. IRC6:2017 is used for load and load combination

II. METHODOLOGY

A. Working Stress Technique (IRC:21-2000)

1) *Effective span of Bridge*
   a) Clear span + Effective depth.
   b) Clear span + Width of bearing.
2) *Depth of Deck Slab*
   a) By assuming L/d ratio determine effective depth.
3) *Bending Moment calculation for dead load for each meter breadth of slab-*
   a) BM = (dead load) slab + (dead load) w.c.
4) *Bending moment computation-*
   a) IRC: 6-2017 is used for load and load combinations and BM is determined.
5) *Effective width dispersion-*
   a) Ld = Effective dispersion length

$$f+2(h+D)$$

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b) Beff = Effective dispersion width

K x X x (1- x/L) + bw & bw = g + 2h

Where,

f = Wheel or track contact length

h= thickness of wearing coat

D= overall depth of slab

Beff= eff. width of dispersion

K= dispersion width constant

X= CG. Of load

G= wheel or track width

6) *Area of reinforcement is calculated and checked for shear stresses.*

B. Limit State Technique (IRC 112-2011)

1) In order to determine the design bending moments and design shear forces, the B.M. and S.F. is multiplied with the factor of safety 1.5.

2) Again area of reinforcement is calculated for design bending moment and checked for shear.

C. IRC Load Considerations

1) *Dead Load:* In order to determine the dead load of members unit weight of materials are provided in the IRC code. These unit weights shall be used which are as follow.

a) Concrete (asphalt) - 2.2 t/m3

b) Concrete (Plain- cement) - 2.5 t/m3

c) Concrete (cement-reinforced) -2.5 t/m3

2) *Live Load*

a) *IRC Class A Wheeled Loading :* This loading is specially used for bridges and culverts which are constructed on permanent basis. A description about the loading and its way of application has been given in Clause no. 204 of IRC:6-2017.

b) *IRC Class 70R Wheeled Loading :* This loading is also used for bridges and culverts which are constructed on permanent basis. A description about the loading and its way of application has been given in Clause no. 204 of IRC:6-2017. In addition to this it is also stated that while designing Bridges for Class 70R loading should also be tested for Class A Loading because class A loading may give heavier stresses under certain circumstances.

3) *Live load Combination*

a) *For carriage way width (5.3 >CW) -* Class A (1lane) to occupy 2.3 m.

b) *For carriage way width (5.3 < CW > 9.6)* **-** Class 70R (1lane) or Class A (2lane).

c) *For carriage way width (9.6 < CW > 13.1)* **-**Class 70R (1lane) or Class A (2lane).

D. AASHTO Load Considerations

1) *Dead Load***-** While determining the dead load, the weight of all the structural components and other loads such as crash barriers, wearing coat, kerbs etc. The unit weights as shown below can be used for calculating dead loads.

a) *Concrete:* Normal Weight of 5.0 ksi < f 'c ≤ 15.0 ksi) + 0.001 f'c - 0.140

2) *Live load***-** HL-93 is the current vehicular loading used by AASHTO. There are different types of vehicular loads under live load.

a) *Design Truck:* This loading is applied in longitudinal direction.It comprises a design truck with three wheels. The first wheel has a loading of 8 kips and the other two wheels i.e. second and third wheel have 32 kips of load. The distance between the first and second wheel is 14 feet, but the distance linking second and third wheel varies in the middle of 14 ft to 30 ft.

1.

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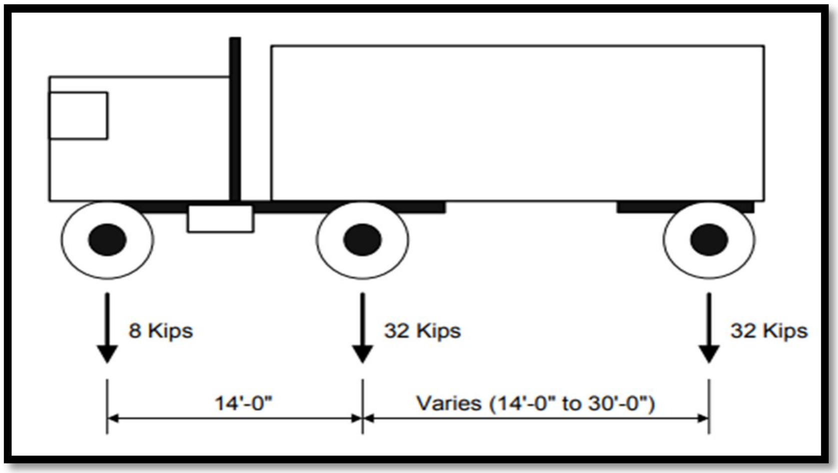

Fig.1 Design Truck

b) *Design Tandem:* The design tandem consist of two wheels; each wheel weighs 25 kips. Both wheels are separated by the distance of 4 feet.

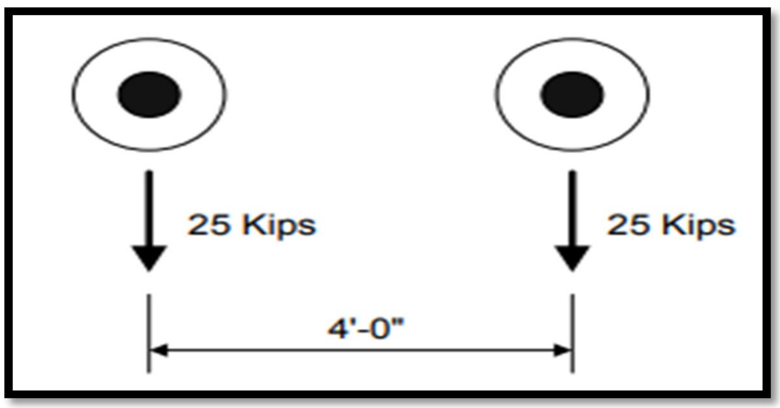

Fig.2 Design Tandem

c) *Design Lane Load:* The design lane load is loaded with 0.64 kips of invariable distributed load applied in longitudinal way for every linear foot.

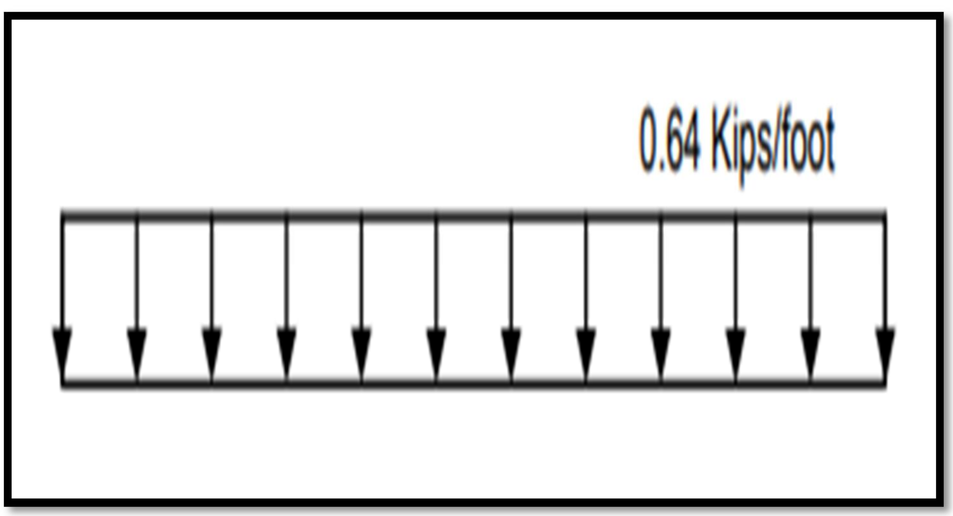

Fig.3 Design lane load

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E. Load Combinations

Load combinations include dead load and all the loads under live load such as vehicular live load, backfill pressure, centrifugal force, braking force etc. As per clause 202.3 of IRC: 6-2017, the governing load combination equations for both working stress technique and limit state technique are as follow.

1) For IRC - 1.35 DC+ 1.35 DW + 1.75SIDL + 1.75LL

The governing load combination equations As per AASHTO -Table 3.4.1-1 and 3.4.1.1-2

2) For AASHTO - 1.25 DC + 1.50 DW + 1.75 (LL + IM)

III.DESIGN AND ANALYSIS RESULTS

Analysis of main longitudinal girders of span length 15m, 20m and 25m respectively is carried out as per IRC and AASHTO code. IRC: 6-2017 is used for load considerations. Bending moment and shear force at different length of span is calculated and compared. Results are also compared on the basis of deflection.

A. Bending Moment and Shear Force For Dead Load And Live Load

1) Span 15m

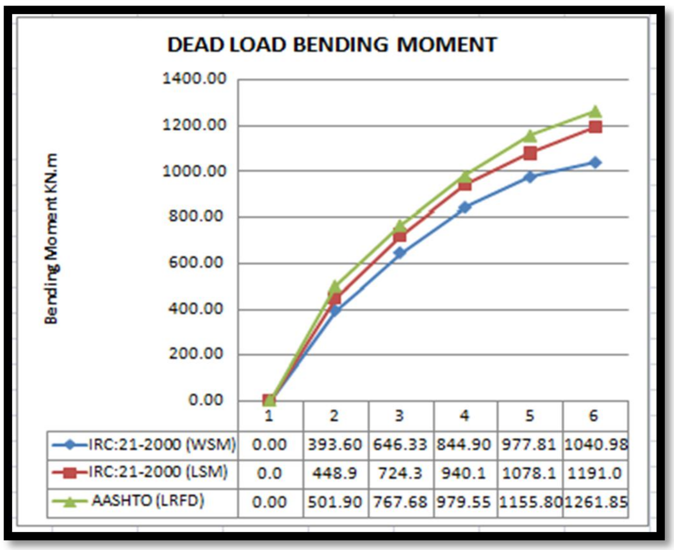

Fig.4 Dead load bending moment comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

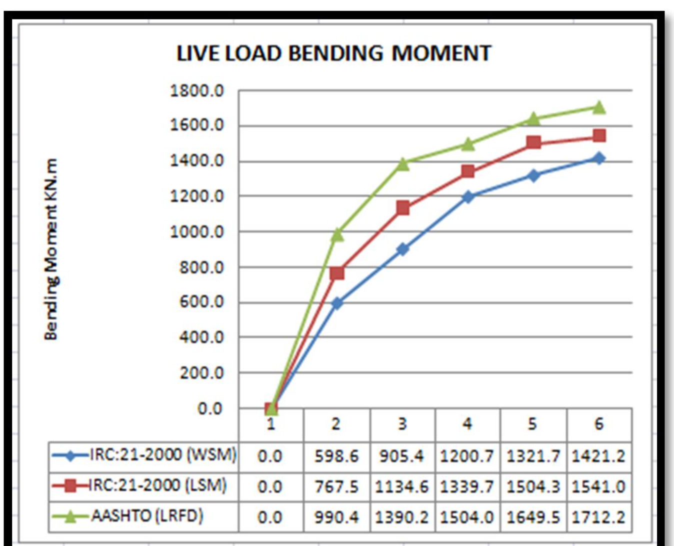

Fig.5 Live load bending moment comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

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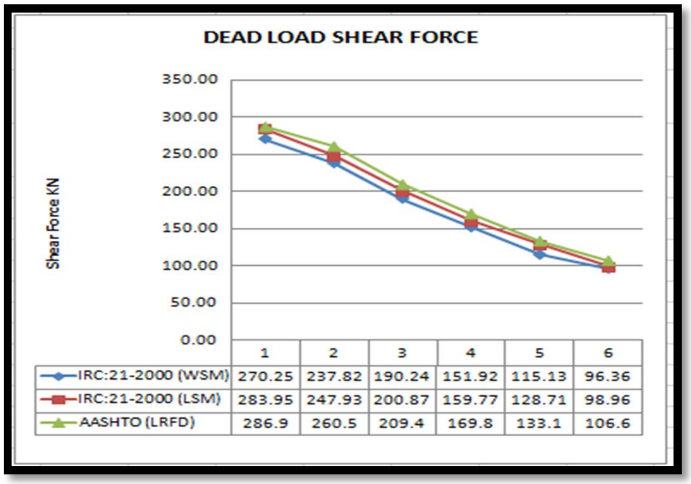

Fig.6 Dead load shear force comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

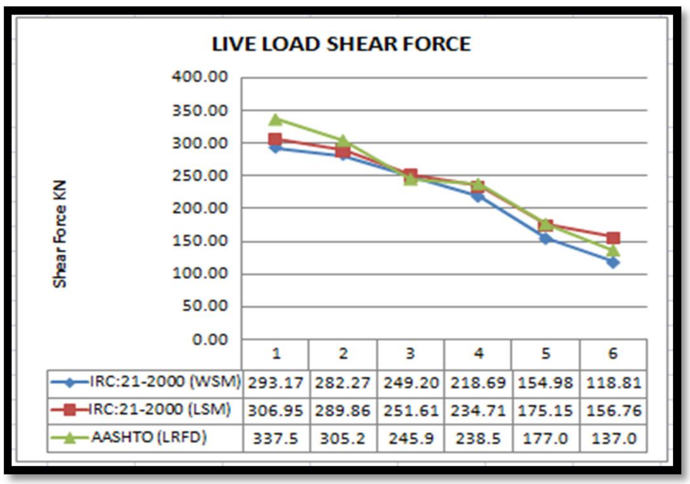

Fig.7 Live load shear force comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

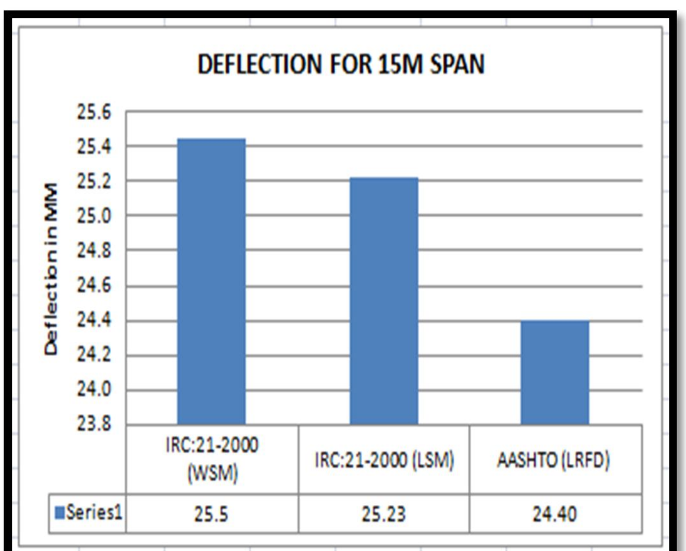

Fig.8 Deflection comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

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2) Span 20 m

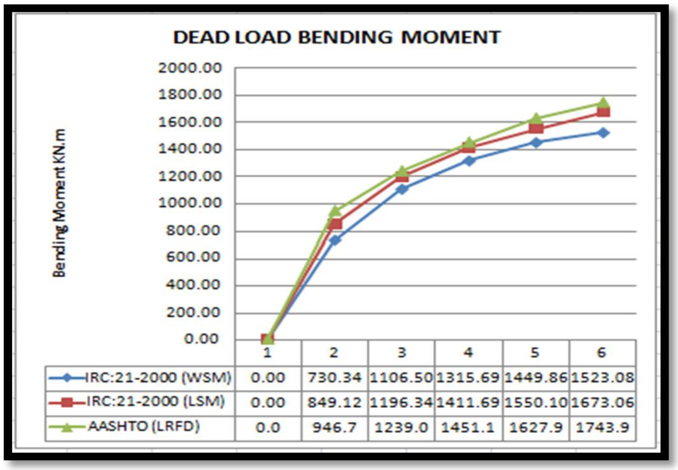

Fig.9 Dead load bending moment comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

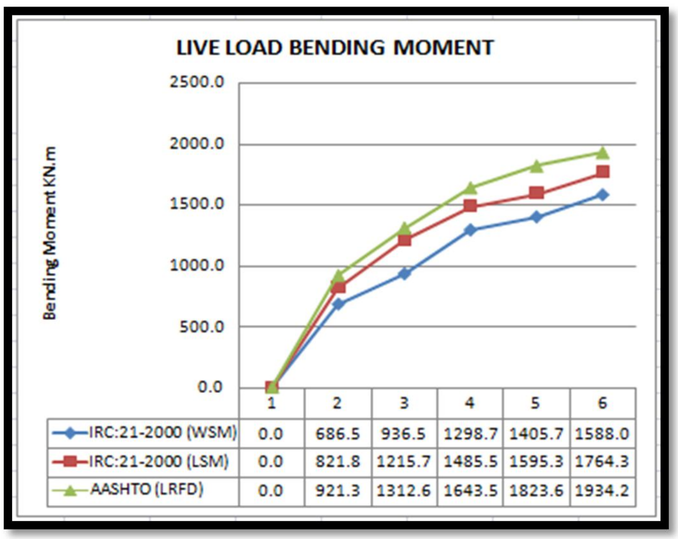

Fig.10 Dead load bending moment comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

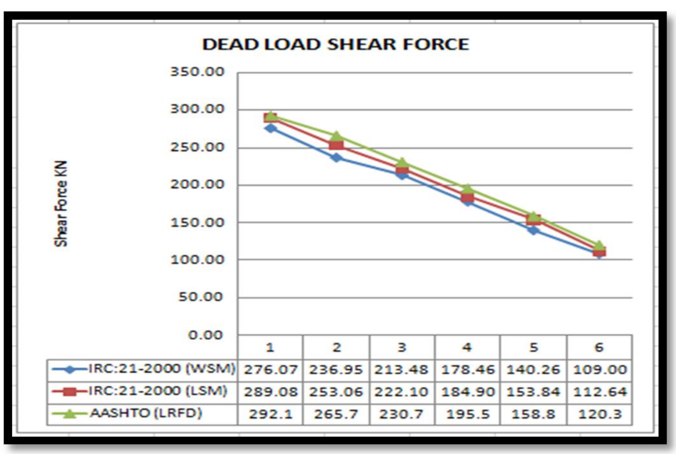

Fig.11 Dead load shear force comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

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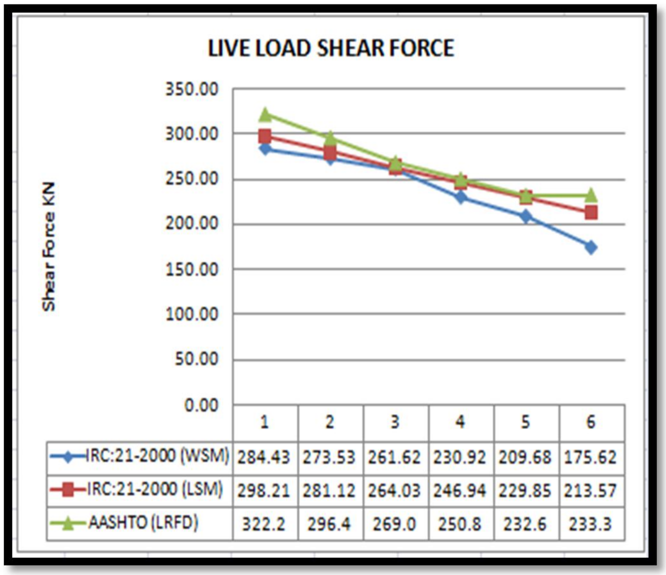

Fig.12 Live load shear force comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

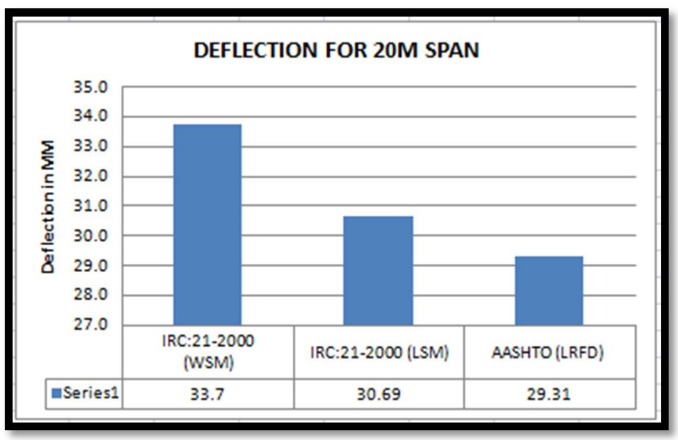

Fig.13 Deflection comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

3) *Span 25 m*

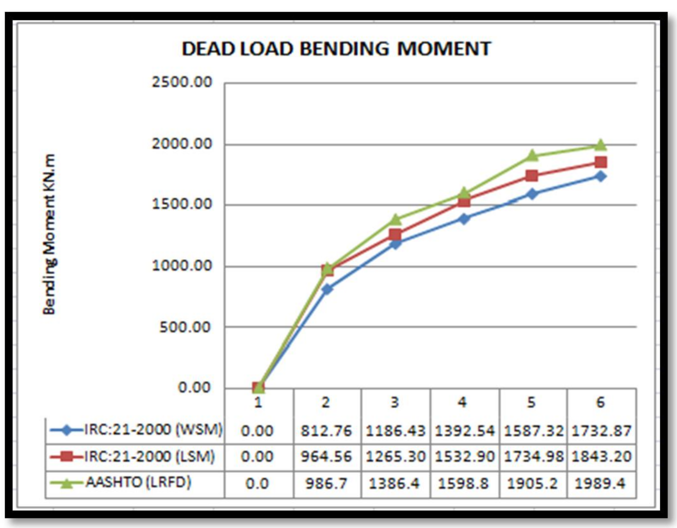

Fig.14 Dead load bending moment comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

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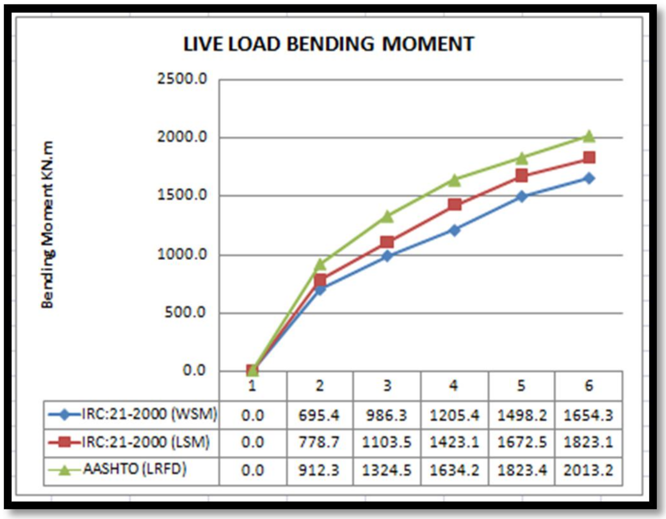
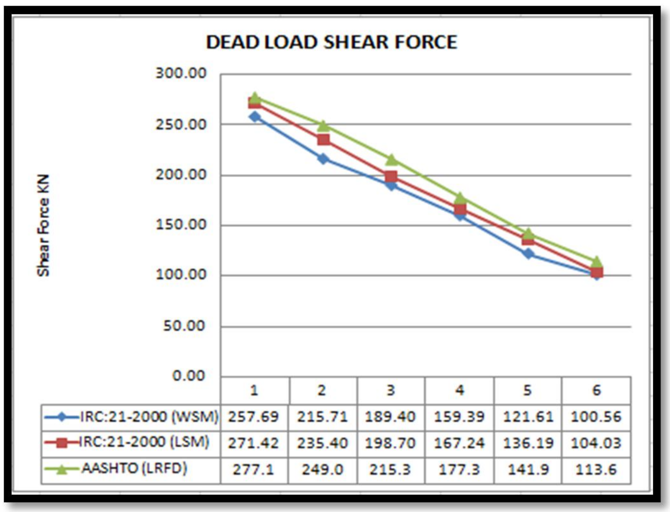


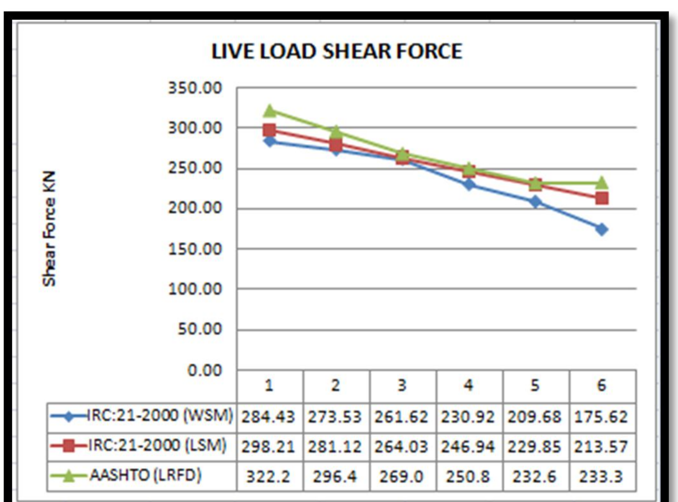
	1	2	3	4	5	6
IRC:21-2000 (WSM)	0.0	695.4	986.3	1205.4	1498.2	1654.3
IRC:21-2000 (LSM)	0.0	778.7	1103.5	1423.1	1672.5	1823.1
AASHTO (LRFD)	0.0	912.3	1324.5	1634.2	1823.4	2013.2

Fig.15 Dead load bending moment comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)



	1	2	3	4	5	6
IRC:21-2000 (WSM)	257.69	215.71	189.40	159.39	121.61	100.56
IRC:21-2000 (LSM)	271.42	235.40	198.70	167.24	136.19	104.03
AASHTO (LRFD)	277.1	249.0	215.3	177.3	141.9	113.6

Fig.16 Dead load shear force comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)



	1	2	3	4	5	6
IRC:21-2000 (WSM)	284.43	273.53	261.62	230.92	209.68	175.62
IRC:21-2000 (LSM)	298.21	281.12	264.03	246.94	229.85	213.57
AASHTO (LRFD)	322.2	296.4	269.0	250.8	232.6	233.3

Fig.17 Live load shear force comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

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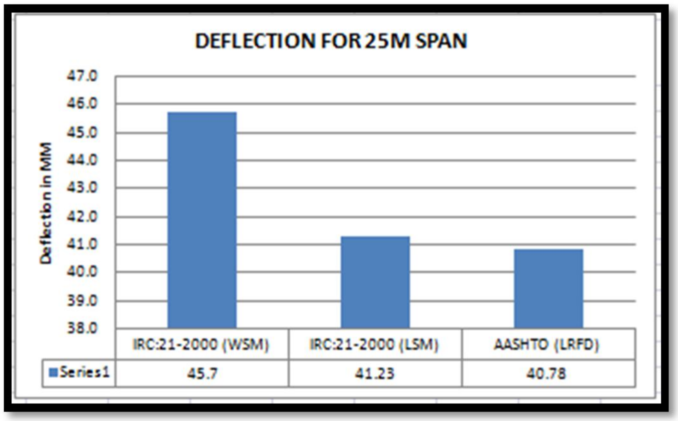

Fig.18 Deflection comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

B. Bending Moment And Shear Force For Load Combinations

1) Span 15m

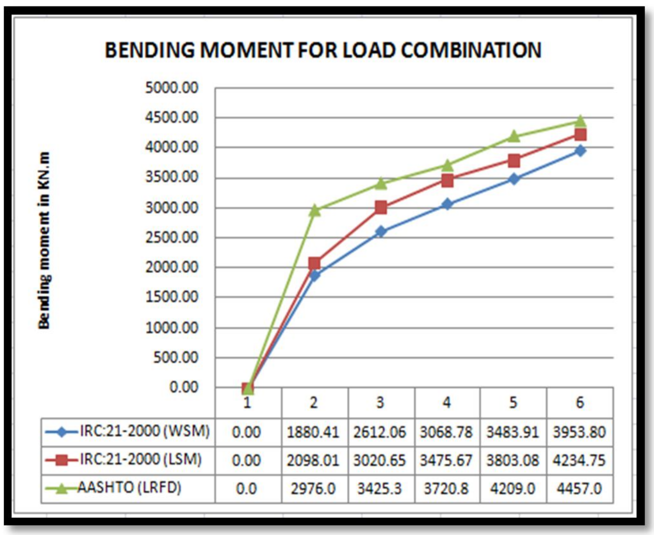

Fig.19 Bending moment comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

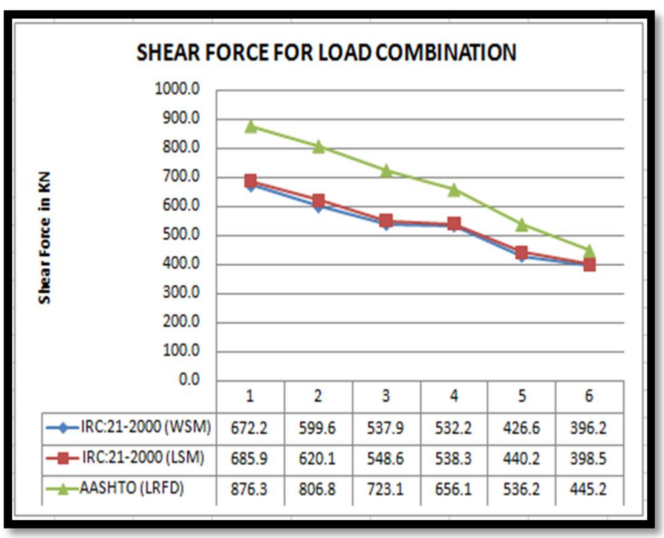

Fig.20 Shear force comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

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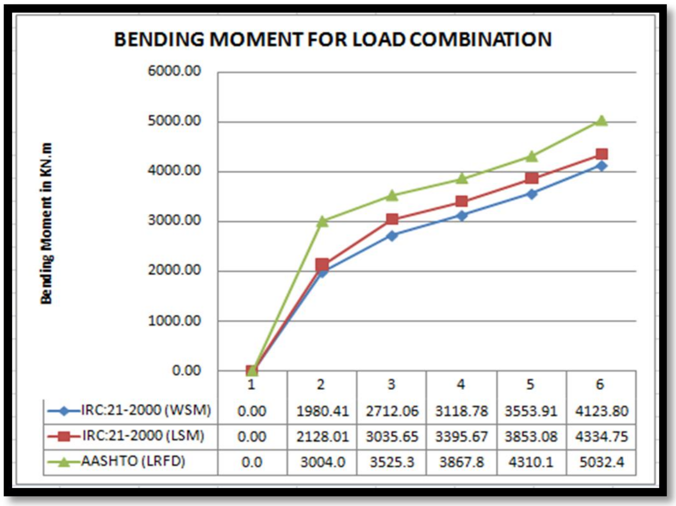
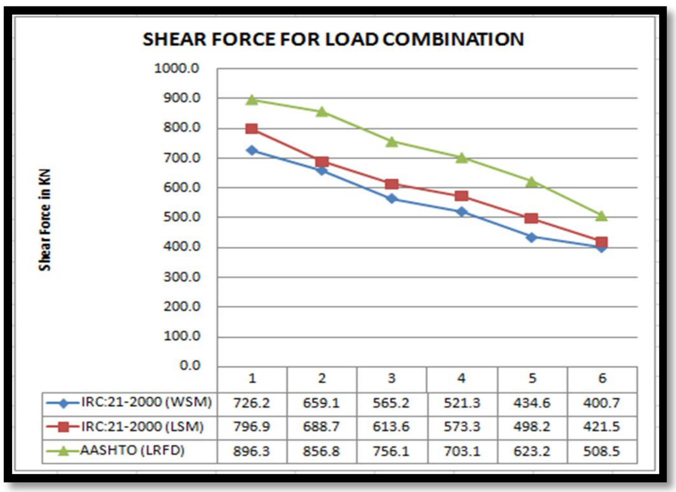
2) Span 20m



	1	2	3	4	5	6
IRC:21-2000 (WSM)	0.00	1980.41	2712.06	3118.78	3553.91	4123.80
IRC:21-2000 (LSM)	0.00	2128.01	3035.65	3395.67	3853.08	4334.75
AASHTO (LRFD)	0.0	3004.0	3525.3	3867.8	4310.1	5032.4

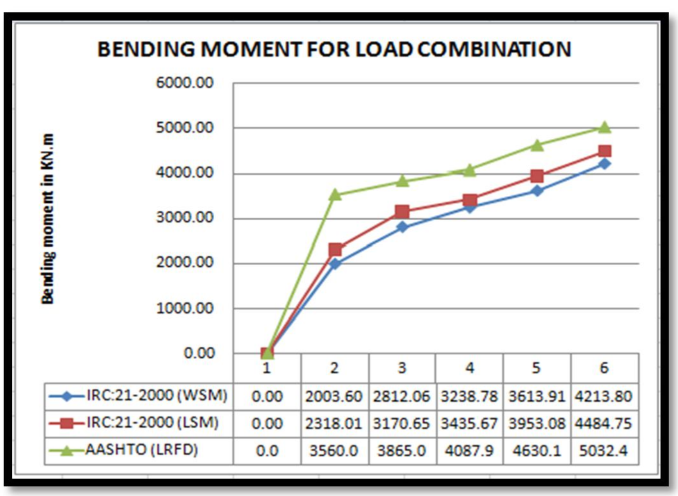
Fig.21 Bending moment comparison chart for IRC (WST), IRC (LST) AASHTO (LRFD)



	1	2	3	4	5	6
IRC:21-2000 (WSM)	726.2	659.1	565.2	521.3	434.6	400.7
IRC:21-2000 (LSM)	796.9	688.7	613.6	573.3	498.2	421.5
AASHTO (LRFD)	896.3	856.8	756.1	703.1	623.2	508.5

Fig.22 Shear force comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

3) Span 25m



	1	2	3	4	5	6
IRC:21-2000 (WSM)	0.00	2003.60	2812.06	3238.78	3613.91	4213.80
IRC:21-2000 (LSM)	0.00	2318.01	3170.65	3435.67	3953.08	4484.75
AASHTO (LRFD)	0.0	3560.0	3865.0	4087.9	4630.1	5032.4

Fig.23 Bending moment comparison chart for IRC (WST), IRC (LST) AASHTO (LRFD)

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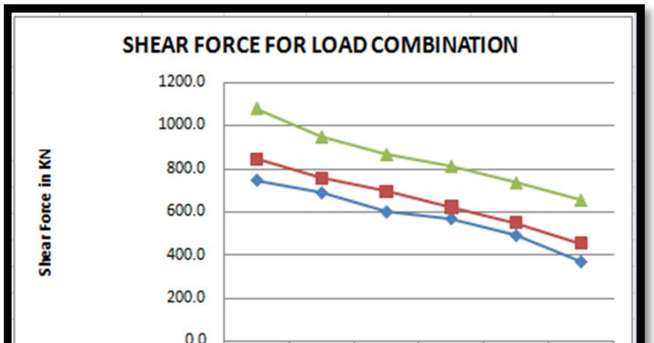

	1	2	3	4	5	6
IRC:21-2000 (WSM)	745.6	687.3	598.5	567.4	489.2	367.5
IRC:21-2000 (LSM)	843.6	757.4	695.4	621.1	548.6	454.3
AASHTO (LRFD)	1080.3	947.3	865.9	811.6	734.6	654.5

Fig.24 Shear force comparison chart for IRC (WST), IRC (LST) and AASHTO (LRFD)

IV. CONCLUSIONS

After designing and analyzing the 15m, 20m and 25m single span of RCC T- beam bridge using IRC 21:2000 (WST), IRC 112-2011 (LST) and AASHTO (LRFD), the results are compared. In other words, working stress method and limit state method of design are compared with AASHTO (LRFD) design technique. All codes have varying design philosophy. Therefore conclusions which are made from the above comparisons are as follow:

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A. It can be seen from all the figs that DL Bending Moment and Live Load Bending Moment for AASHTO is higher than both IRC (WST) and IRC (LST). But the difference between B.M. values for IRC (LST) and AASHTO is very less because of the use of safety factor and load factor in both design procedures. While difference between the B.M. values for IRC (WST) and AASHTO is more.

B. In limit state method, there is inherent unpredictability of loads and live loads are increased by much higher safety factor. It can be seen that live load B.M. values for IRC (LST) are higher than IRC (WST) to some extent.

C. From shear force comparison figs, it can be seen that dead load shear force for AASHTO is higher than IRC (LST & WST). Shear force for both IRC and AASHTO are descending uniformly.

D. From deflection comparisons, it is clearly seen that the deflection in AASHTO design is less than IRC design for all the girders.

E. Therefore, the design of RCC T-beam bridge girder by AASHTO (LRFD) gives B.M. and S.F. values higher than IRC in all the cases. The deflection in AASHTO design method is lesser than other methods. So therefore it can be concluded that AASHTO (LRFD) is much preferable and optimal method for the design of RCC T-beam bridge for all the spans.

REFERENCES

[1] R.Shreedhar, Spurti Mamadapur, "Analysis of T-beam Bridge Using Finite Element Method," International Journal of Engineering and Innovative Technology (IJEIT) Volume 2; Issue 3; September 2012.

[2] Y. Yadu Priya , T. Sujatha, "Comparative Analysis of Post Tensioned T- Beam Bridge Deck by Rational Method and Finite Element Method," International Journal of Research in IT; management and Engineering, ISSN 2249-1619; Volume 06 Issue 09; September 2016.

[3] Nivedhitha M, Gowtham Raja M and Sharu.E, "design of RCC t-beam bridge considering overloading due to congestion," Indian J.Sci.Res. 17(2): 211 – 216; 2018.

[4] Abrar Ahmed, Prof. R.B. Lokhande,"comparative analysis and design of t-beam and box girders," International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 ; Volume: 04 ; Issue: 07; July -2017.

[5] Jagdish Chand, Ravikant, "Design and Analysis of Bridge Girders using Different Codes," International Journal of Engineering and Innovative Technology (IJEIT); ISSN: 2278-0181; Vol 8 Issue 07; July-2019.

[6] Anisha Chauhan, Dimple Desai and Bijal Chaudhri , "A Review On Comparative Study Of Bridge Super Structure With Reference To IRC And AASHTO Standards," International Journal of Technical Innovation In Modern Engineering & Science (IJTIMES); e-Issn:2455-2585; (RTSE-2018); Volume 4; Sept.2018.

[7] Kamde D. , John B. and Hulagabali A. , "Comparative Study for the Design of single span bridge using AASHTO LRFD and Indian Standard Method," IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278-1684; p-ISSN: 2320-334X; PP 40-44.

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[8] Hussein Yousif Aziz, Jianlin Ma,"Design and analysis of bridge foundation with different Codes," Journal of Civil Engineering and Construction Technology; ISSN 2141-2634; Vol. 2(5); pp.101-118; May 2011.

[9] Dr.Maher Qaqish, Dr.Eyad Fadda and Dr.Emad Akawwi, "Design Of T-Beam Bridge By Finite Element Method And Aashot Specification," KMITL Sci. J. ;Vol.8 No.1; January – June 2008.

[10] Sudip Jha, Cherukupally Rajesh, P.Srilakshmi, **"**Comparative Study of RCC Slab Bridge by Working Stress (IRC: 21-2000) and Limit State (IRC: 112-2011)," International Journal & Magazine of Engineering, Technology, Management and Research; ISSN No:2348-4845 **;**Volume No: 2 ;Issue No: 8; August 2015.

[11] IRC: 112 – 2011, "Code of Practice for Concrete Road Bridges," Indian Roads Congress ; New Delhi ; India 2011.

[12] IRC 6 – 2017, "Standard Specifications and Code of Practice for Road Bridges," Section II, Loads and Stresses; Indian Roads Congress; New Delhi; India; 2017.

[13] IRC: 21 – 2000, "Standard Specifications and Code of Practice for Road Bridges," Section III; Cement Concrete (Plain And Reinforced); Indian Roads Congress; New Delhi; India 2014.

[14] AASHTO-LRFD,"American Association of State Highway and Transportation Officials – Load and Resistance Factor Design, "Sixth Edition; 2012.

[15] Rajan Patel, B.N. Kadia and Pooja Mistry, "Comparative Study of Live Load Condition on RCC Girder Span Bridge using IRC and AASHTO," Journal of Civil Engineering and Environmental Technology; p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 3; Issue 4; pp. 280-286; January-March; 2016.

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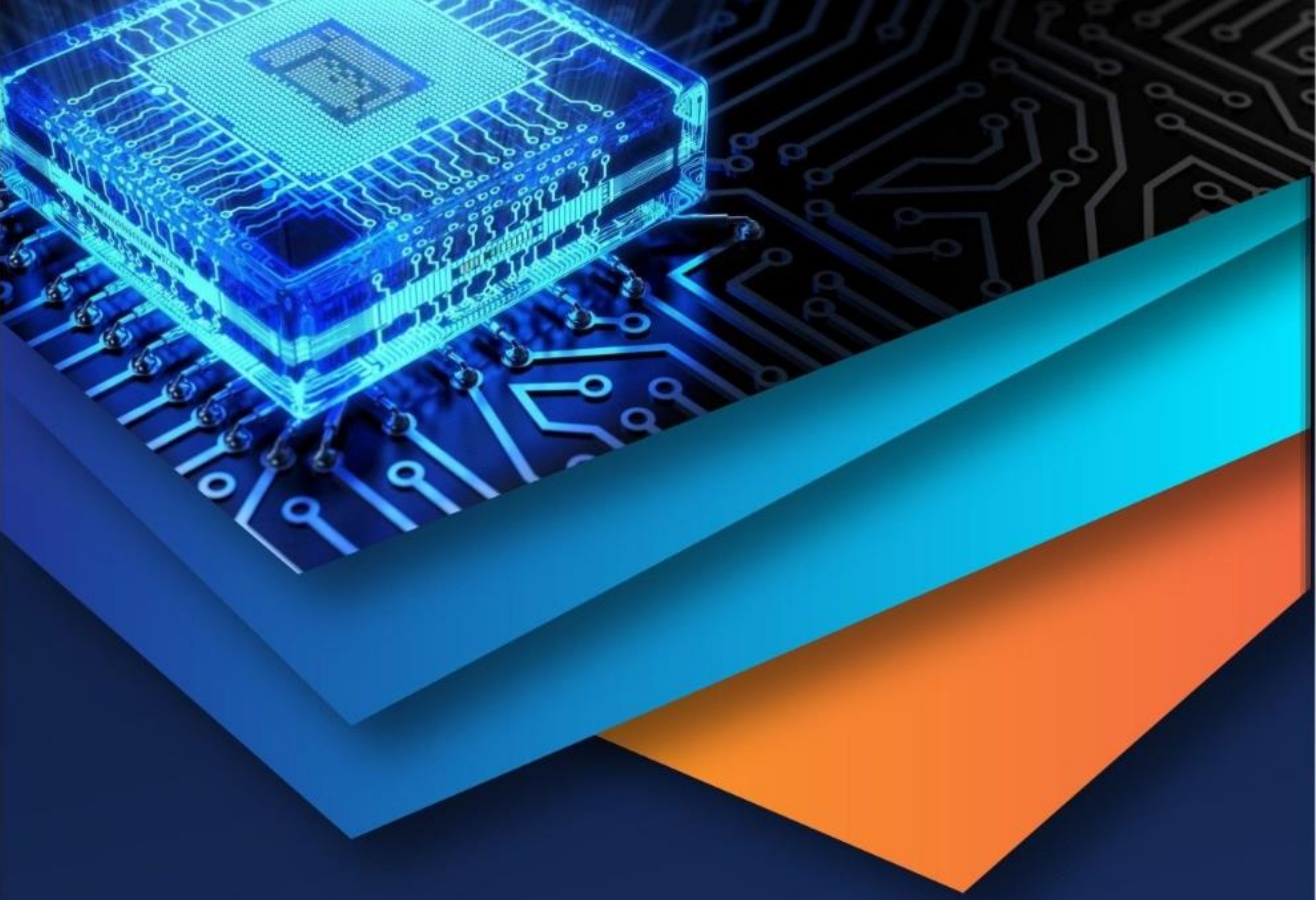

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