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Comparative Study of Simply Supported, Continuous and Integral Slab Bridge

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***Abstract*— The present work is to convert the simply supported bridge slab into continuous and integral bridge slab and then the behavior of simply supported bridge slab is compared with continuous and integral bridge slab. Here we first analyze simply supported slab under dead load and live load of IRC class A-A and class A by finite element analysis. The nine cases of simply supported slab from 4m. to 12 m. are taken. And convert them into continuous two and three span slab and integral slab. The comparative study results that the continuous section having less moment as compare to single span and the smaller sections can be adopted this result is shown economy of steel and concrete. Therefore from slab design view point it is better to go for continuous two or three spans. Continuous two spans or three spans in multiple of 4 m, 5 m and 6 m may be taken. If the length of bridge is more than 6m. then at least two continuous spans may be taken in place of single span. The values of moment and deflection in different slab are compared by different table and graph.**

Keywords — Simply supported slab Bridge Simply Continuous slab Bridge, Integral slab Bridge, IRC Class A-A, IRC Class A, Finite Element Analysis.

I. INTRODUCTION

A bridge is a structure providing the passage over an obstacle which is not closing the way. The passage may be for a road, or a railway, pedestrians, a canal or a pipeline. The obstacle which is crossed may be a river, or a road, railway etc. The bridge is a structure which is carrying the traffic of the road and other moving loads over a different type of obstruction.

There are various types of bridges are built now a days. In present study our main concern is with

1) Simply supported bridge
2) Continuous bridge
3) Integral bridge

Analysis of these bridges are carried out with the FEM software. There are nine cases are taken and analysis take place under dead load and live load of IRC loading. Literature study is performed to study the bridge basics with respect to behavior or bridge. The basics of configuration and bridge analysis are being studied.

Many researchers only performed analysis of simply supported slab and many researchers perform seismic analysis on single bridge. Push over analysis is also performed by many researchers, Comparative study of simply supported slab bridge and Continuous Slab Bridge are also perform with taking some spans. And Comparative study of simply supported slab bridge and Integral Slab Bridge are also performed with taking some spans.

II. MODELLING AND METHODOLOGY

First structure of simply supported slab is model in FEM software, then this slab is converted into continuous slab and integral slab. Various loading are applied on slab and analysis carried out. In this research simply supported slab is model of width 9.5m, and various spans are taken from 4-12 m. then this slab convert into continuous slab (two & three span) and integral slab bridge.

A. Methodology

- Convert the simply supported bridges into continuous bridges.
- Study of the simply supported slab deck under the IRC class AA loading and class A loading by existing method.
- Study of the simply supported slab deck under the IRC class AA loading and class A loading by FEM method.
- Use Staad pro. Software for FEM analysis.
- Nine cases of simply supported slab are considered and convert them to continuous bridge slab.
- The span of slab varies from 4m to 12m.
- Apply the IRC loading on the slab using Staad pro.
- Study the slab deck under the IRC class AA loading and class A loading as per IRC:6-2000.

Comparative study of the various span of simply supported slab and continuous slab bridge.
Convert simply supported bridge slab into integral bridge slab.
Comparative study of the various span of simply supported slab and integral slab bridge.

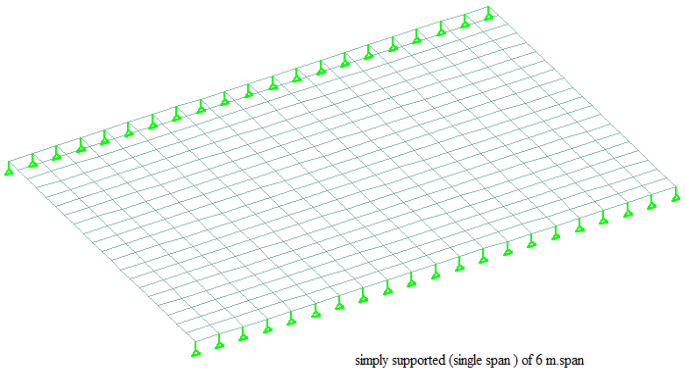

Fig.1 Simply supported slab bridge.

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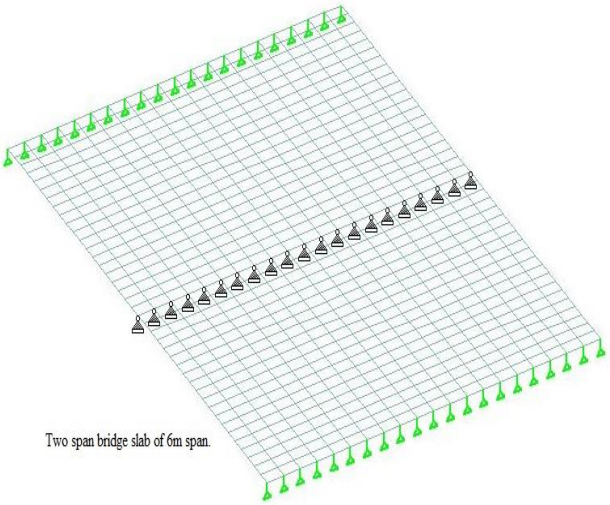

Fig.2 Continuous slab bridge(Two span)

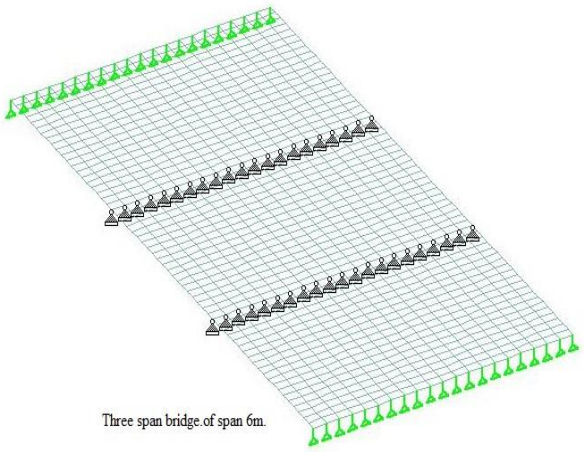

Fig.3 Continuous slab bridge(Three span)

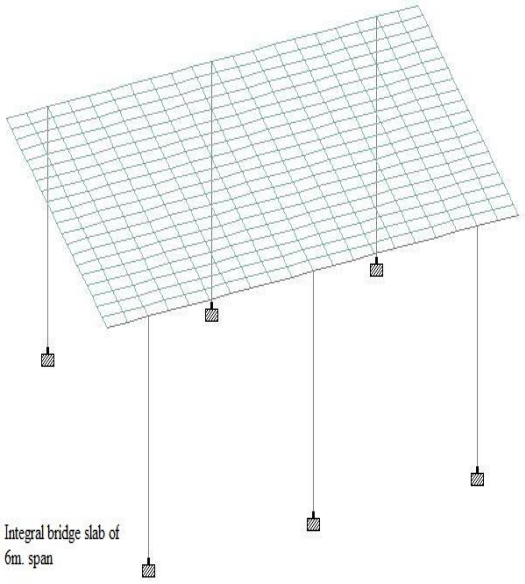

Fig.4 Integral slab bridge.

III.RESULT ANALYSIS OF BRIDGE MODELS

Table 1 Moment (KN-m/m). due to dead & live load in simply supported slab bridge.

Span(m.)	Dead load moment	Live load moment (classA-A)	Live load moment (classA)	Max. design moment
4	23.59	90.36	51.789	113.9
5	40.79	125.97	67.92	166.76
6	70.45	153.22	72.55	223.67
7	105.95	181.54	85.2	287.49
8	153.11	201.13	111.71	354.24
9	212.3	220.63	130.5	432.93
10	283.37	240.7	153.4	524.07
11	372.63	260.6	168.73	633.23
12	495.1	284.971	185.54	780.07

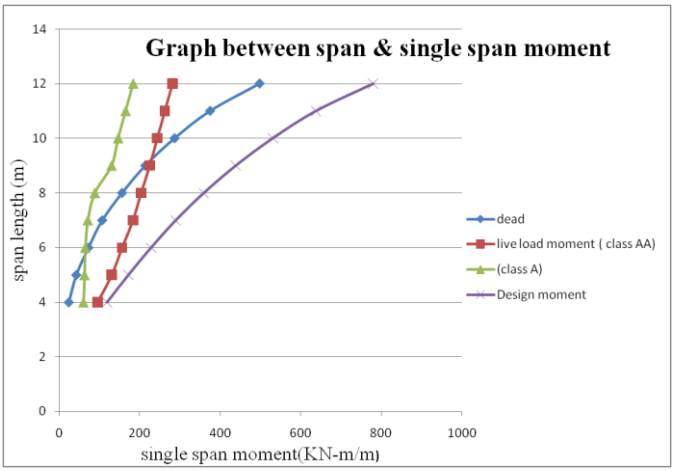

Fig.5 Graph b/w span and single span moment

Table 2 Comparison of positive bending moment (KN-m/m) in simply supported and continuous slab bridge due to live load.

Span (m.)	Single span	Two span	Three span
4	90.36	58.3	63.545
5	125.97	81.9	89.553
6	153.22	105.5	113.499
7	181.54	124.7	132.76
8	201.13	142.2	152.207
9	220.63	159.6	169.686
10	240.7	173.4	184.828
11	260.6	189.3	201.14
12	284.971	203.8	215.038

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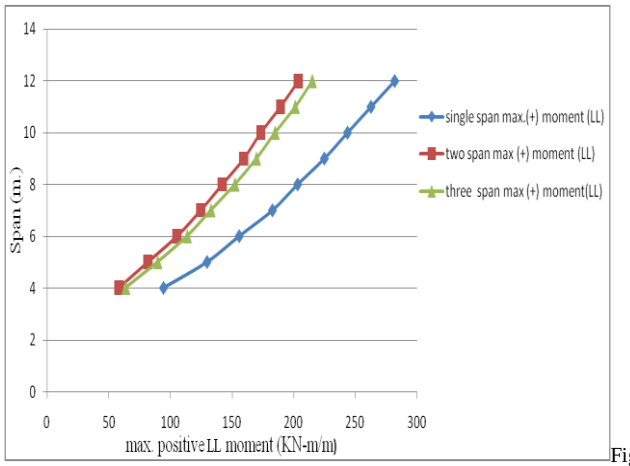

Fig.6 Graph b/w max. positive moment under live load and simply supported and continuous slab under moments value .

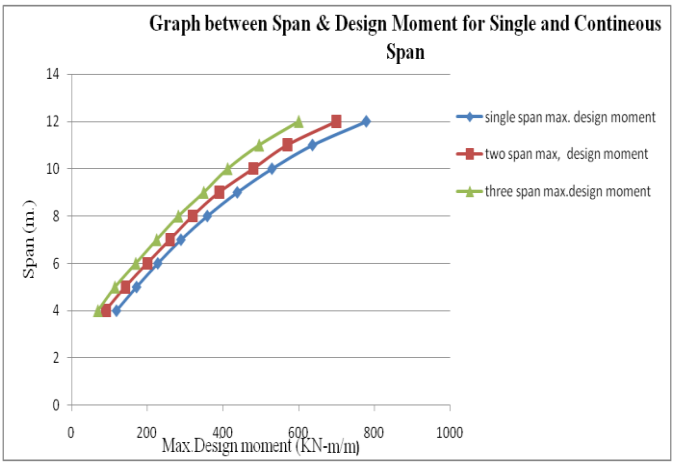

Fig.8 Graph of design moment b/w simply supported and continuous slab.

Table 3 Comparison of negative bending moment(KN-m/m) in two span and three span slab bridge due to live load.

Span (m.)	Two span	Three span
4	79.485	65.071
5	118.985	97.714
6	152.243	126.092
7	184.628	153.56
8	203.522	170.557
9	228.869	192.664
10	242.069	204.669
11	258.994	219.69
12	275.089	233.831

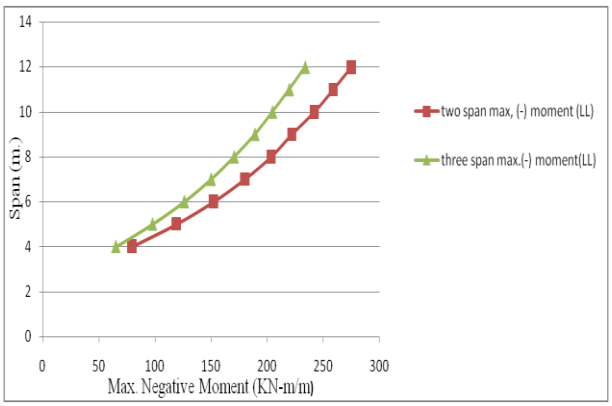

Fig.7 Graph b/w two & three span negative moment

Table 4 comparison of design moment(KN-m/m) in simply supported and continuous slab bridge

Span (m.)	Single span	Two span	Three span
4	113.9	97.8	80.2
5	166.76	153.4	125.4
6	223.67	215.5	176.7
7	287.49	280.75	230.5
8	354.24	343.2	282.4
9	432.93	424.7	349.4
10	524.07	501.5	412.5
11	633.23	603.4	495.7
12	780.07	732.2	600.1

Table 5 Comparison of simply supported and integral slab(single span) bridge dead load moment.

Span (m.)	Simply supported slab(KN-m/m)	Integral slab(kn-m/m)
4	23.8	14.1
5	41.5	22.75
6	71.9	43.7
7	106.2	67.4
8	155.6	98
9	213.32	136.5
10	286.3	183.5
11	374.6	240
12	498	307.8

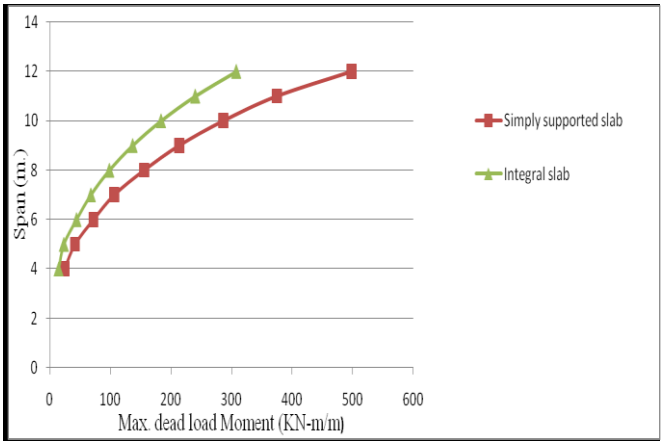

Fig.9 Graph b/w simply supported and integral slab dead load moment.

Table 6 Comparison of simply supported and integral slab(single span) bridge live load moment(Class A-A):.

Span (m.)	Simply supported slab(KN-m/m)	Integral slab(kn-m/m)
4	94.5	70.7
5	129.77	102.3
6	155.8	135.15
7	182.77	164.4
8	203.2	185.3
9	224.8	211.2
10	243.5	231.5
11	262.7	251.2
12	282	271.4

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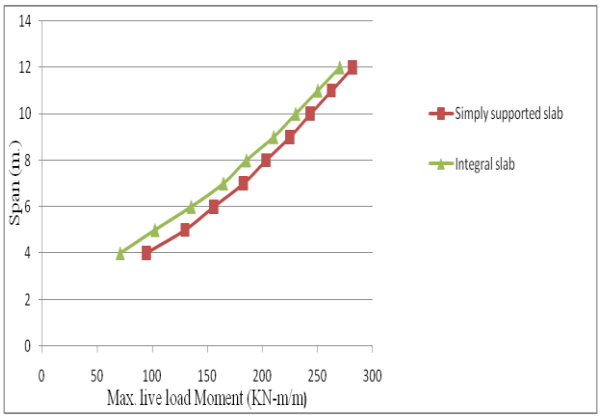

Fig.10 Graph b/w simply supported and integral slab live load moment.

Table 7 Comparison of simply supported and integral slab (single span) bridge design moment.

Span (m.)	Simply supported slab(KN-m/m)	Integral slab(kn-m/m)
4	118.3	84.8
5	171.27	125.05
6	226.9	178.85
7	288.97	231.8
8	358.8	283.3
9	438.12	347.7
10	529.8	415
11	637.3	491.2
12	780	579.2

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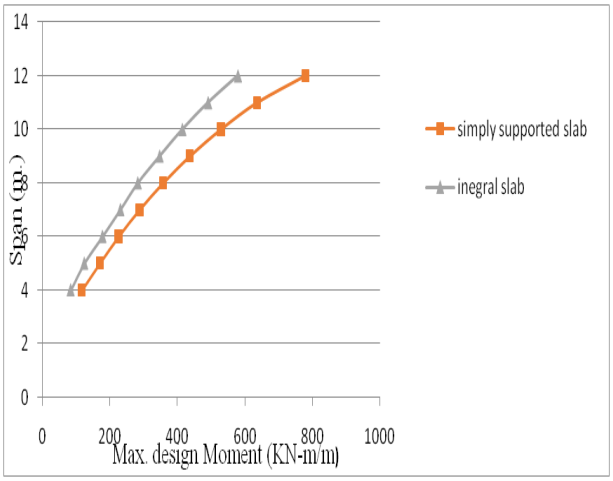

Fig.11 Graph b/w simply supported and integral slab design moment.

Table 8 Comparison of displacement(mm) in simply supported slab and continuous (two & three span) slab.

SPAN (M)	SIMPLY SUPPORTED SLAB	CONTINUOUS SLAB(TWO SPAN)	CONTINUOUS SLAB(THREE SPAN)
4	1.67	0.75	0.9
5	2.65	1.225	1.477
6	2.8	1.33	1.603
7	3.52	2.23	2.004
8	3.78	2.513	2.158
9	4.4	3.03	2.48
10	4.82	3.421	2.74
11	5.4	3.885	2.98
12	5.45	4.05	3.029

Table 9 Comparison of displacement(mm) in simply supported slab and integral (two & three span) slab.

SPAN (M)	SIMPLY SUPPORTED SLAB	CONTINUOUS SLAB(TWO SPAN)	CONTINUOUS SLAB(THREE SPAN)
4	4.07	2.65	2.78
5	6.31	3.38	3.73
6	6.74	4.33	4.71
7	8.16	5.15	5.65
8	9.42	5.85	6.37
9	10.77	6.5	7.06
10	12.13	7.1	7.89
11	13.51	7.84	8.74
12	14.8	8.7	9.23

IV CONCLUSION

Analysis are done on different span on simply supported, continuous and integral slab bridge. Varieties of results were obtained in the form of graphs and tabulated form. Further graphs are plotted for comparison purpose.
Following are the conclusions from present study:
At 4m span dead load moment is @75% of live load moment and at 5m, 6m ,7m ,and 8m span these are 68% , 54% ,42% and 23 % respectively. and at 9 m span these are almost equal. At 10m, 11m, and 12m span dead moments are 1.18 times, 1.43 times and 1.77 times of that of live load moments respectively.

Provision of continuous span in place of single span causes considerable reduction in dead load, live load and design moments

Provision of two span in place of one span results in reduction in moments of 70-80%.

Provision of three span in place of one span results in reduction in moments of 80-90%.

Provision of integral slab in place of simply supported slab results in reduction in moments of 25-30%.

Deflection in all the span of simply supported , continuous and integral slab is under the permissible limit.

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