PARAMETRIC STUDY OF DOUBLE BOX CELL TYPE BRIDGES BY CHANGING CONFIGURATION OF BOX CELL

A

THESIS

Submitted in partial fulfillment of the requirements

for the award of the degree

of

MASTER OF TECHNOLOGY

IN

CIVIL ENGINEERING

With specialization in

STRUCTURAL ENGINEERING

Under the supervisionof

DR. SAURAV

(Assistant Professor)

by

Naveen Chauhan

(202655)

to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT, SOLAN-173234

HIMACHAL PRADESH, INDIA

May-2022

STUDENT'S DECLARATION

I hereby declare that the work presented in the thesis entitled **"Parametric study of Double Box Cell Type Bridges by Changing Configuration of Box Cell"** submitted for partial fulfillment of the requirements for the degree of Master of Technologyin Civil Engineering (Structural engineering) at **Jaypee University of Information Technology, Waknaghat** is an authentic record of my work carried out under the supervision of **Dr. Saurav.** This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

Naveen Chauhan (202655)
Department of Civil Engineering
Jaypee University of Information Technology, Waknaghat, India
23 May, 2022

CERTIFICATE

This is to certify that the work which is being presented in the thesis titled **"Parametric study of Double Box Cell Type Bridges by Changing Configuration of Box Cell"** in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering (Structural engineering) submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat** is an authentic record of work carried out by **Naveen Chauhan (202655)** during a period from July, 2021 to May, 2022 under the supervision of **Dr. Saurav,** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: …………………

Dr. Saurav	Prof. (Dr.) Ashish Kumar
Assistant Professor	Professor and Head
Department of Civil Engineering	Department of Civil Engineering
JUIT, Waknaghat	JUIT, Waknaghat

ACKNOWLEDGEMENT

I take this opportunity to acknowledge all who has been great sense of support and inspiration thought the thesis work successful. There are lots of people who inspired me and helped, worked for me in every possible way to provide the detail about various related topics. Thus, making and report work success. My first gratitude goes to our head of department **Prof. (Dr.) Ashish Kumar** for his guidance, encouragement and support.

I am very grateful to **Dr. Saurav**, for all his diligence, guidance, encouragement and helped throughout the period of thesis, which has enabled me to complete thesis work in time. I also thank him for the time that he spared for me, from his extreme busy schedule. His insight and creative ideas are always the inspiration for me during the dissertation work.

I would thank the almighty for empowering me to work fully on my project and last but not the least like to thank my parents for their continuous support and motivation.

Finally, I would like to thank to all who directly or indirectly helped me.

Naveen Chauhan

ABSTRACT

A bridge is a man-made structure that is used to convey moving loads or other objects over a barrier. The needed passage may be for pedestrians, a road, a railway, a pipeline, or a canal, for example, while the obstruction could be rivers, valleys, sea channels, or other structures like bridges, buildings, railroads, or roads, for example. "Due to the economic method, exquisite existence, great ability to adapt, and satisfying stress state, as well as the overall increase of bridge building methods and techniques and the desire for efficacious implementations and recognition of municipal bridges, the self-anchored suspension bridge has become an extremely challenging bridge type". The impact of the number of cells on the optimum cost of non-prismatic reinforced concrete (RC) box girder bridges is investigated in this research using a parametric study. As well as other configurations, the parameters are cross section geometry, tapered length, concrete strength, and box girder reinforcement.

In this research work use three cases for analysis a beam with different section like 45 degree, 90 degree, triangle, inverted triangle and last one is single box. In first case use IRC Loading for study. In second case use response spectrum for study and in last third case applies combination of response spectrum and IRC loading for study. SAP200 used for modeling and analysis work. "In this study, the form and shapes of two boxes Cell Bridge are modified to study for economy and better structural stability".

Key point: - Box cell, bridge box, Class A load, dead load, IRC, 70R load.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

INTRODUCTION

1.1 General

According to the effective distribution of crowded traffic, economic considerations, and aesthetic appeal, bridge construction has already reached a global level of significance. Advanced highway networks, particularly urban interchanges, are progressively using box girder bridges. Flyovers on Highway and contemporary elevated light rail transportation infrastructure frequently feature box girder bridges.

A box beam bridge is a bridge whose main lease is a hollow box beam. “It is usually composed of pre-stressed concrete, steel or reinforced concrete components. A box beam bridge is a bridge whose main beam consists of a concave box beam. Box beams are often made of precast concrete, structural steel or reinforced concrete components”. The cross section is usually rectangular or trapezoidal. Road overpasses and modern light rail transport infrastructures are often fitted with box bridges. Gate bridges, arch bridges as well as rope and suspension bridges of all types of caisson beams can already be used.

Girders are large section beams that support the slab (deck). They are frequently used for bridges. Hollow channel-shaped beams with two (or more) side’s webs and 2 flanges are known as Box Girders. The box might be trapezoidal or rectangular in form. Each flange is in compression while the other is in tension in just such a girder. Box Girder Bridge are those that have these girders.

- They’re commonly used on flyovers and lightweight rail bridges with a lot of traffic and dynamic loads.
- They’re also employed for bridges at very high elevations from either the ground because of their great aerodynamics strength.
- Because the box girder bridge has a great torsional rigidity and can withstand a lot of torque, it’s ideal for building curving bridges.

1.2 Double Cell Box Bridge

It is advised that a single cell box girder bridges be developed when the depth of a box girder bridge approaches 1/6 or 1/5 of the bridge width. A twin-cell or multiple-cell bridge, on the other hand, is a better alternative if the bridge depth is less than 1/6 of the bridge width. Including for broader bridges with shallower depths, the numbers of cells should indeed be kept to a minimum because expanding the number of box girder cells to 3 or more does not enhance transverse load distribution significantly. There really are two common layouts for multiple-cell box girders. The first is that independent cells are only interconnected at the upper flanges, but the second is that cells are linked both at the upper as well as bottom flanges. It is advised that the second configuration be used from a structural standpoint. Due to flexure that cannot be efficiently redistributed all across cross - sectional area, the flanges of cells connected solely by top flanges are strongly stressed in the transverse orientation.

Fig. 1.1 Double Cell Box Bridge diagram

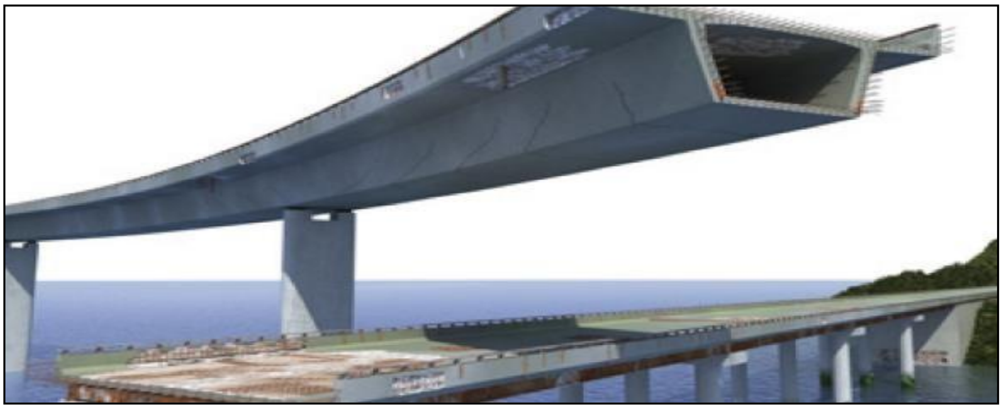

Fig. 1.2 Typically Box Section Diagram

1.3 Proposed Study

This work investigates the parametric analysis of a double box cell bridge as well as its configuration. The goal of this study is to find the greatest configuration of the double box cell bridge for the specified parameters. The variables are altered and varied in order to obtain alternative configurations of double box cells, and a parametric research is conducted with all conditions of bridge cells and loads with analysis.

1.4 Objectives

- The impact of the strengthening on the bridge’s dynamic behavior.
- With a two-cell box, evaluate box girders for various spans.
- At various skew angles, the maximum bending moment, shear force, and torsional force are compared & for different time periods.
- To explore the parametric performance of single and four cell Box Girder Bridge prototype models.
- Assuring the safety of the bridge
- The effect of the strengthening on the dynamic behavior of the bridge
- to learn about the configuration change

1.5 Structure of This Dissertation Work

- Introduction
- Objectives of the Research
- Literature Review
- Methodology
- Result and Discussion
- Conclusion of Work
- Future scope of the work

Chapter 2

LITERATURE REVIEW

2.1 Kaveh, A., L. Mottaghi, and A. Izadifard-2022

The impact of the cell calculate the optimum cost of non-prismatic ferroconcrete (RC) box beam bridges is investigated during this paper employing a parametric model. The parameters are the cross section geometry, tapering length, concrete strength, moreover as reinforcement of box girders additionally as slabs, all of which are calculated utilizing the ECBO metaheuristic algorithm. The designed supported the AASH to plain. Bending and shear strength, geometric limits, and superstructure deformation are the restraints. The upgraded colliding bodies' optimization algorithm yields optimum bridge solutions. In step with the findings, the cost and bars for a three-cell beam is a smaller amount than that of a two-cell or four-cell beam. However, because the number of construction utilised improves because the count of CELL grows, the cost of concrete, bars, and formwork for two-cell box girders is cheaper than another two.

2.2 Jyoti Arora, et-al.-2021

In this investigation, 5 distinct box sections were prepared and a couple of distinct loadings were imposed to them.. Just choose best portion for designing the bridge using the conclusions of the result. Development has contributed in several changes within the use and building of assorted styles of bridges. The box beam bridge is linked to offering construction approaches and maximising material consumption for specified spans and uses. This can be a major concern since a rise in span resulted in a rise in loading. Thanks to its exceptional structural performance and chic appearance, beam bridges are widely used and approved everywhere the globe. Box girders have cross-sections that are single-cell, multi-spine, but rather multi-cell, with vertical or inclination webs. Betting on what form of concrete utilized, they'll indeed be reinforced or pre-stressed concrete bridge.

2.3 Wasim Sheikh, Mayur Singi, Nikita Thora-2021

A beam could be a monolithic construction composed of several slabs, top and bottom slabs, which are joined by 2 or maybe more vertically branches referred to as webs, which may be slanted or vertically positioned pro re nata. This sealed construction is more efficient than conventional opening structures in terms of torsional stiffness. "Boxes girders are commonly employed in arch bridges, portal frame bridges, cable-stayed bridges, and suspension bridges of all sorts. Box girders are cast-in-place to fulfill the specifications". Thanks to their high torsional rigidity, box girders are ideally suitable for straight, curve, and skew bridges. During this work, SAP2000 technology is employed to conduct a comparative analysis on concrete two cell, three cell rectangular, and trapezoidal box girders. "The assorted characteristics including shear force, deflection, torsion, including bending moment around horizontal yet as vertical axes at the full girder are explored during this for various cells and varied forms".

2.4 Fangwen Wu-2021

The influence of design variables on the mechanical characteristics of a double-sided steel beam is investigated using simulation studies. The result indicated that the bridge's deformation has high symmetric, that there has been apparent shear lag impact on the main girder, and also that the U-rib thickness, diaphragm spacing, still as vehicles load can all significantly affect the strain of the most girder upper plate. The acquired results of the analysis result in a decent knowledge of the mechanical characteristics and function a tenet for the planning of a self-anchored bridge with a double-sided steel beam. Obtained from trial, the mechanical property of a self-anchored bridge featuring ultra-wide double-sided steel beam was investigated, and a probabilistic research was done to judge the consequences of varying factors on the girder's mechanical behaviour.

2.5 Nidhi Gupta, Preeti Agarwal & Priyaranjan Pa-2020

This study analysis that and reveals, the section characteristics of the bridges must be adjusted since the deflection exceeds the allowable limits of deflection. The research could've been expanded by using multiple kinds of box girder portions, such as trapezoid box girders and multi-spine box girders. A comparative might be conducted by keeping the volume of material constant throughout all parts. 3 distinct bridge segments are explored in this research. Both dead as well as live loads are analysed using the finite element approach. According to the Indian Road Congress, the load scenarios examined include dead load and live load (IRC). The variability of bending moment, torsional moment, shear force, as well as deflection is investigated, and it is discovered that they rise with curvature. The enhanced deflection of single, double, and triple cell box girder bridges between 0° (straight) and 60° curving bridges is calculated to be roughly 295 percent, 280 percent, and 245 percent, accordingly. According to this research, designing curved bridges is a difficult task that must be done with great attention.

2.6 Abdul Khader A S1, A R Pradeep-2019

This research developed a foundation for designing a full bridge model in the finite strip environment by developing a new kind of strip component for modelling piers and a particular transitioning segment to merge stripes of random orientation. The suggested finite elements approach accurately describes the bending behaviour of pier buildings in a spline finite strip environment. The current research will focus on the box girder evaluation of elevating box girder structural systems.

2.7 Abhishek Gaur[1], Ankit Pal-2019

Bridge girder materials, shape, size, and choosing are dependent on technical and economic criteria, therefore the paramedic analysis aids in determining the economic side throughout bridge planning and design. Research study effort created to assess the findings of various researchers in the field of economic and safe bridge design. The research work proposes many research projects and closes with discovered gaps in the investigation and also the objective of required effort.

2.8 Md. Nazmul Hassan-2019

The study revealed that employing a twin planes cable design scheme in extra dosed box girder bridges had numerous benefits. The consequent tension, flexure, and shear inherent in single plane cable design systems can be decreased by employing a double plane cable design method. The use of a two plane cable architecture decreased longitudinal stress by around 50% (top stress) and 42% (bottom stress). In addition, the moment on the Horizontal Axis was around 25% lower than on the single plane bridge.

2.9 J Chithra1*, Praveen Nagarajan-2018

A twin cell concrete box beam bridge was chosen for this research. The bridge is modelled in three dimensions utilizing finite element software, and therefore the results are compared to the simpler frame analysis. The work primarily involves determining correction factors for SFA-derived transverse bending moment values. The numerical investigation conducted for double cell box beam bridges shown that SFA produces quick performance than 3DFEA. However, as previously said, there are some differences from the 000 outcomes. These deviations are kind of like single cell deviations. To verify the effectiveness of SFA for multi-cell concrete box beam bridges, extensive research with various cross-sections and loads must be conducted.

2.10 NADAVALA MAHESH-2016

Due to the apparent consistent span length, the parameterized research of box beam bridges revealed that because the radial distance of curvature increment, responses parametric longitudinal stresses so at the very top and bottom, shear, torsion, moment, and deflection reduce for 3 differing kinds of box beam bridges. This also demonstrates so little variability for frequency components of three styles of beam bridges. The present research focuses on 2 important structural parts of the elevated metro system: the pier and also the beam. During a seismic loading, the performance of one pier elevating bridge is entirely addicted to its ductility in addition as displacement capability.

2.11 M.G. Kalyanshetti[1], S.A. Gosavi-2014

In the current work reveals that The topmost slab of a box culvert is a crucial part that bears the most bending moment, and in this parametric study ,a 12 m channel lengths with an elevation fluctuation of 2m to 6m is considered for evaluation, which is further subdivided into single cell, double cell, as well as triple cell. The IRC class AA monitored live load is taken into account. The stiffness matrix method is used in the investigation, and a computer programme in C programming language is written to determine the cost. The variance in bending moment is studied, and then price comparisons for better contrast proportions are conducted. The reducing costs percentages for single cell, double cell, and triple cell thickness are shown. The optimal thicknesses described here are being used to develop the most cost-effective box culvert design.

2.12 Saumya E[1], Biby Aleyas-2014

The current research focuses on double cell box girder bridges with rectangular, trapezoidal, and round cross-sections. The current study will mainly focus on parametric studies such as changing the span to depth ratio, radius of curvature, as well as span length. The reaction of a box girder will be evaluated utilising IRC category a loads and performance spectrum evaluation in finite element program ANSYS 16. This will be possible to achieve the longitudinally deflection, stress, momentary reaction, and frequency response.

The reveals that, According to the results of a research for varied radius of curvature, as the radius of curves grows, deflection, moment response, and stress decline. According to a study performed for varied span lengths, as span length grows, so do deflection, moment response, & stress.

2.13 Antonio Navarro-Manso 2014

The goal of this work is to clearly demonstrate an innovative bridge launched technique that maximises the utilisation of structural design features. When compared to existing techniques, this approach is both technically and economically competitive. Auxiliary essentially means are not required, and the material is effectively utilised where it is required. All of this is done in an environmentally friendly, safe, and sustainable manner. On one hand, the main structural variables are determined, and a numerical simulation using FEM is produced. To do so, numerous numerical models are created and tested in a variety of scenarios. The most relevant variables, on the other hand, are optimised via sensitivity analysis of structures of trials.

2.14 M. Arab Naeini[1], A. Kheyroddin[2], H. Naderpour[3], R. Arab Naeini-2013

"Weight" is a significant issue in bridges structure design, associated with long spans, since decreasing weight lowers seismic forces but also superstructure and substructure costs. Among the most frequent and appropriate pre - stressed concrete bridges is the posttensioned concrete boxed girder. The design of this sort of bridge involves a number of considerations. It is decided that time is acceptable to do improvement on huge constructions including such bridges due to the existence of fast computers and sophisticated algorithms such as GA. It is feasible to optimise a bridge with desired qualities by formulating the bridge analysis and design all at once. As a result, in addition to saving material, time, money, and human effort, the environment is preserved.

2.15 Felix Kulka 1983

The viability of producing standard sections for segmental prestressed concrete box girder bridges was studied in this work. The study was based on a thorough examination of segmental box girder bridges in the United States and Canada. It was believed that in order for standardisation of box girder segments to find success, a uniform approach must be used to enable bridge engineers and designers such segments with adequate homogeneity and to enable precasters and contractors to bid and build them as they would any other improved form of Structure. The goal of this research was to weigh all of the benefits and drawbacks of standardisation and give suggestions for future improvement.

Chapter 3

METHODOLOGY

3.1 General

Box cell type bridge comprises of pre stressed steel, concrete and combination of RC materials & steel. This sort box cell bridge may have different shape of section like rectangular, trapezoidal & circular of cross-section. Box cell taper edges bridges are commonly used for highway flyovers, metro, and for contemporary elevated structure like rail transport. Very High torsional rigidity provides bridge box tapers to resist the torsional forces which are because of loading.

Box cell type bridge Analysis & design is alienated into two parts:

1) Analysis in Longitudinal

2) Analysis in Transverse

3.2 Model Geometry

This section provides model geometry information, including items such as joint coordinates, joint restraints, and element connectivity.

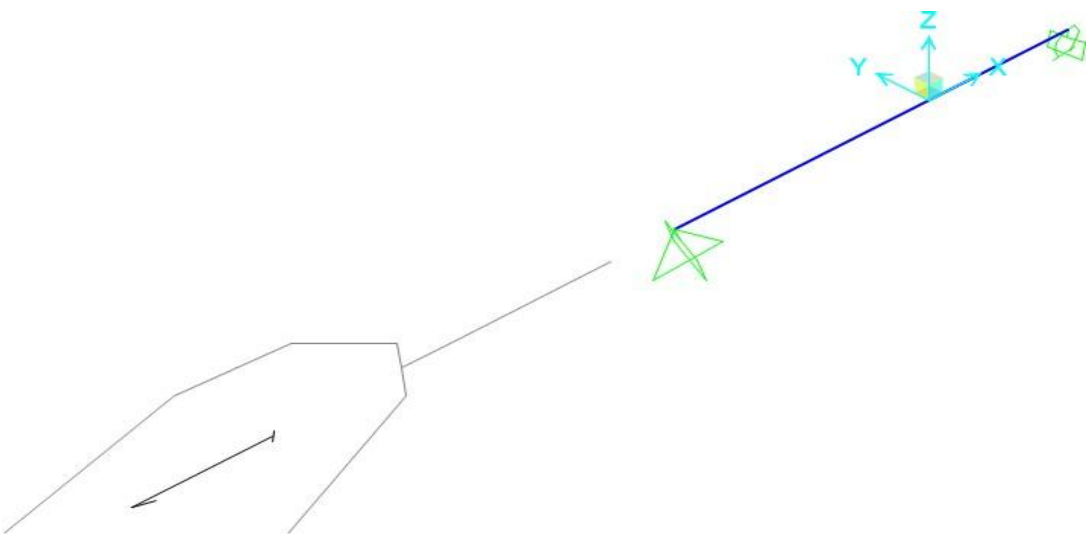

Fig. 3 1 Beam in SAP 2000

Table: 3.1 Coordinates of Joint

Joint	Cord System	Type of Cord	Global X	Global Y	Global Z
			m	m	m
1	GLOBAL	Cartesian	-15m	0m	0m
2	GLOBAL	Cartesian	15m	0m	0m

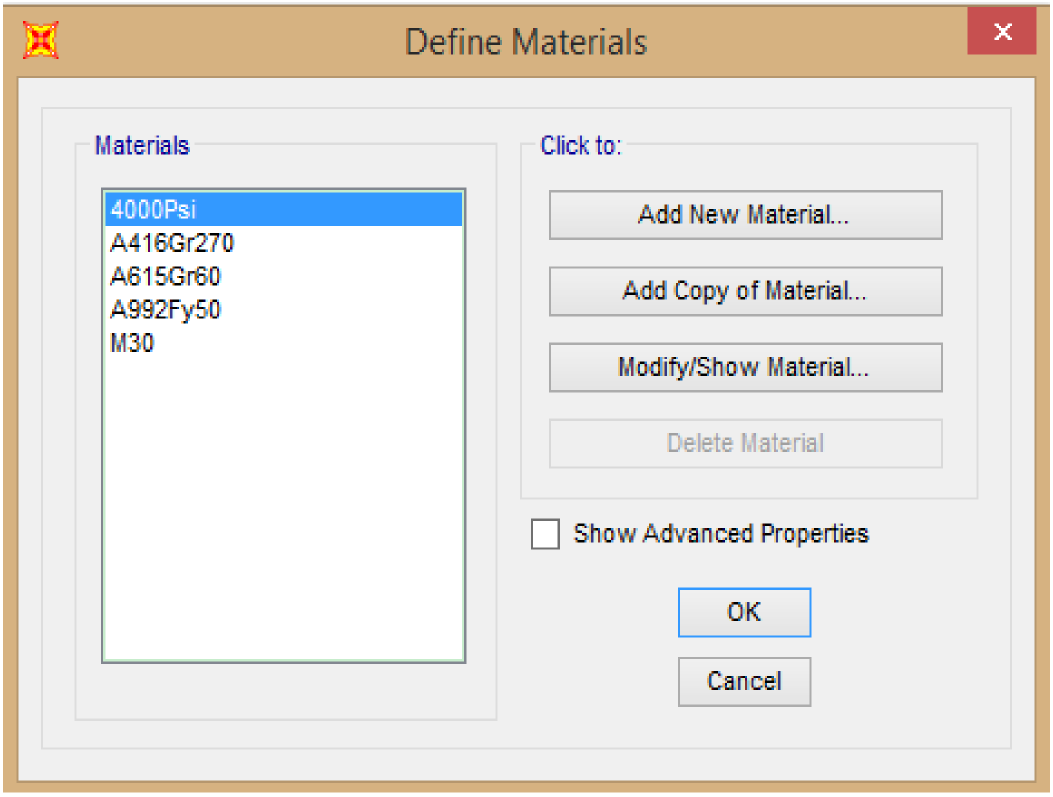

Fig. 3.2 Material define in SAP 2000

Material -concrete

Concrete grade M-30

Young modulus of elasticity	=	5000 square root of (fck)
	=	5000 square root of 30
	=	27386.12 KN/square meter
Modulus of rigidity	=	11410886.67KN/m2
UNIT mass	=	25.48KN-s2/m4

Table: 3.2 Material Properties

Material	Unit Weight	Unit Mass	E	G
	(KN/m3)	(KN-s2/m4)	(KN/m2)	(KN/m2)
M30	2.4993E+01	2.5485E+00	27386128	11410886.67

E= Young Modulus of Elasticity

G=Modulus of Rigidity

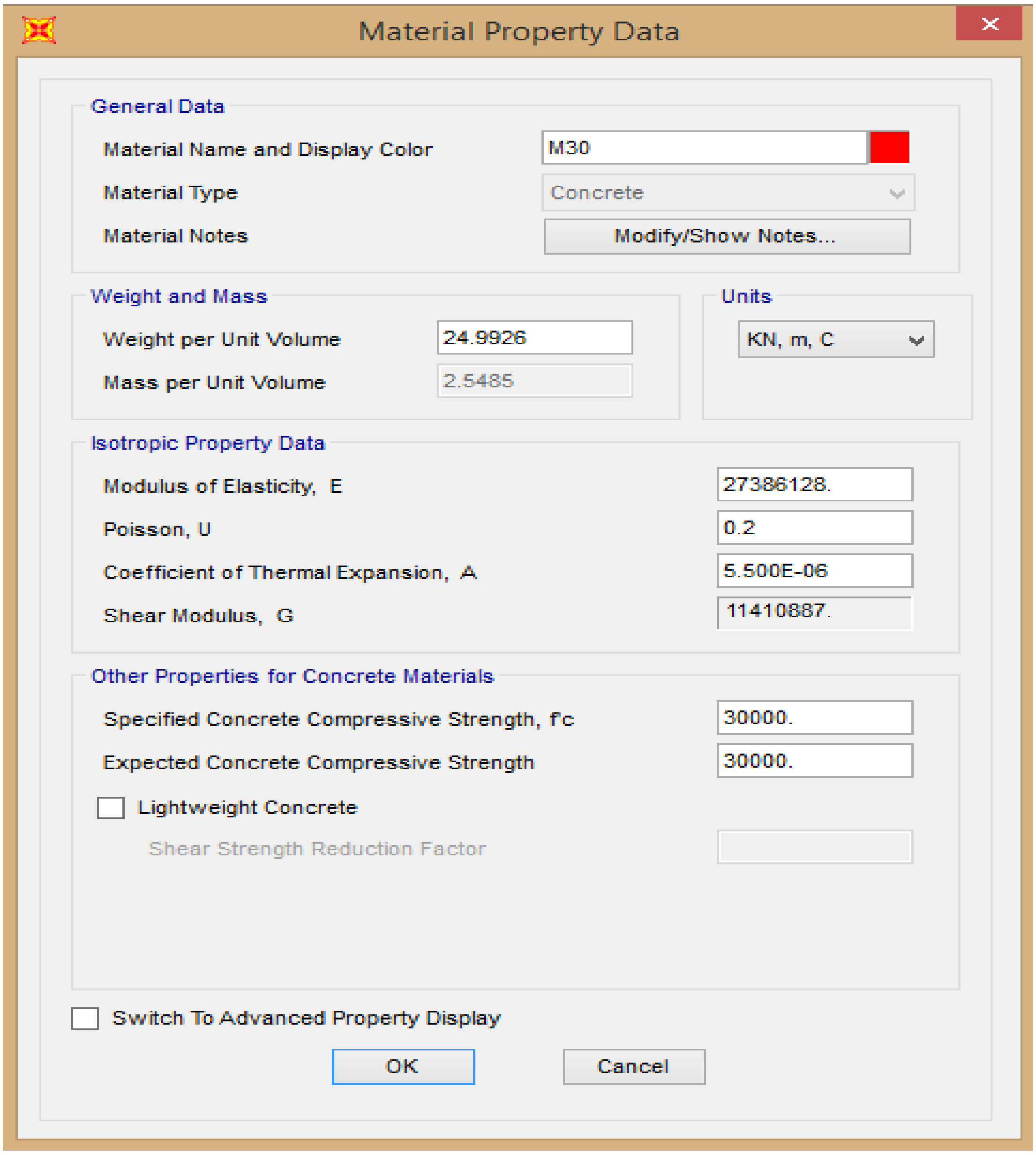

Fig. 3.3 Material property data

3.3 Definitions for Load

We only considered "Dead Load and Live Load" for this study.

1. Dead Load:

The main design load must be calculated as part of the bridge design. "The load is calculated by the SAP 2000 software and is the weight of the elements of the bridge box. Main characteristics of the box bridge, the supporting mantle, the fence, the parapet, the stiffening, etc. We only set the weight of a concrete box".

2. Live Load:

"This is the moving load of the bridge span". This includes trucks, cars, motorcycles, bicycles, buses, vehicles, pedestrians, etc., but choosing a vehicle or combination of vehicles to analyze and design bridges in depth is complex.

According to recommendations from the IRC, certain critical vehicles are considered a traffic load when designing bridges according to their use on different road classes. As per IRC

1) Class 70R IRC-Loading (Used for study)

2) Class AA IRC-Loading

3) Class A IRC-Loading (Used for study)

4) Class B IRC-Loading

In this research work used only 2 type loading for analysis are finalized mainly class A & 70 R for observing BM, SF & deflection.

1) **Class 70R IRC-Loading:**

This type of loading is in the main occurs on all roads of permanent bridges & culverts. Generally all Bridges designed for Class-70R IRC-Loading should be checked for Class A Loading also as under certain conditions reactions may occur due to Class A Loading.

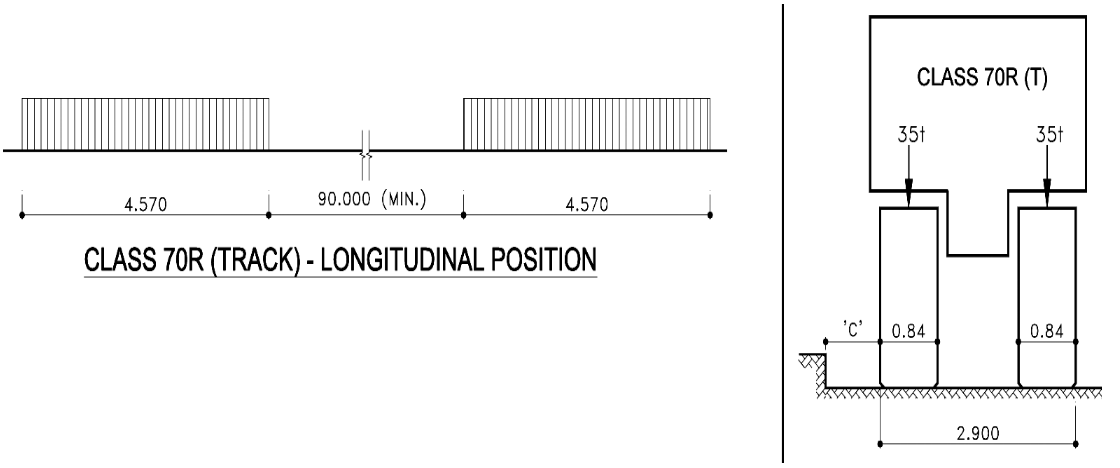

Fig. 3.4 Wheel Arrangement for 70R (Wheeled) Vehicle

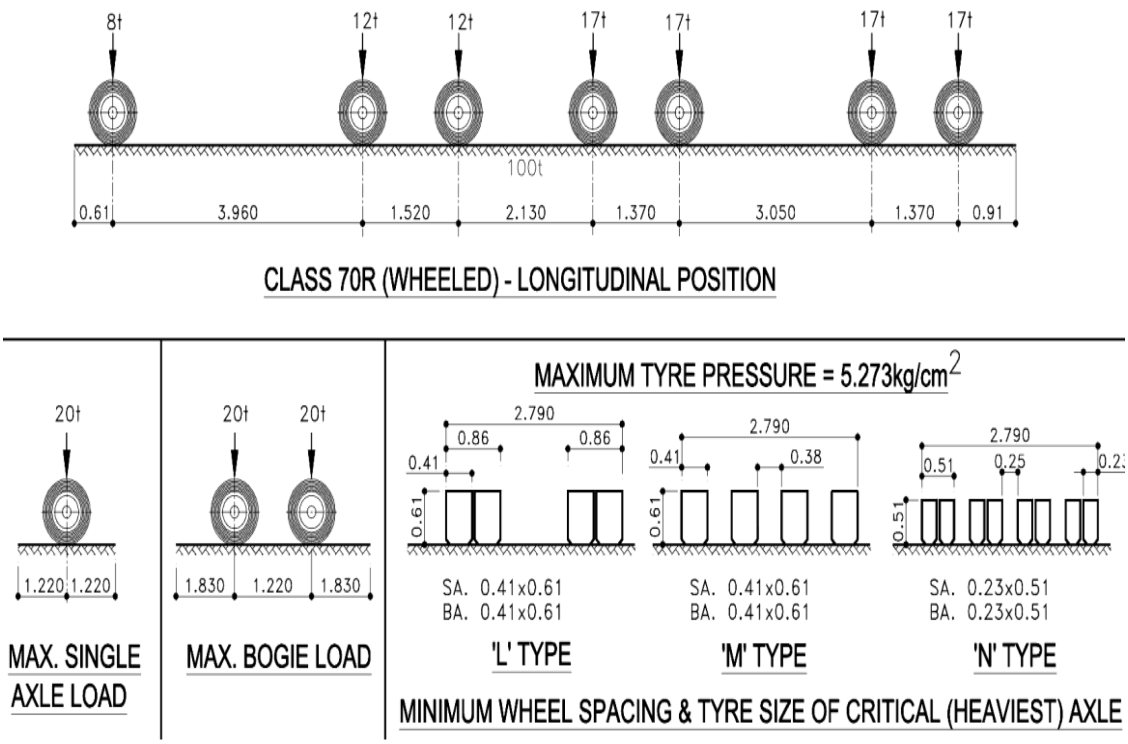

Fig. 3.5 Load Define In SAP 2000

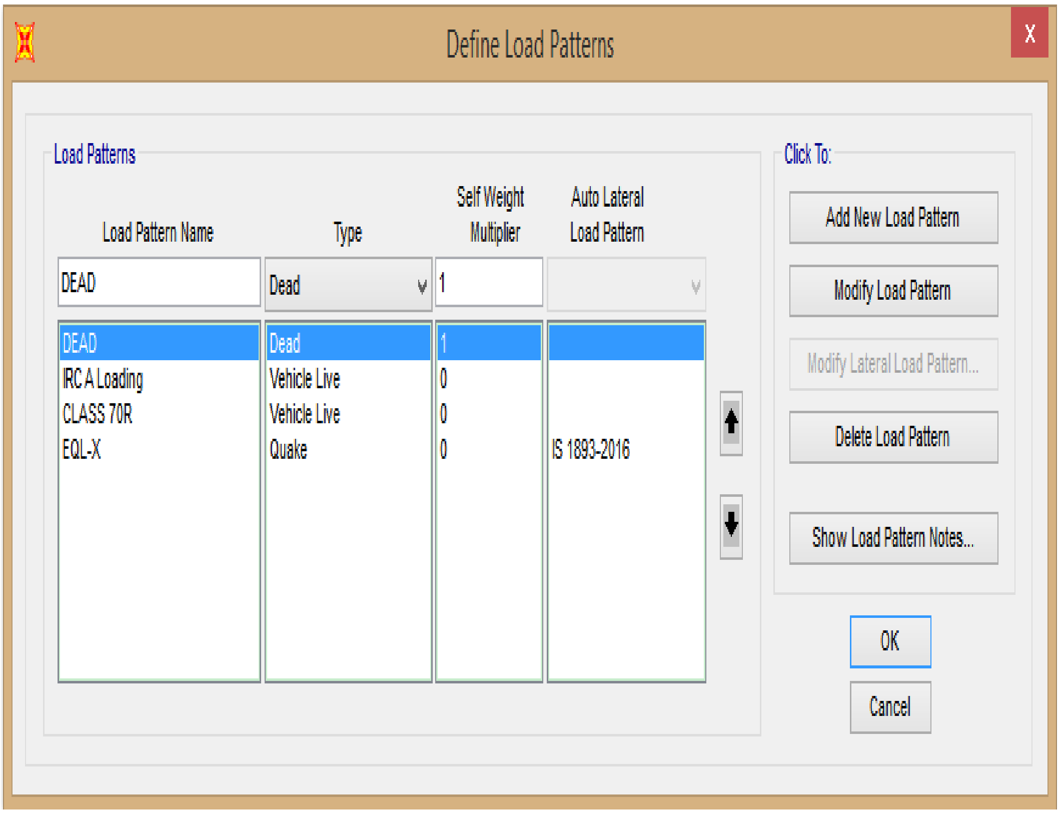

Fig. 3.6 Load Pattern Defined in SAP 2000 Window Tab

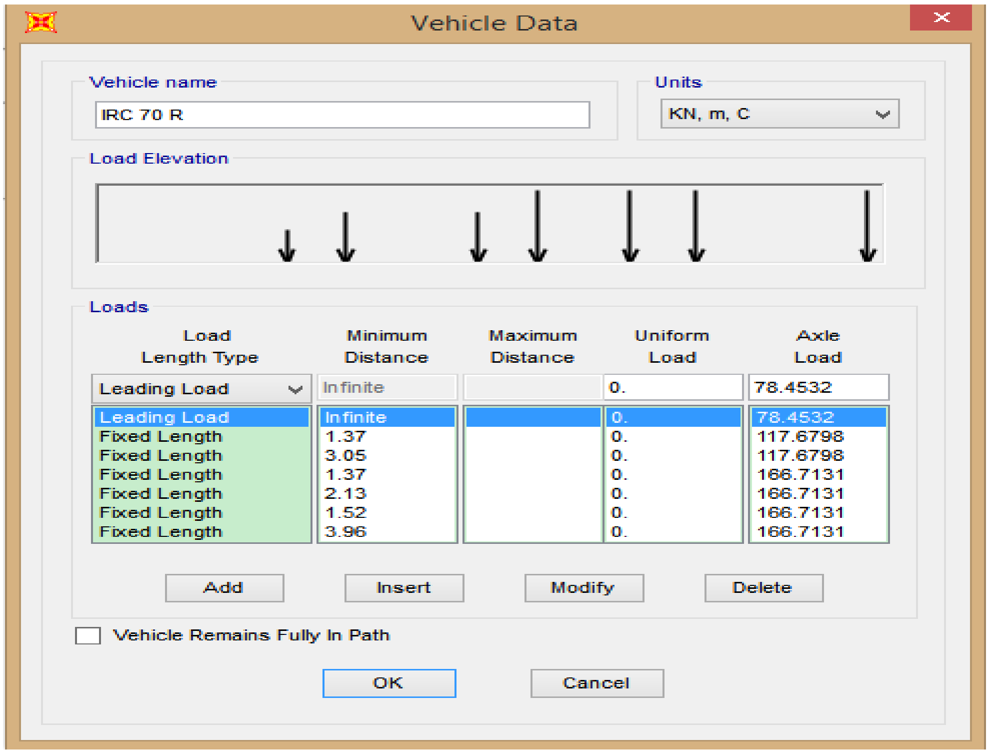

Fig. 3.7 Vehicle Data Define in SAP 2000 Window Tab

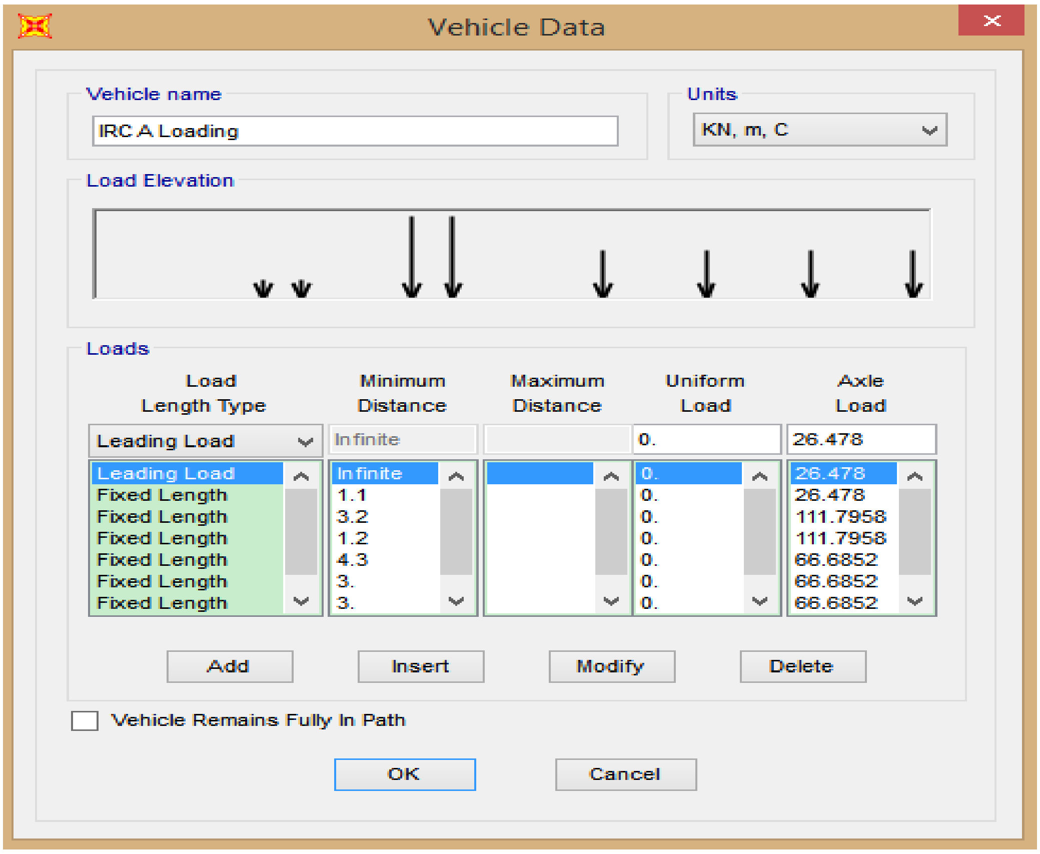

Fig. 3.8 IRC Class A Load Defined In SAP 2000

2) IRC Class A Loading:

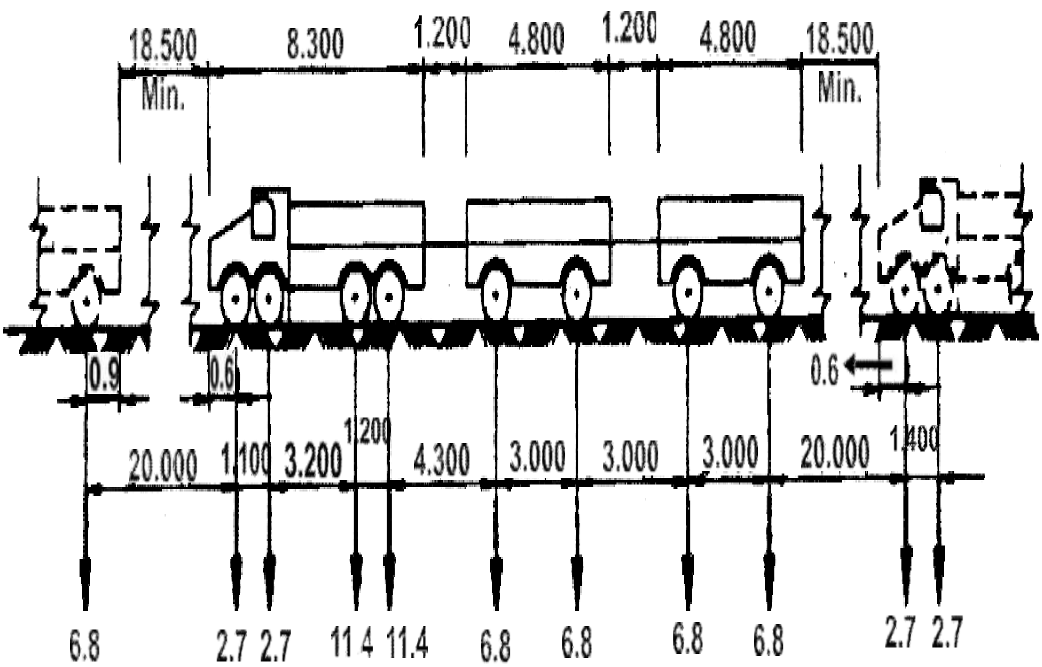

Fig. 3.9 IRC Loading of Class-A Vehicle

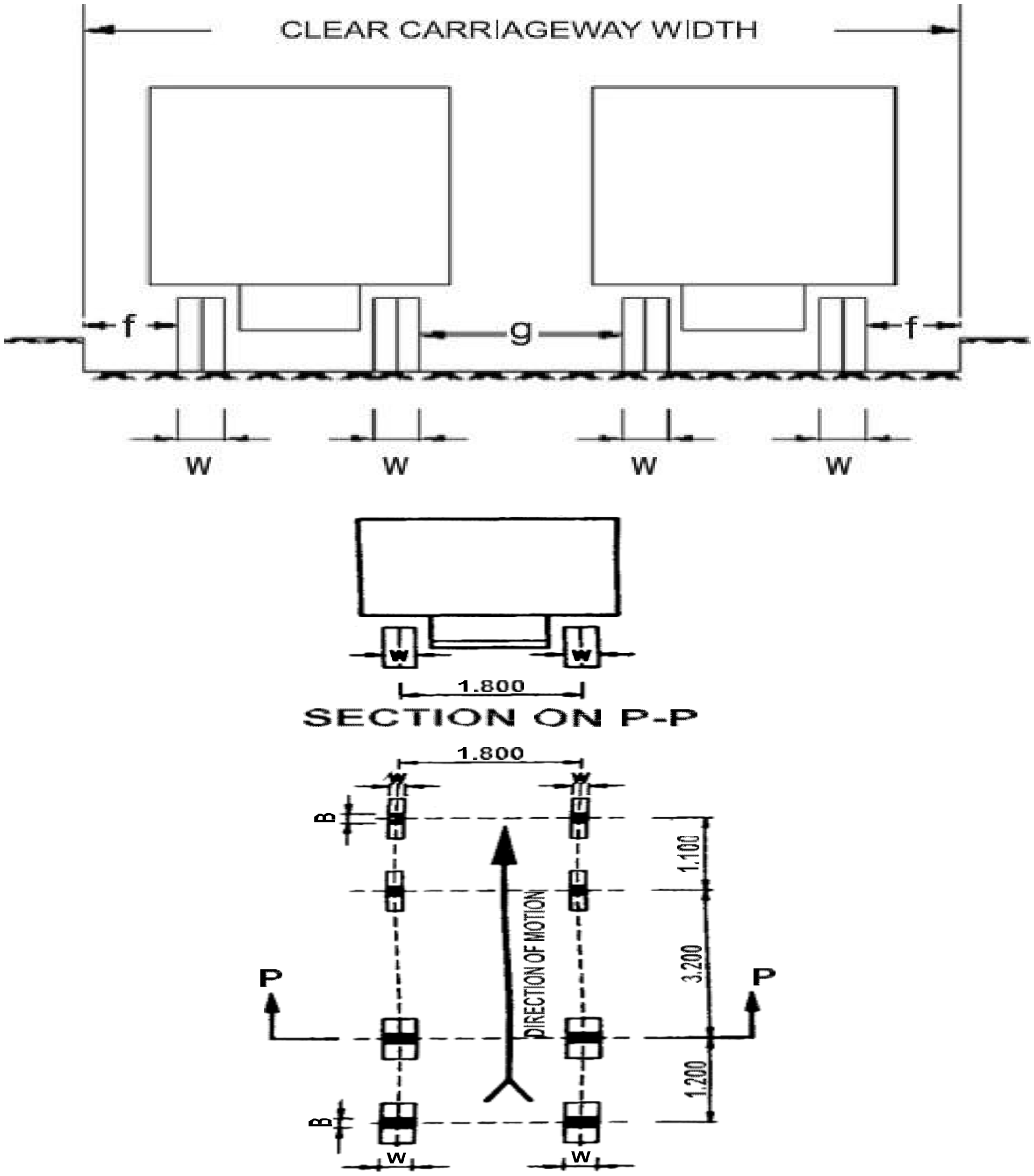

Fig. 3.10 Front View of IRC Class A Vehicle

Table: 3.3 Carriage Way Width Data

Clear Carriage way Width	**g**	**f**
5.3m - 6.1m	Varying from 0.4m - 1.2m	150 mm for all Carriage way Width
Above 6.1m	1.2 meter	

Table: 3.4 Ground Contact Area Data

Axle load (tone)	Ground Contact Area	
	B (mm)	W (mm)
11.4	250	500
6.8	200	380
2.7	50	200

3.4 Geometry Parameter Defined For Different Case

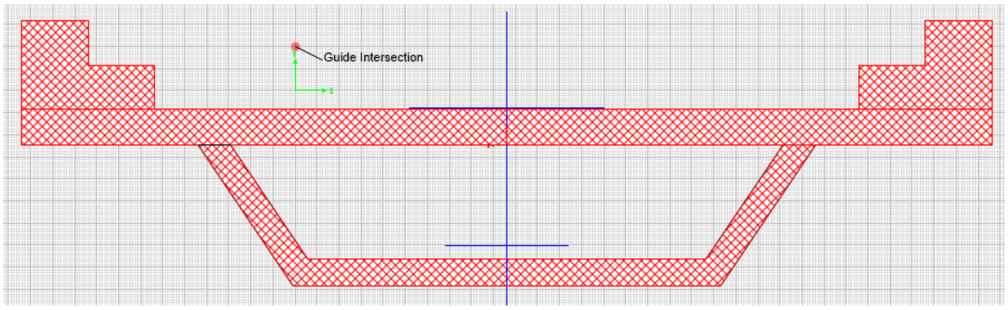

Fig. 3.11 Case of Double Box Modify To Single Box

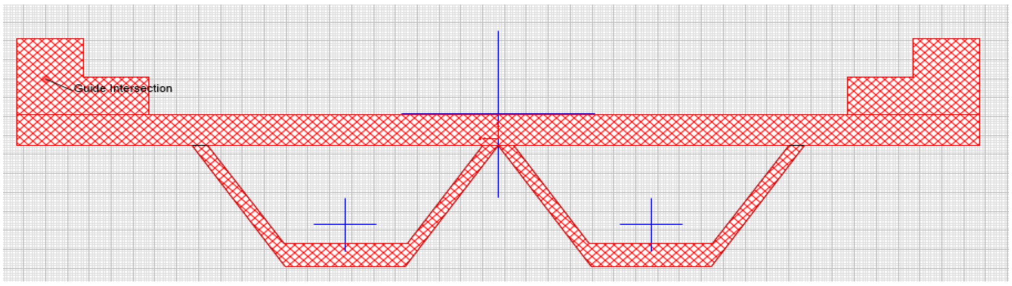

Fig. 3.12 Case of Double Box Cell of 45 Degree

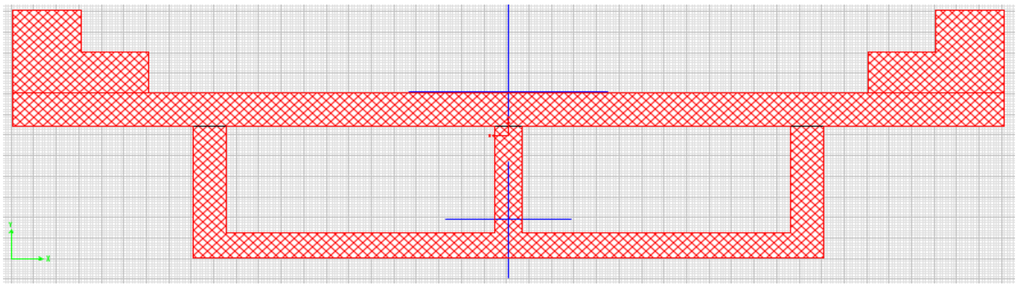

Fig. 3.13 Double Box Cell 90 Degree

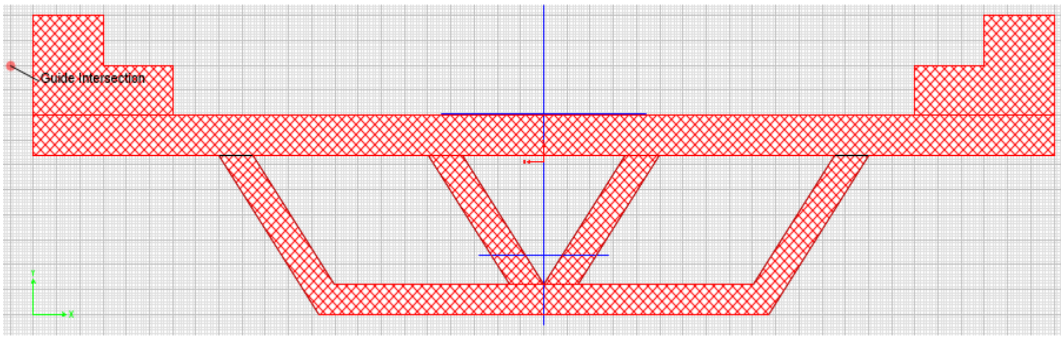

Fig. 3.14 Double Box Cell of (Inverted) Triangle

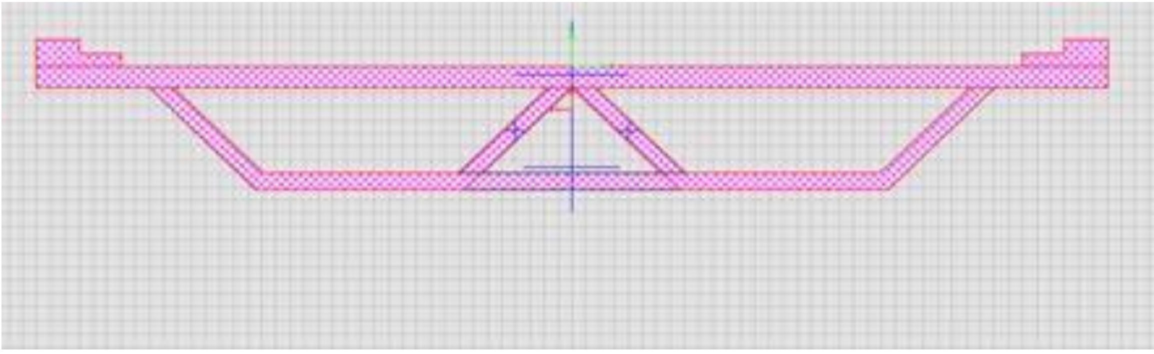

Fig. 3.15 Section data of triangle

3.5 Path and Eccentricity Calculation

Width of vehicle =1.8 m

Width of tire is 500 mm (.50 meter) (very heavy & standard tire)

Lane width is 8 m

Kerb to center of tire distance is “X”

Eccentricity = “e”

Eccentricity for class A : e = 2.7 m

Eccentricity for 70 R : e = 1.65 m

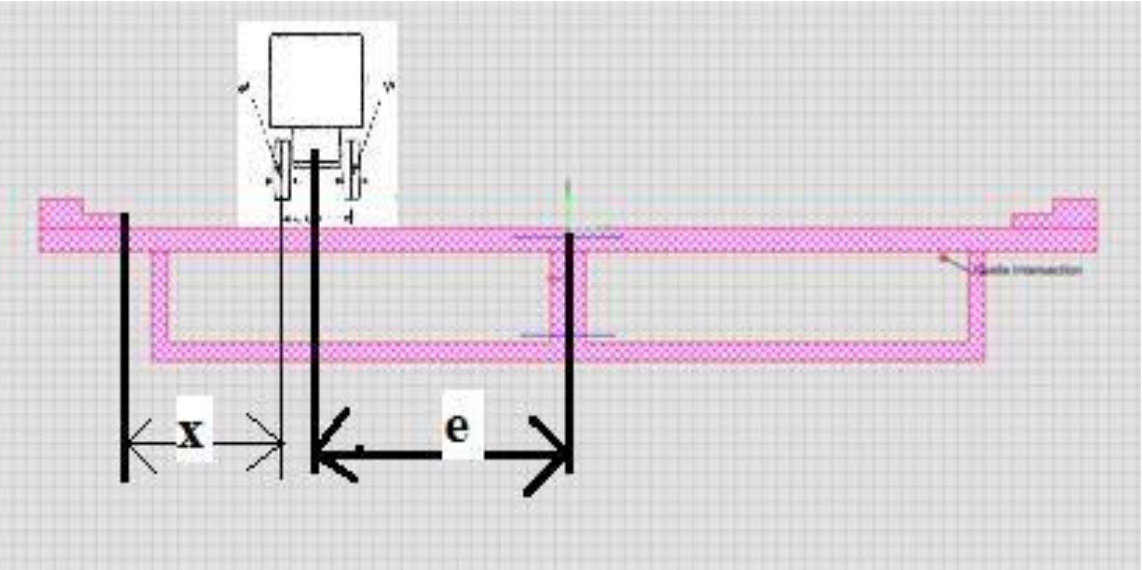

Fig. 3.16 Eccentricity of Vehicle along Moving Path

Calculated path is defined in SAP 2000 software in define path tab. Path assigned in loading in load case tab of SAP 2000 for IRC class A 2.7 eccentricity and for IRC 70 R loading a path of eccentricity 1.65.

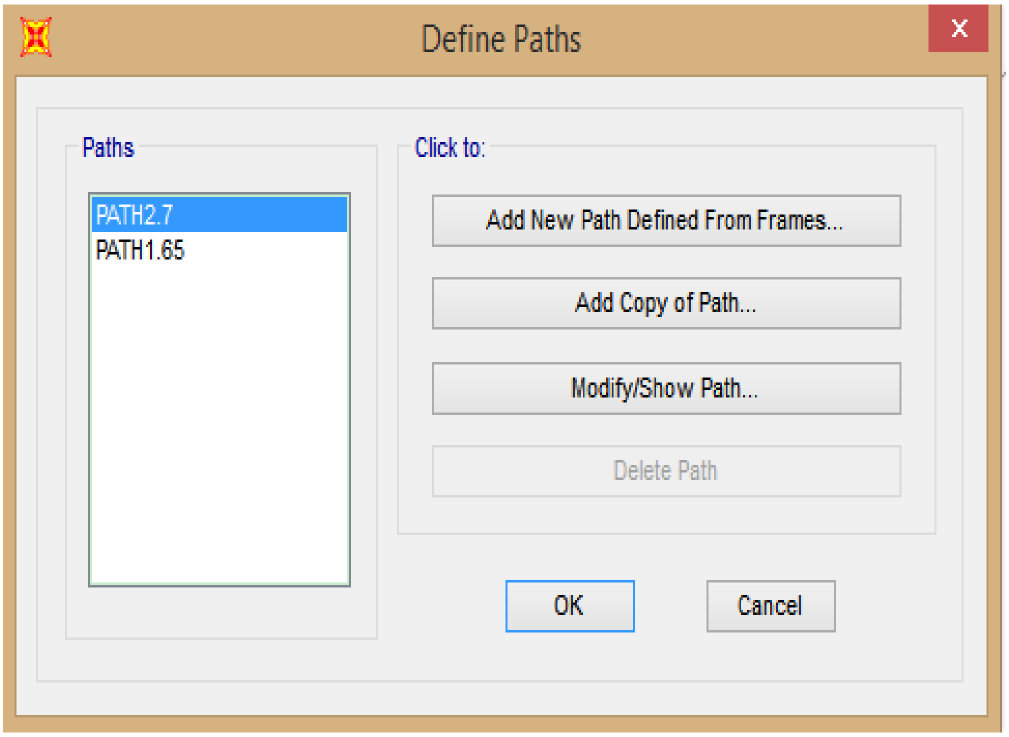

Fig. 3.17 Eccentricity Defined in SAP 2000 Window Tab

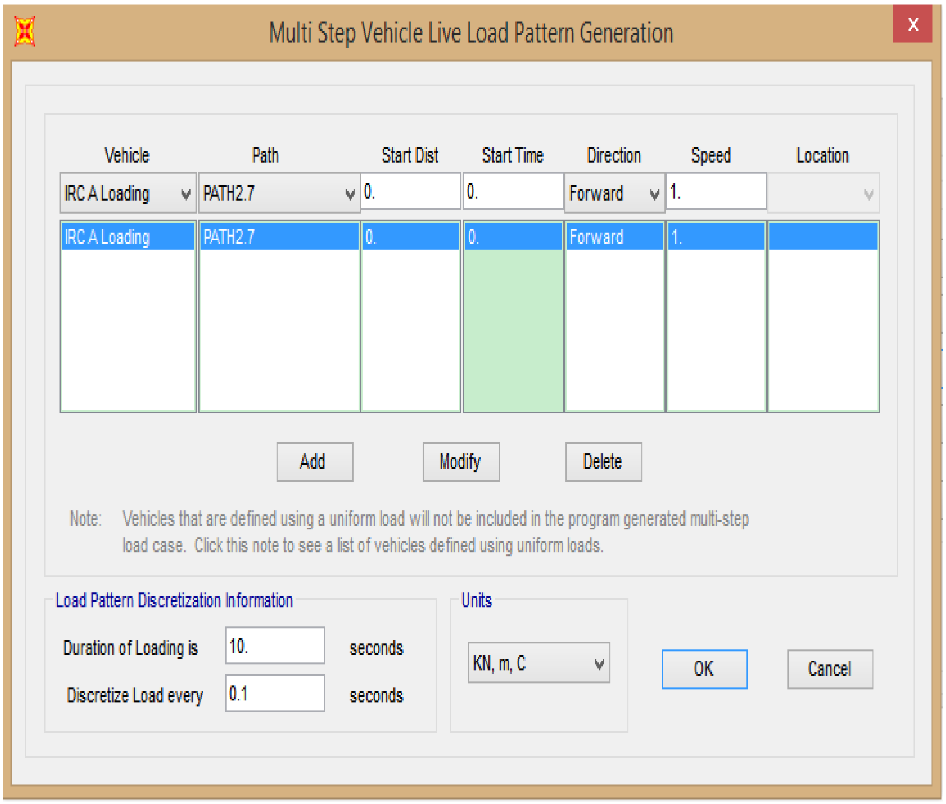

Fig. 3.18 Vehicle Class for Path 2.7

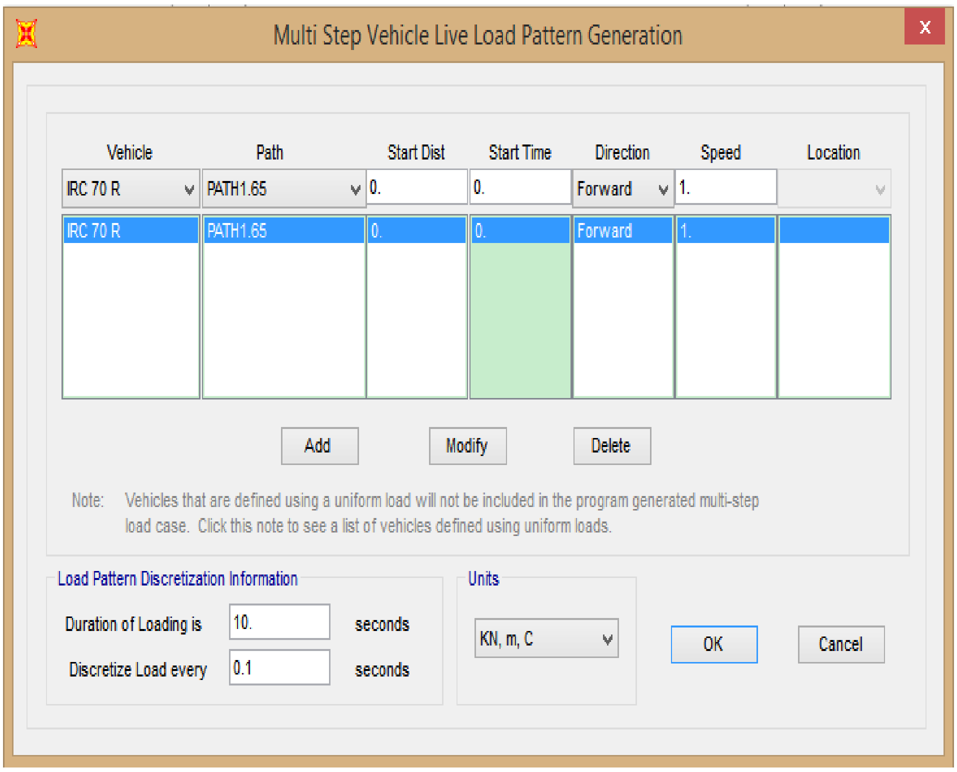

Fig. 3.19 Vehicle Class for Path 1.65

3.6 Response Spectrum Assign to Beam

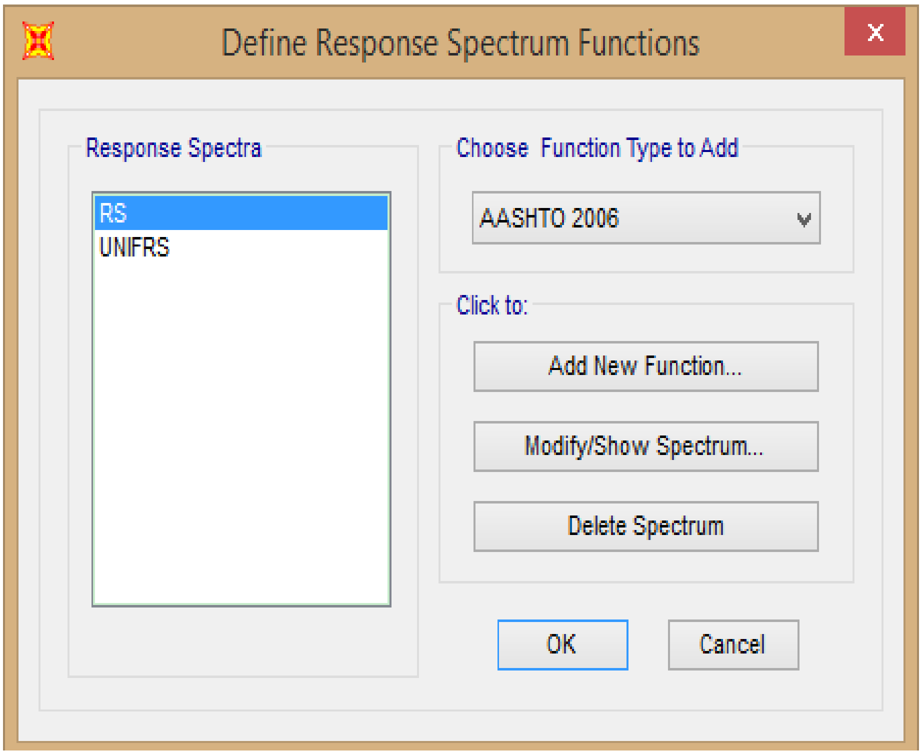

Fig. 3.20 Define Response spectrum

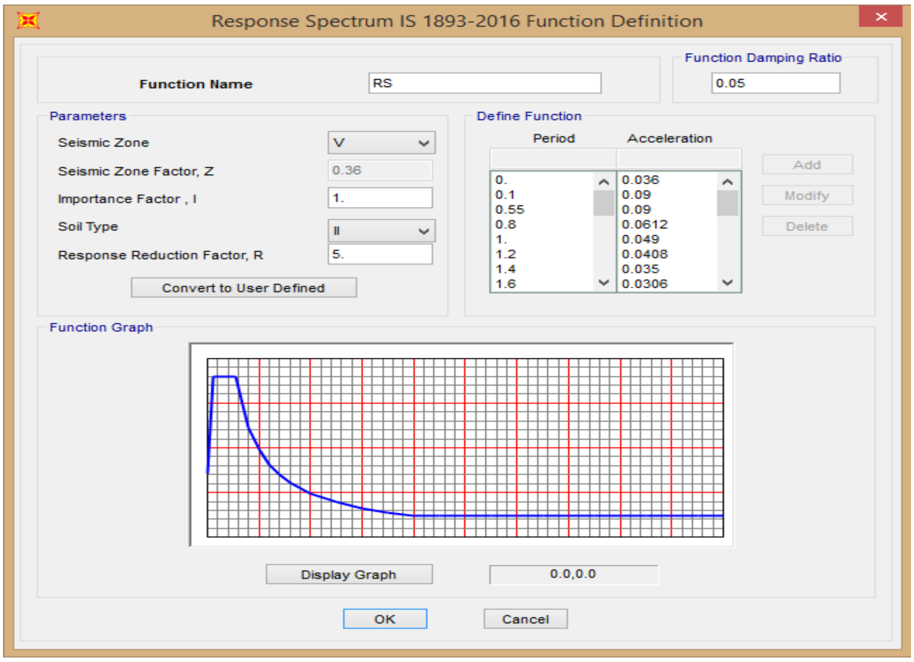

Fig. 3.21 Response spectrum IS 1893-2016

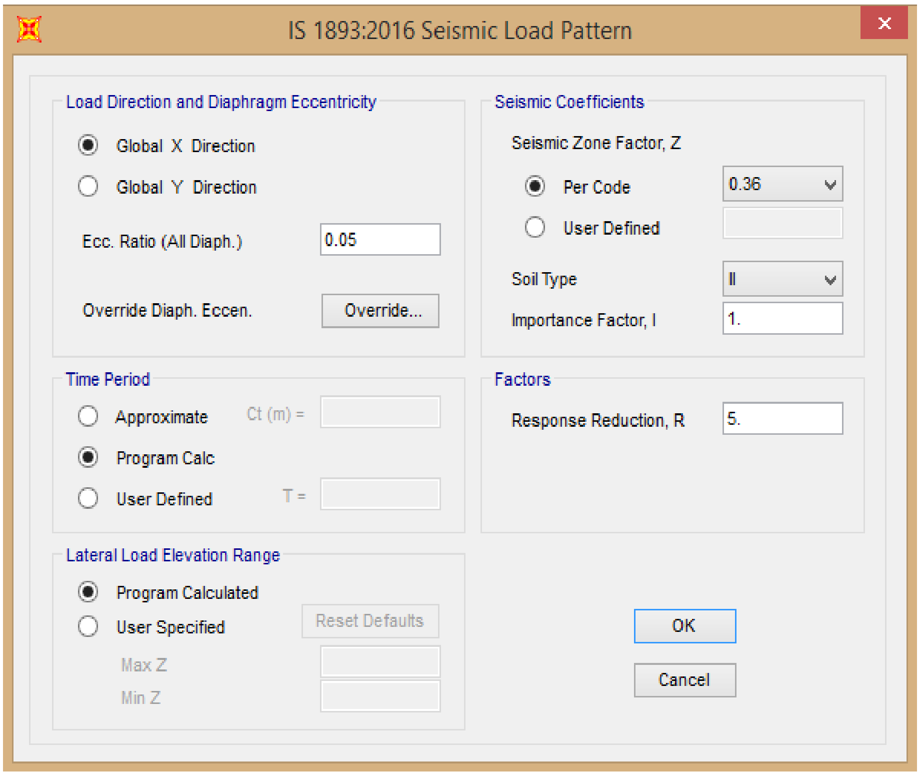

Fig. 3.22 Seismic Load Pattern IS 1893:2016

3.7 Load Combination

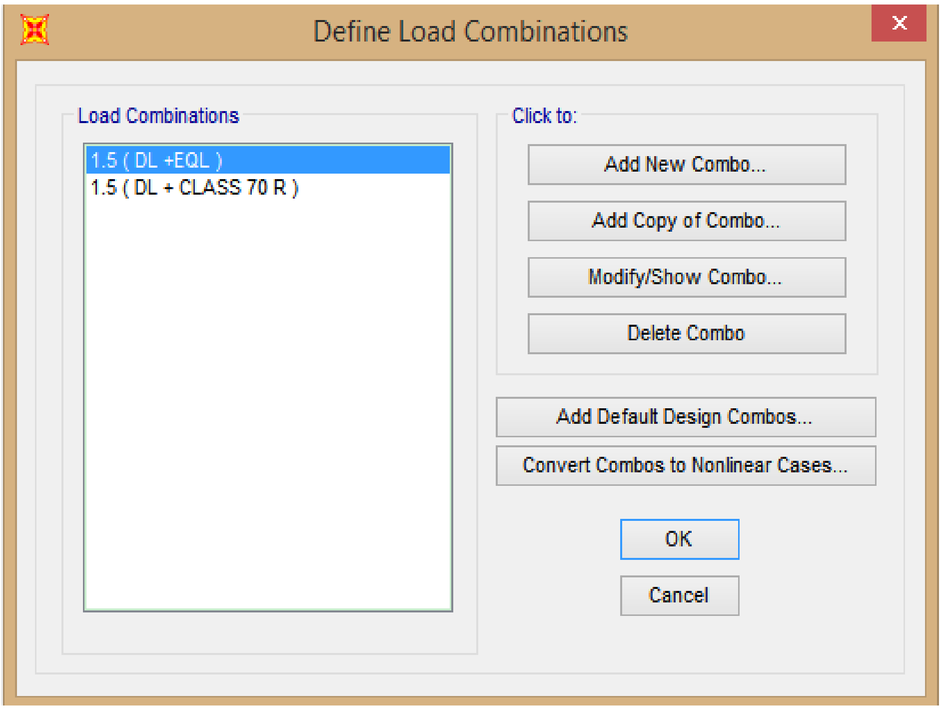

Fig. 3.23 Define Load Combinations

3.8 Deformed Shape of Beam Due to Various Loads and Load Combinations

3.8.1 Deformed Shape Due to Dead Load

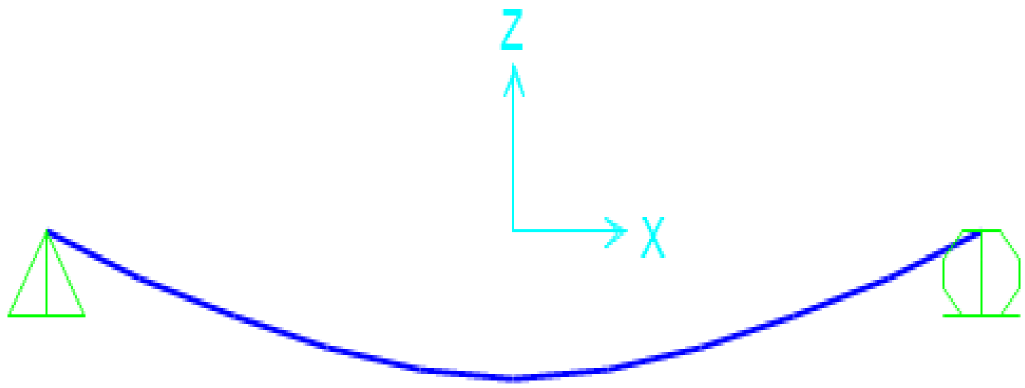

Fig. 3.24 Deformed shape of Beam Due Dead Load

3.8.2 Deformed Shape Due to Load Combination of 1.5(DL+EQL)

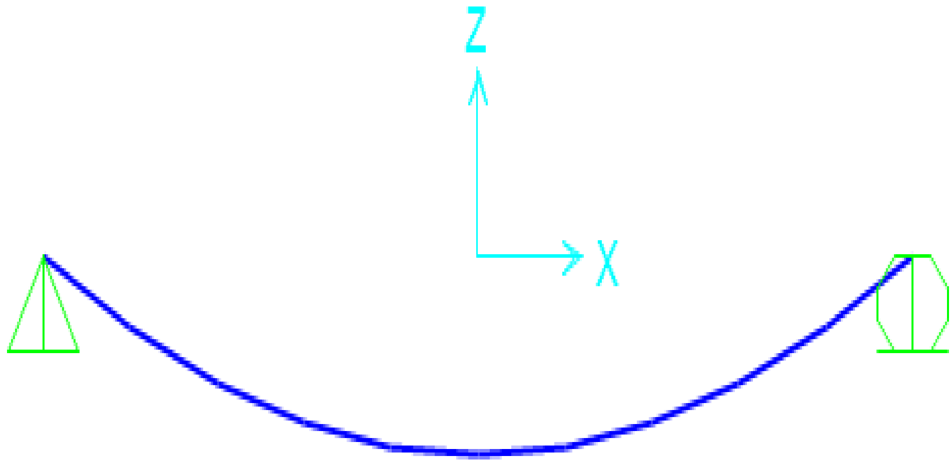

Fig. 3.25 Deformed shape of Beam Due Load Combination 1.5(DL+EQL)

3.9 BM, SF and Other Diagrams in Beam due Various Loads and Load Combinations

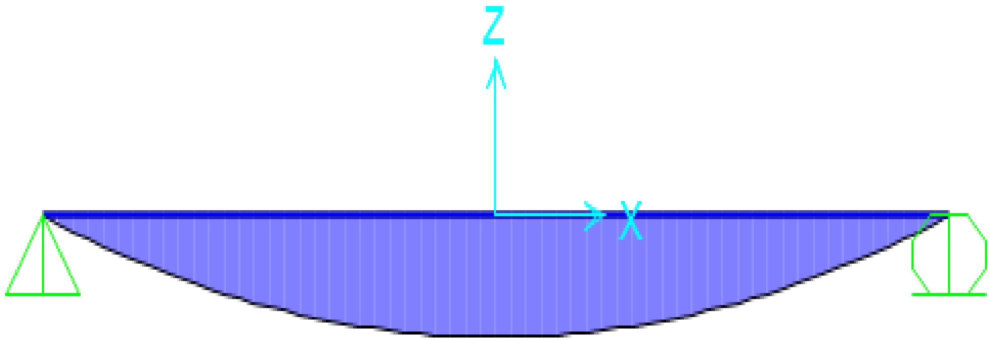

Fig. 3.26 Bending Moment in Beam due Dead Load

3.9.1 BM, SF and Other Diagrams Beam due Dead Load

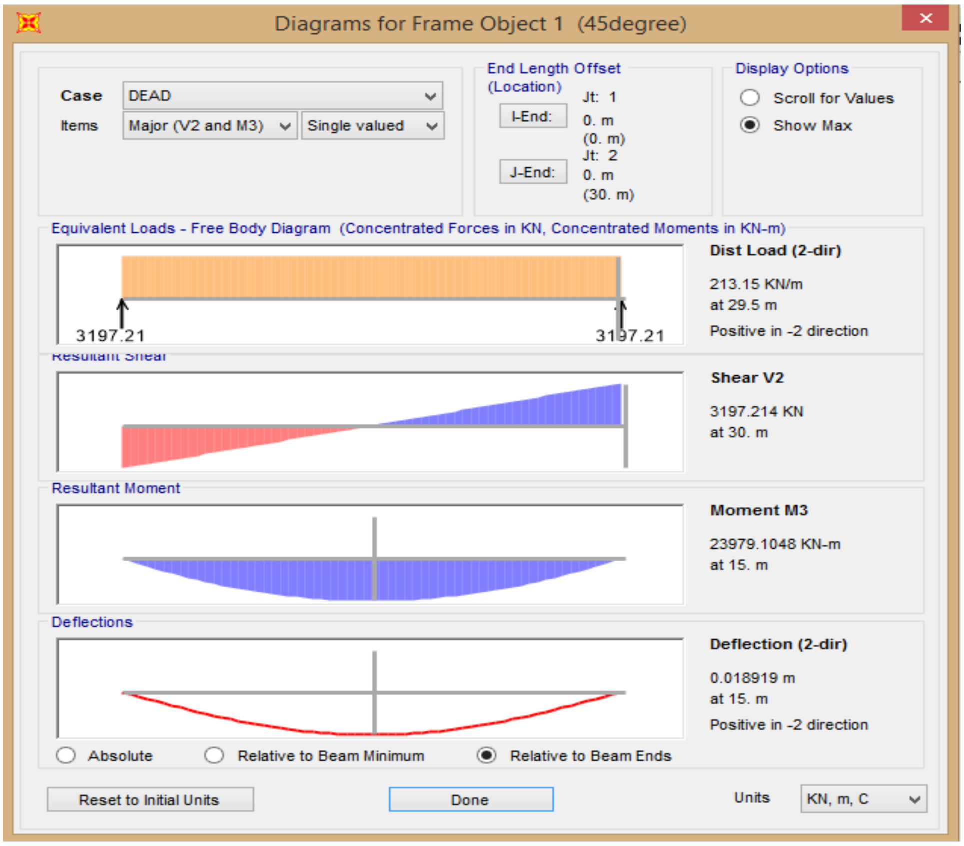

Fig. 3.27 Various Diagram for frame Object in 45 Degree due Dead Load

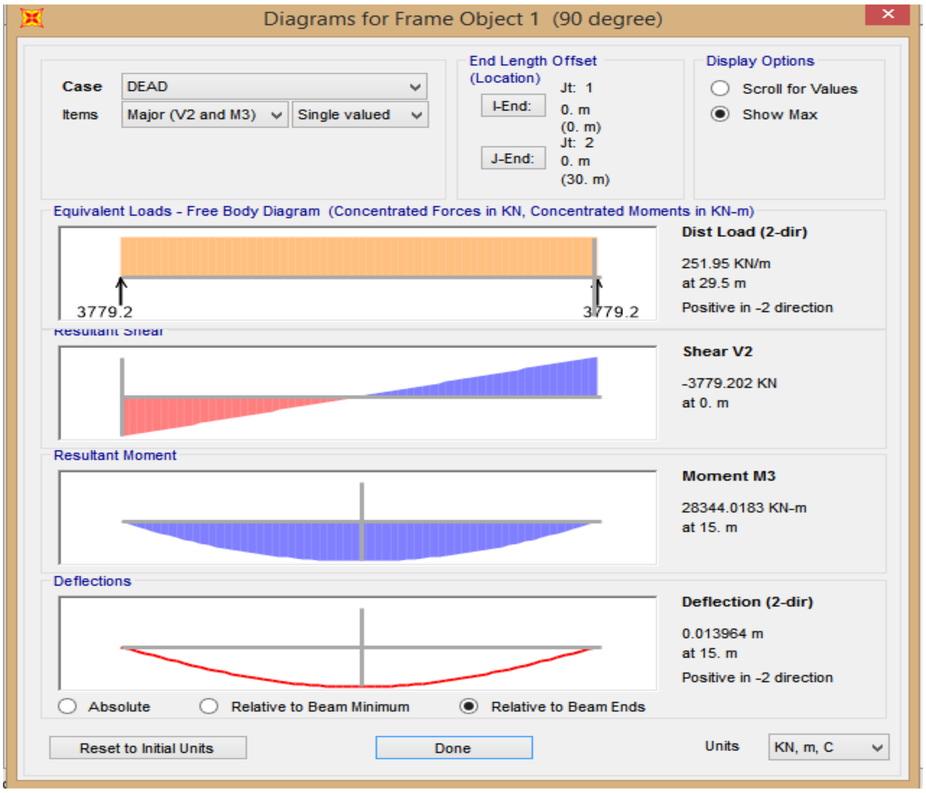

Fig. 3.28 Various Diagram for frame Object in 90 Degree due Dead Load

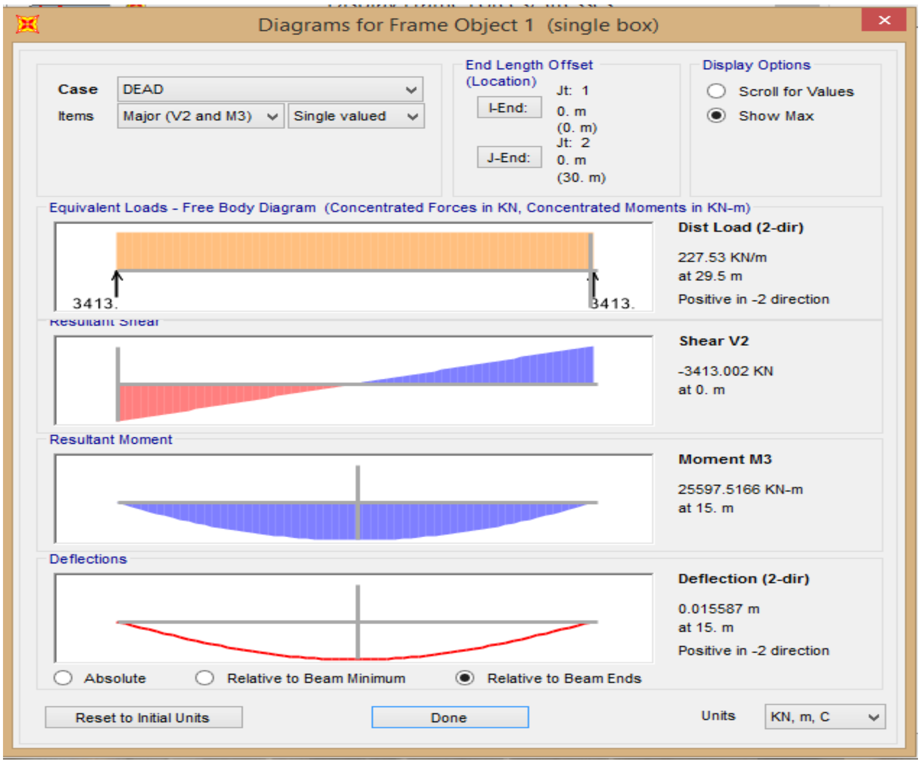

Fig. 3.29 Various Diagram for frame Object in Single Box due Dead Load

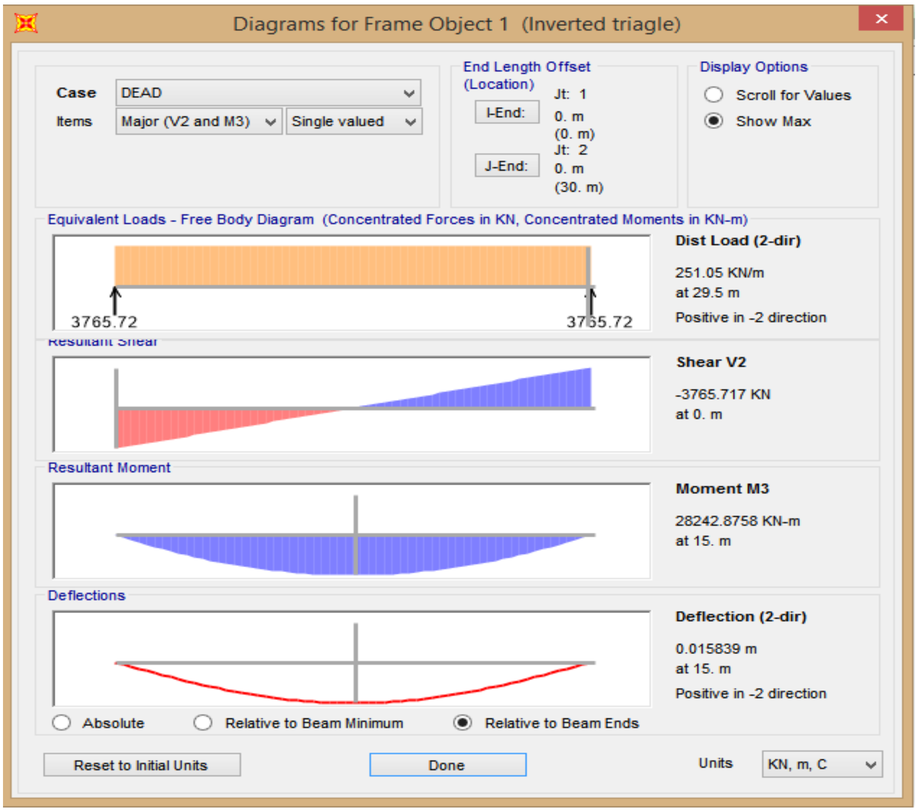

Fig. 3.30 Various Diagram for frame Object in Inverted Triangle due Dead Load

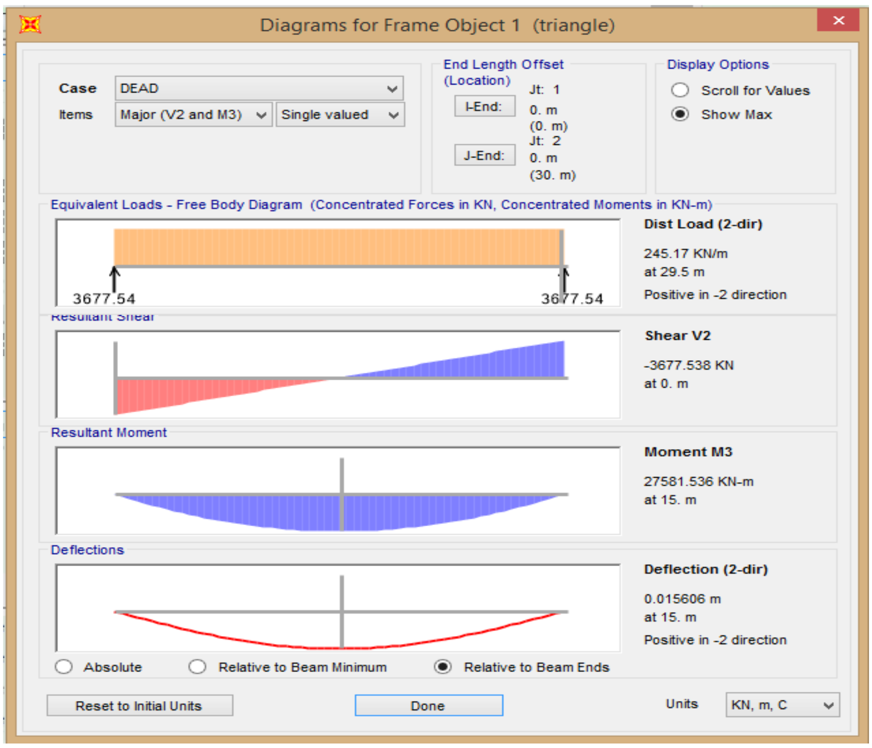

Fig. 3.31 Various Diagram for frame Object in Triangle due Dead Load

3.9.2 BM, SF and Other Diagrams Due to Load Combination of 1.5(DL+EQL)

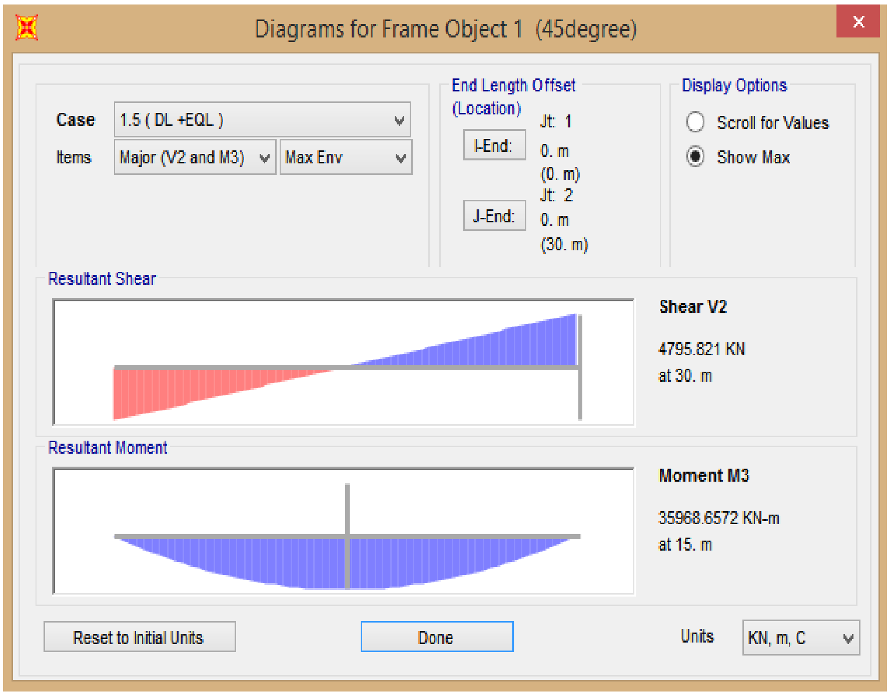

Fig. 3.32 Various Diagram for frame Object in 45 Degree due Load Combination 1.5 (DL+EQL)

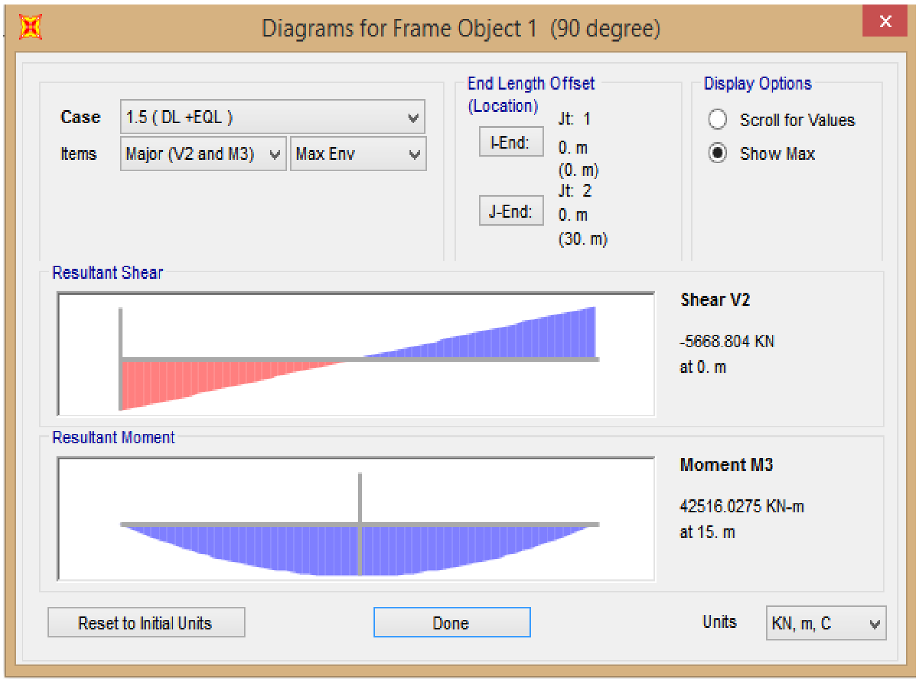

Fig. 3.33 Various Diagram for frame Object in 90 Degree due Load Combination 1.5 (DL+EQL)

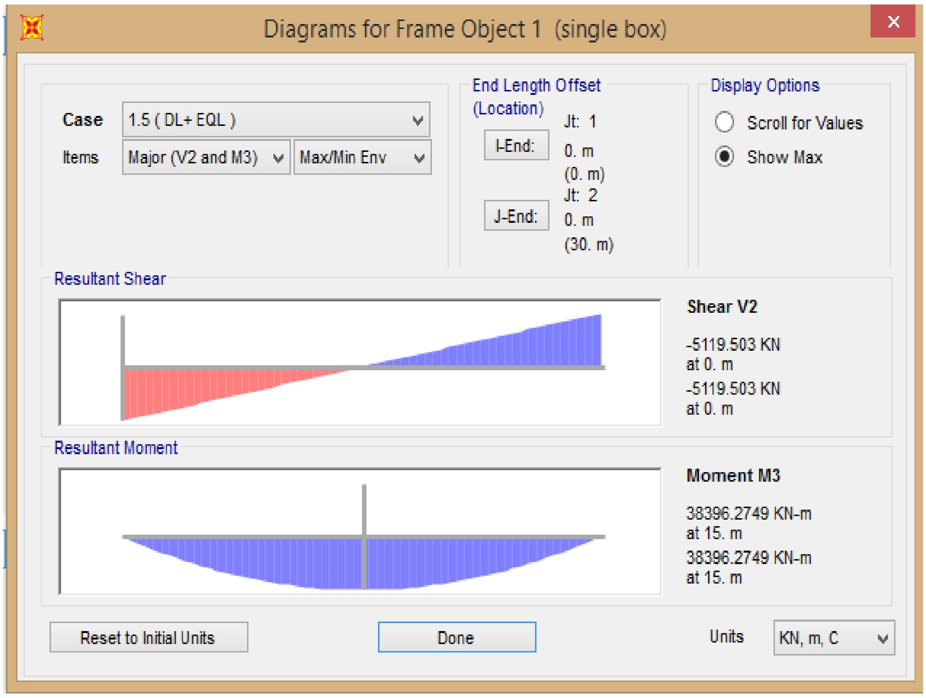

Fig. 3.34 **Various Diagram for frame Object in Single Box due Load Combination 1.5 (DL+EQL)**

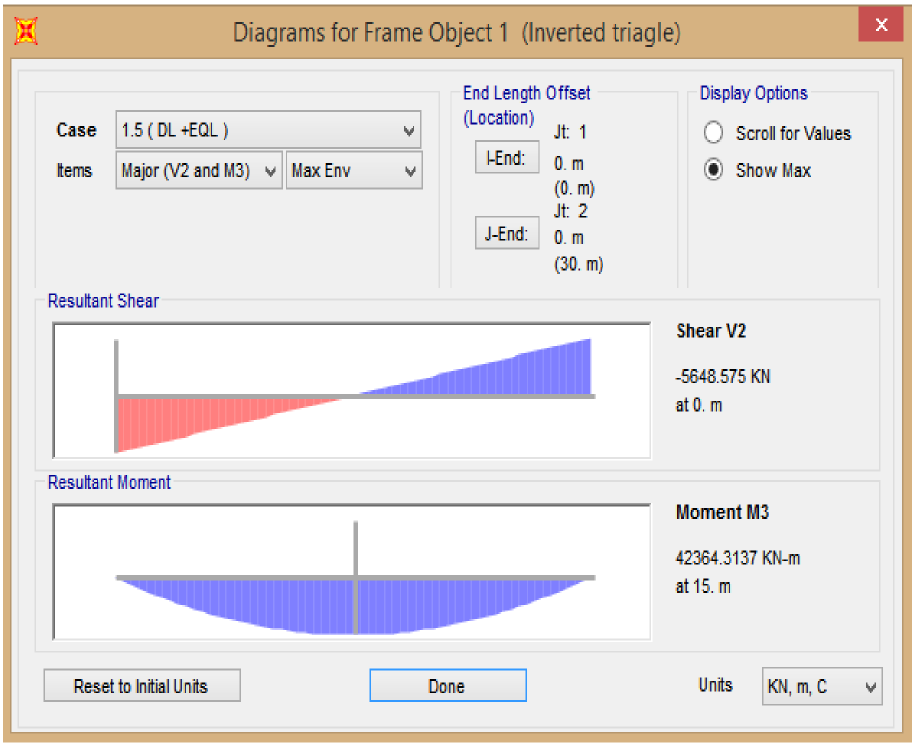

Fig. 3.35 **Various Diagram for frame Object in Inverted Triangle due Load Combination 1.5 (DL+EQL)**

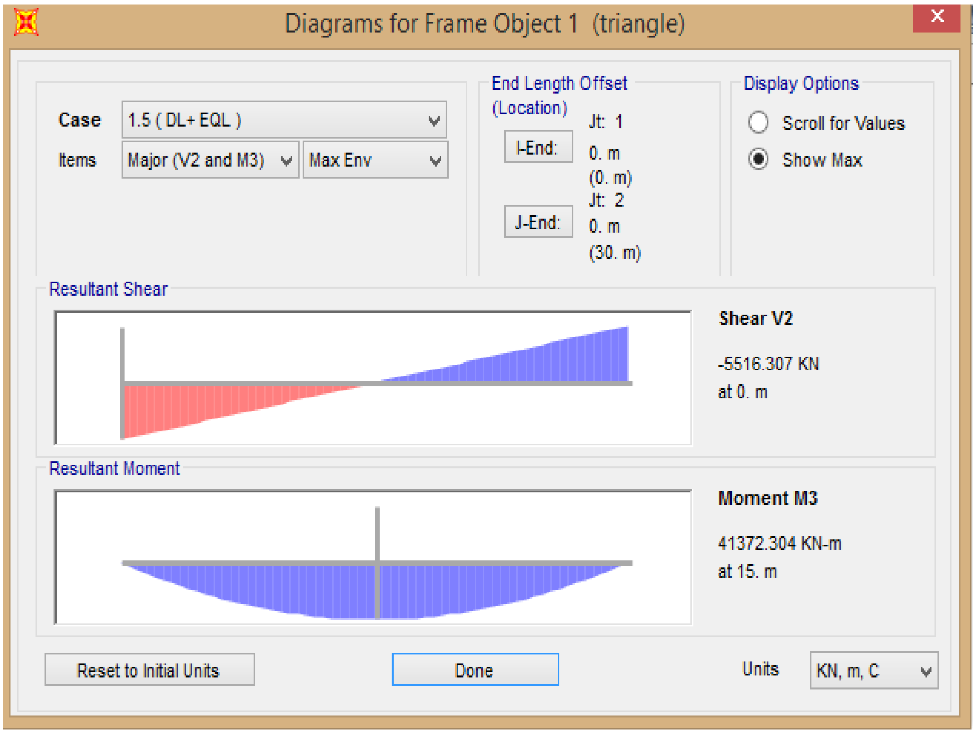

Fig. 3.36 **Various Diagram for frame Object in Triangle due Load Combination 1.5(DL+EQL)**

3.9.3 BM, SF and Other Diagrams Beam due IRC A Loading

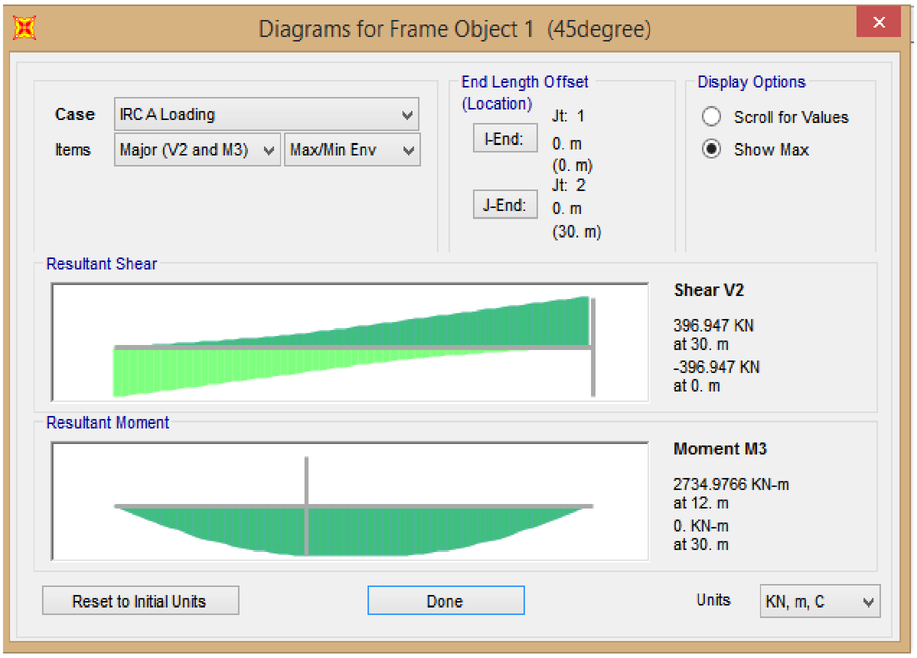

Fig. 3.37 **Various Diagram for frame Object in 45 Degree due IRC A Loading**

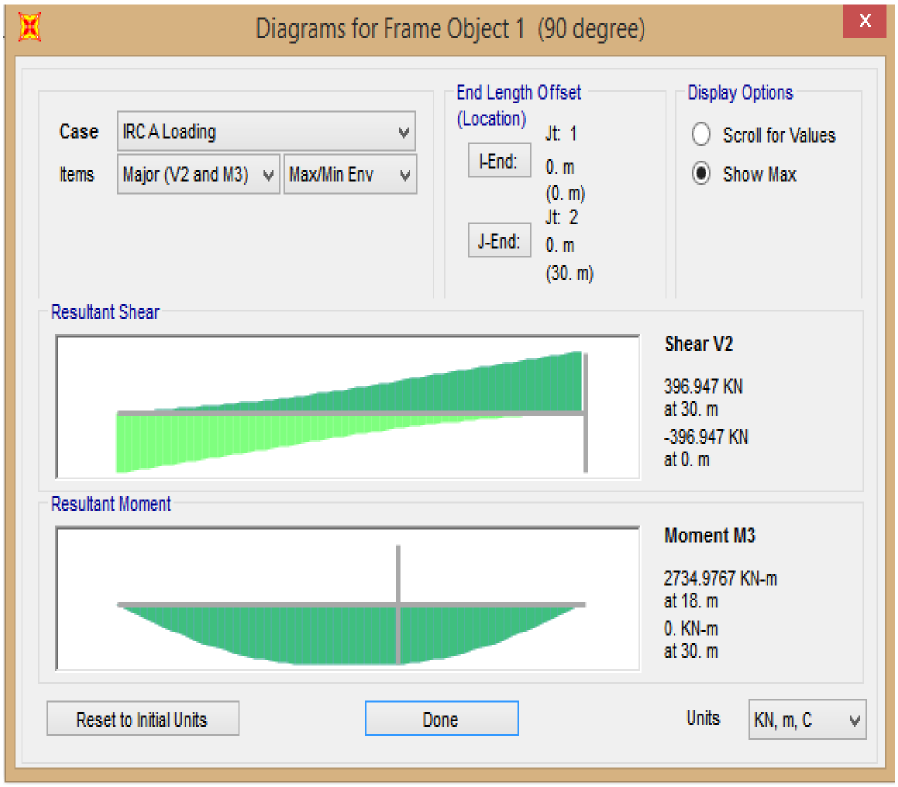

Fig. 3.38 Various Diagram for frame Object in 90 Degree due IRC A Loading

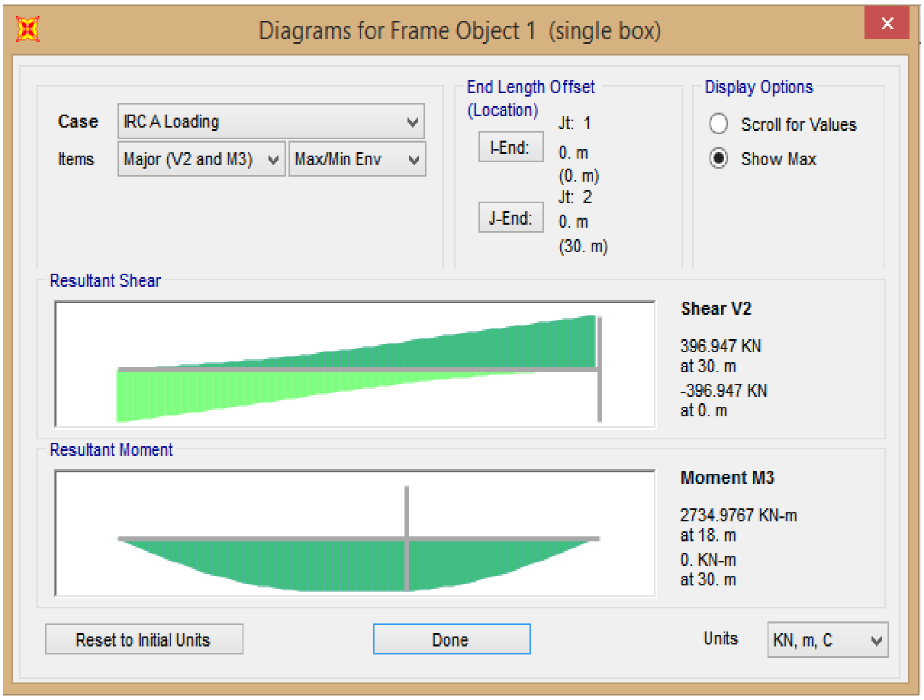

Fig. 3.39 Various Diagram for frame Object in Single Box due IRC A Loading

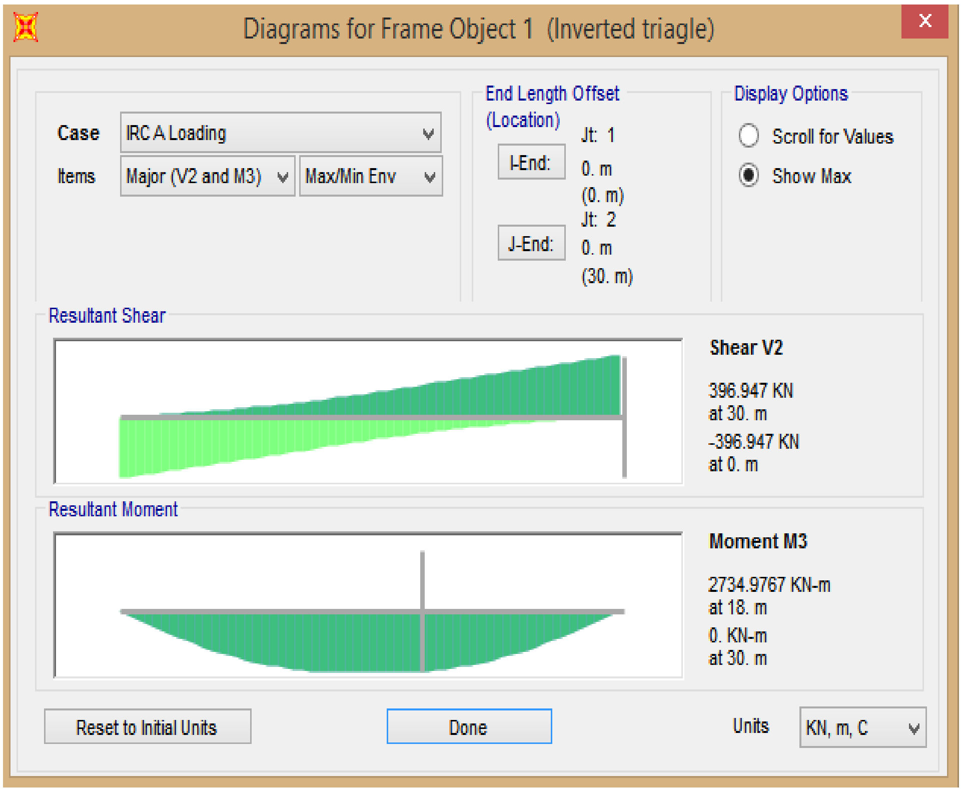

Fig. 3.40 Various Diagram for frame Object in Inverted Triangle due IRC A Loading

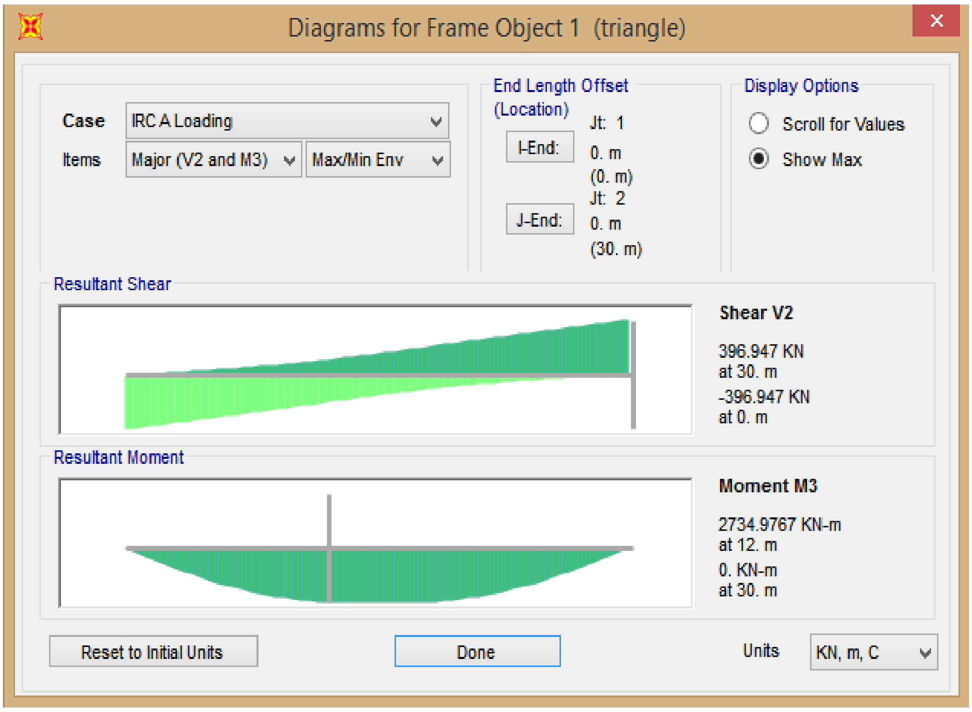

Fig. 3.41 Various Diagram for frame Object in Triangle due IRC A Loading

3.9.4 BM, SF and Other Diagrams Beam due Class 70R

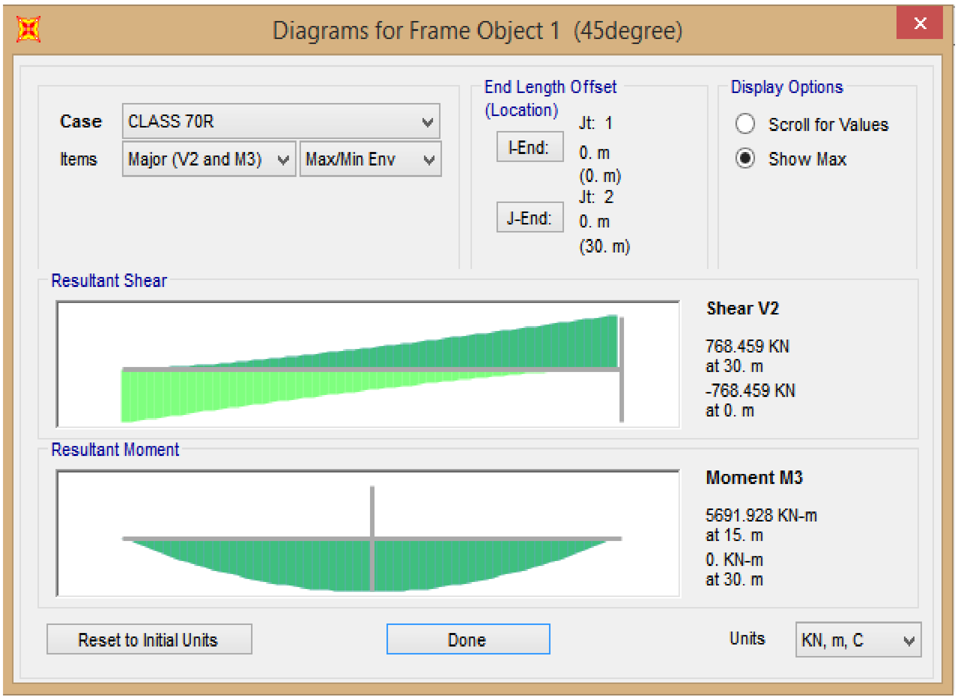

Fig. 3.42 Various Diagram for frame Object in 45 Degree due Class 70 R

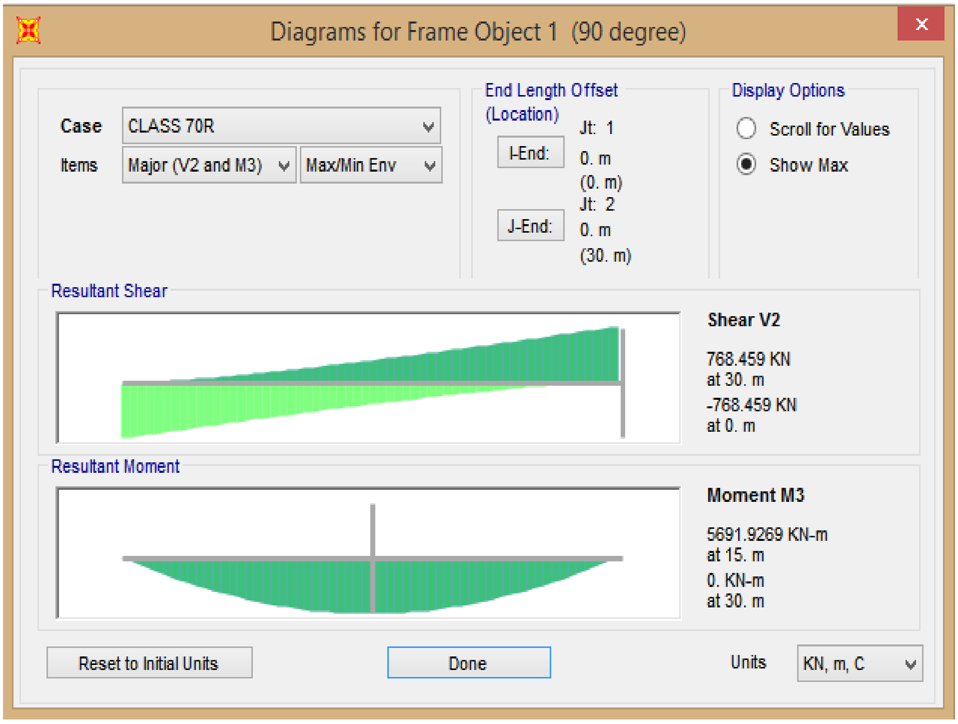

Fig. 3.43 Various Diagram for frame Object in 90 Degree due Class 70 R

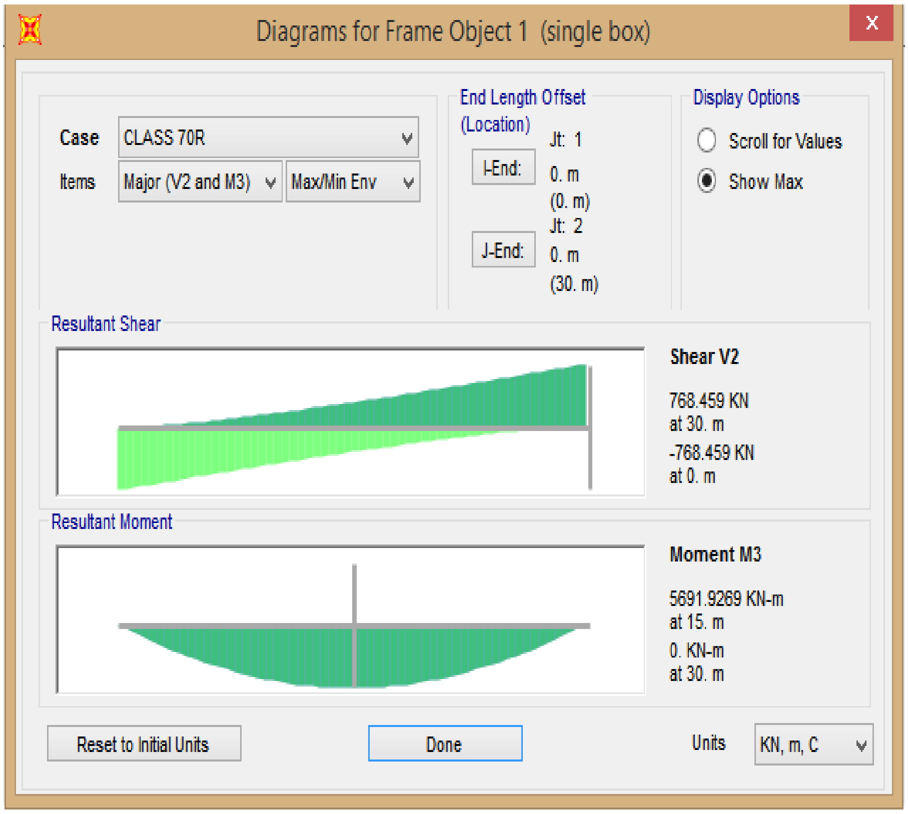

Fig. 3.44 Various Diagram for frame Object in Single Box due Class 70 R

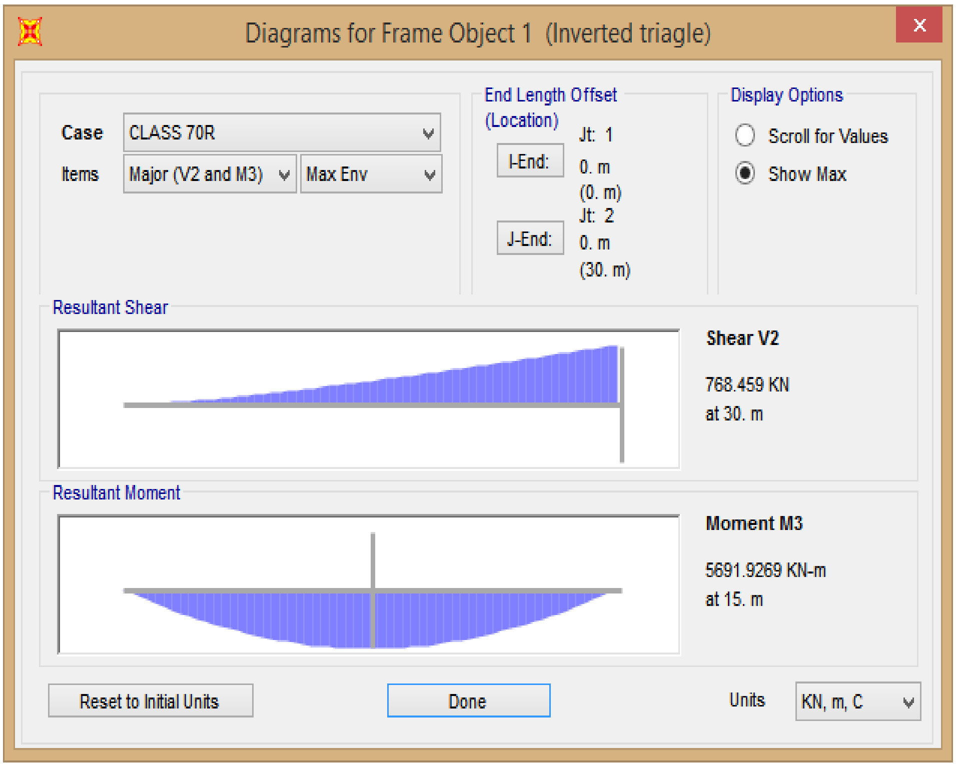

Fig. 3.45 Various Diagram for frame Object in Inverted Triangle due Class 70 R

3.9.5 BM, SF and Other Diagrams Beam due Load Combination 1.5 (DL+ CLASS 70 R)

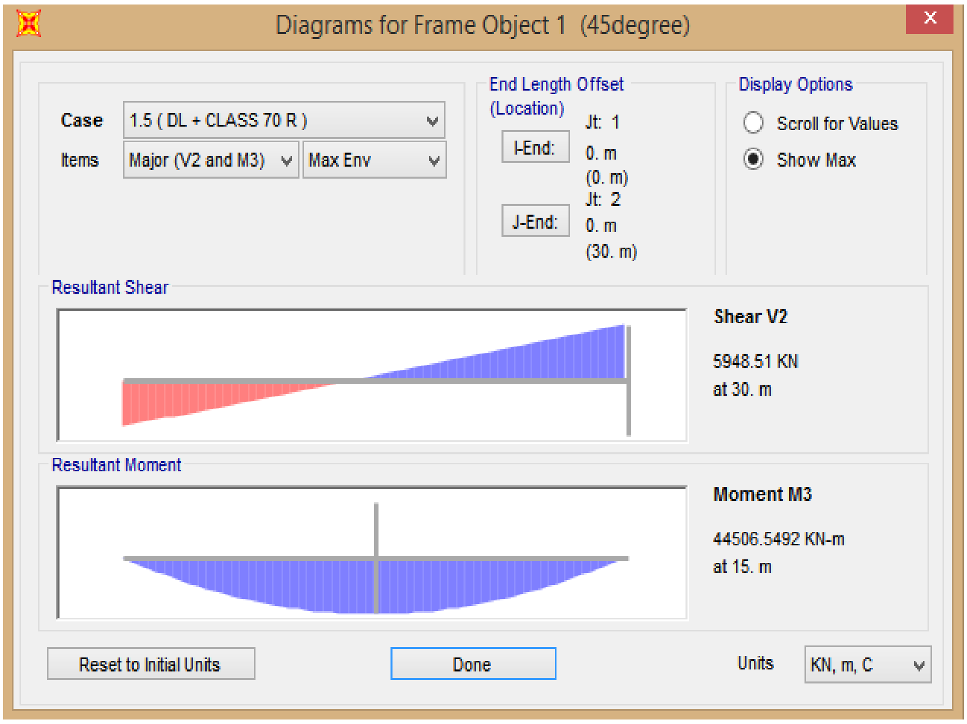

Fig. 3.46 Various Diagram for frame Object in 45 Degree due Load Combination 1.5 (DL+ CLASS 70 R)

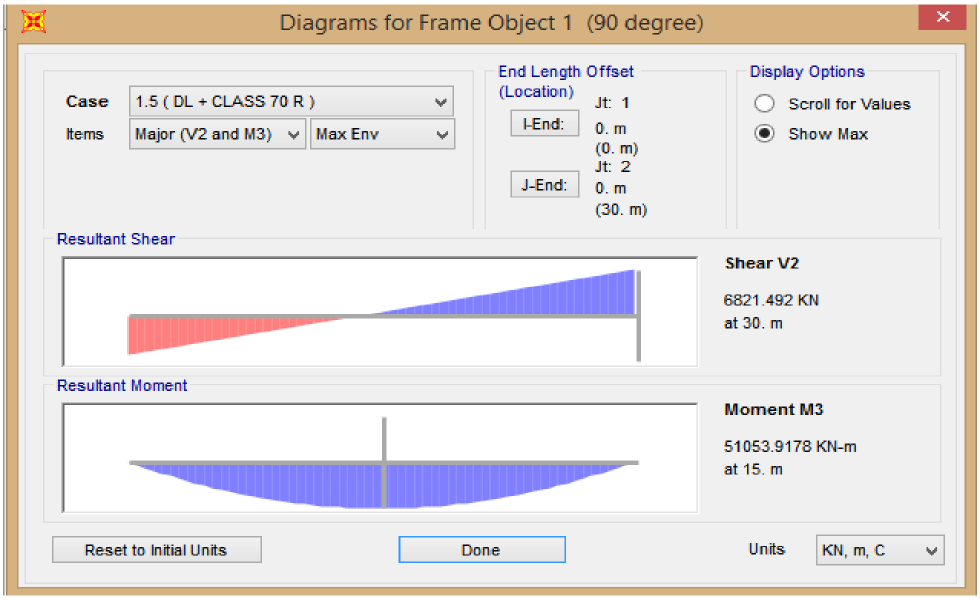

Fig. 3.47 Various Diagram for frame Object in 90 Degree due Load Combination 1.5 (DL +Class 70R)

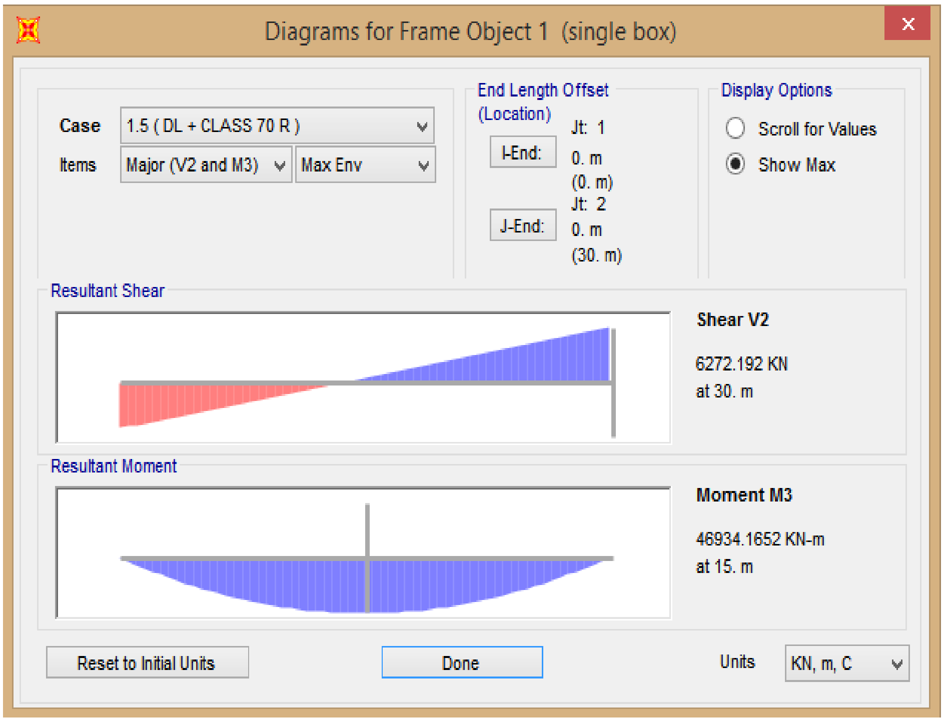

Fig. 3.48 Various Diagram for frame Object in Single Box due Load Combination 1.5 (DL+ CLASS 70 R)

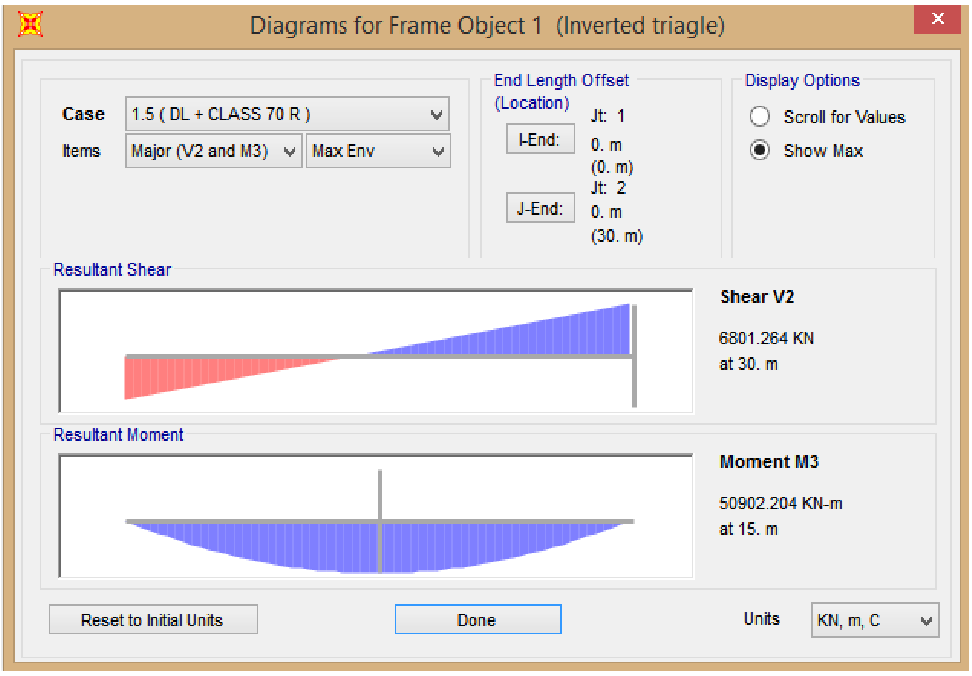

Fig. 3.49 Various Diagram for frame Object in Inverted Triangle due Load Combination 1.5 (DL+ CLASS 70 R)

Chapter 4

RESULT AND DISCUSSION

In this study, the total area of the 30-meter box was used for analysis. In this study, we worked hard to find the best one that provides the minimum bending, shear force and deflection.

For analysis of bridge we set load case to run, shown in figure

4.1 Bending Moment Due to Dead Load

Table: 4.1 Bending Moment in Various Sections Due to DL

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	Box Cell of (Inverted) Triangle
0	1.819E-12	1.819E-12	-3.64E-12	-7.28E-12	-3.64E-12
3	8632.4777	9215.106	9929.353	10203.847	10167.435
6	15346.627	16382.411	17652.183	18140.172	18075.441
9	20142.448	21501.914	23168.49	23808.975	23724.016
12	23019.941	24573.616	26478.275	27210.258	27113.161
15	23979.105	25597.517	27581.536	28344.018	28242.876
18	23019.941	24573.616	26478.275	27210.258	27113.161
21	20142.448	21501.914	23168.49	23808.975	23724.016
24	15346.627	16382.411	17652.183	18140.172	18075.441
27	8632.4777	9215.106	9929.353	10203.847	10167.435
30	1.004E-11	3.77E-11	6.97E-11	2.94E-11	8.124E-11

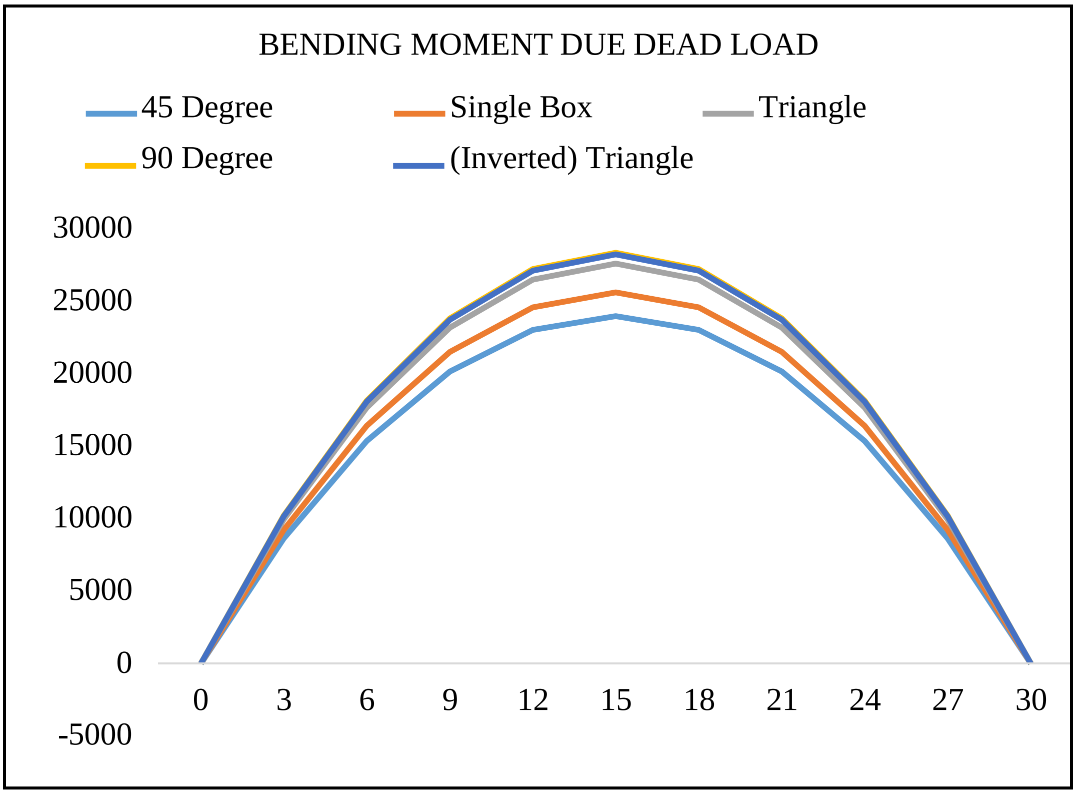

Fig. 4.1 Bending Moment in Various Section Due to Dead Load

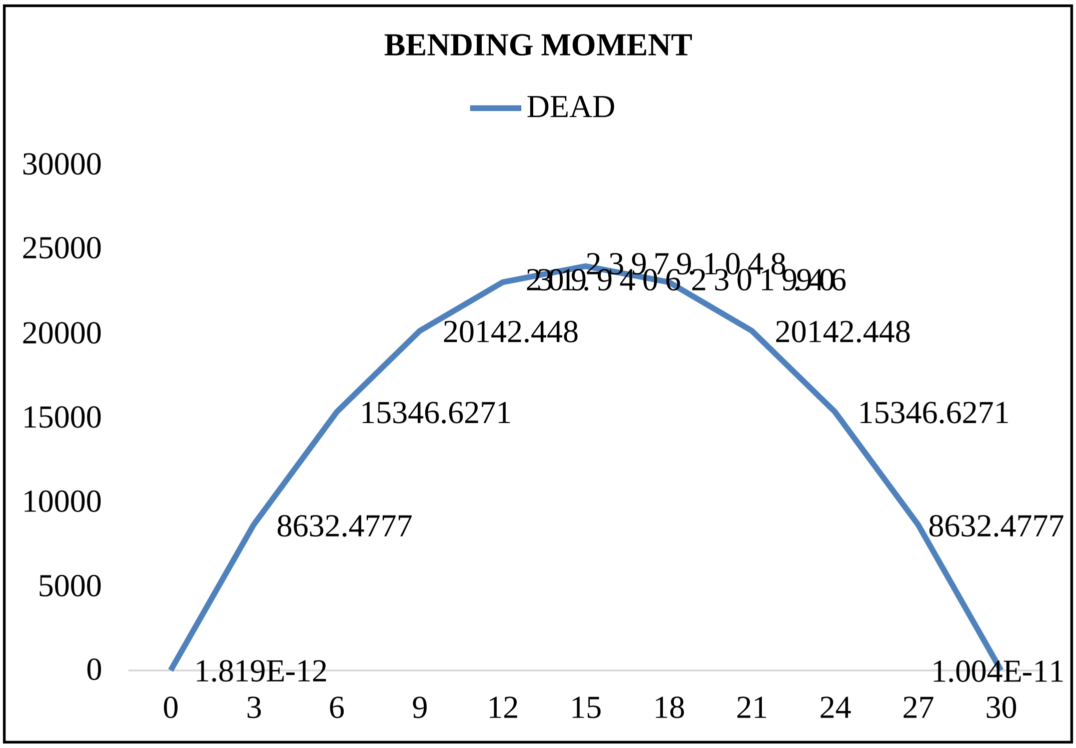

Fig. 4.2 Bending Moment in 45 Degree Due to Dead Load

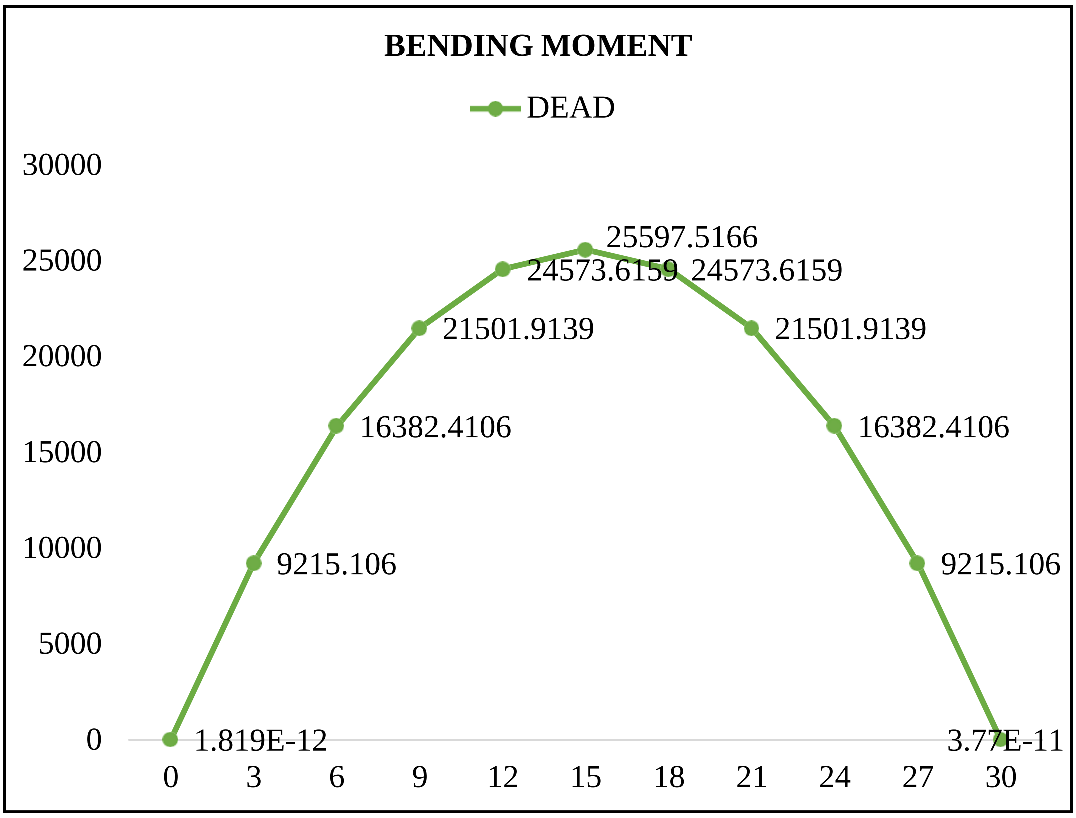

Fig. 4.3 **Bending Moment in Single Box Due to Dead Load**

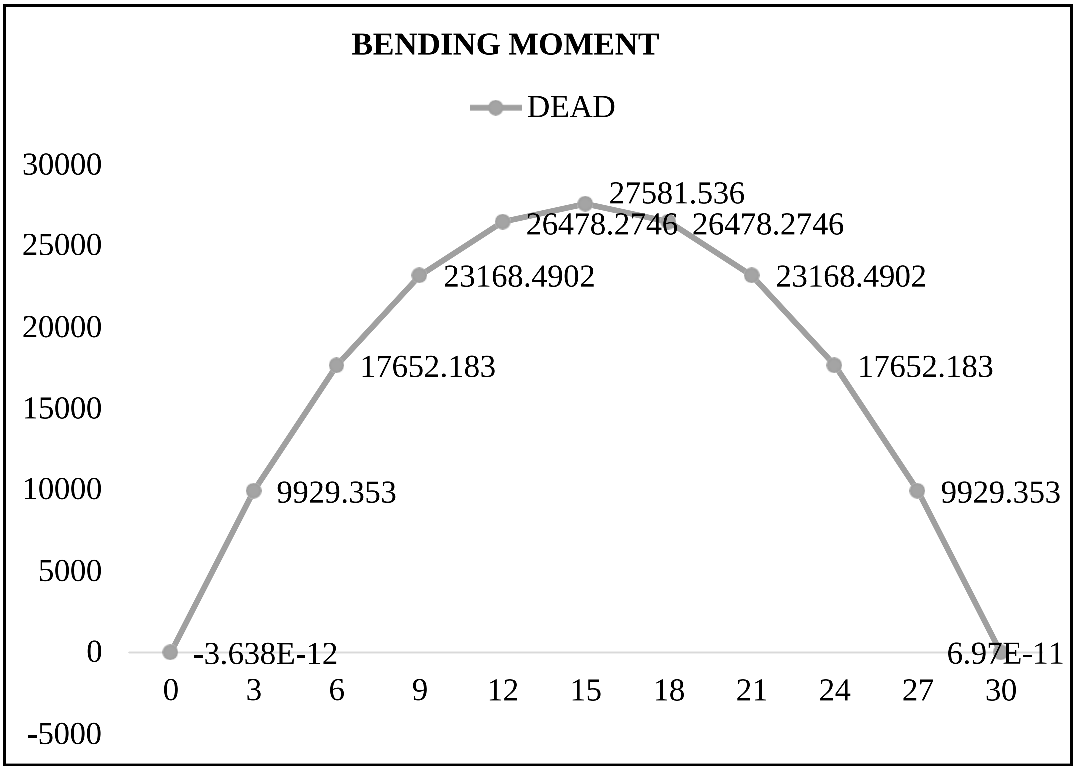

Fig. 4.4 **Bending Moment in Triangle Due to Dead Load**

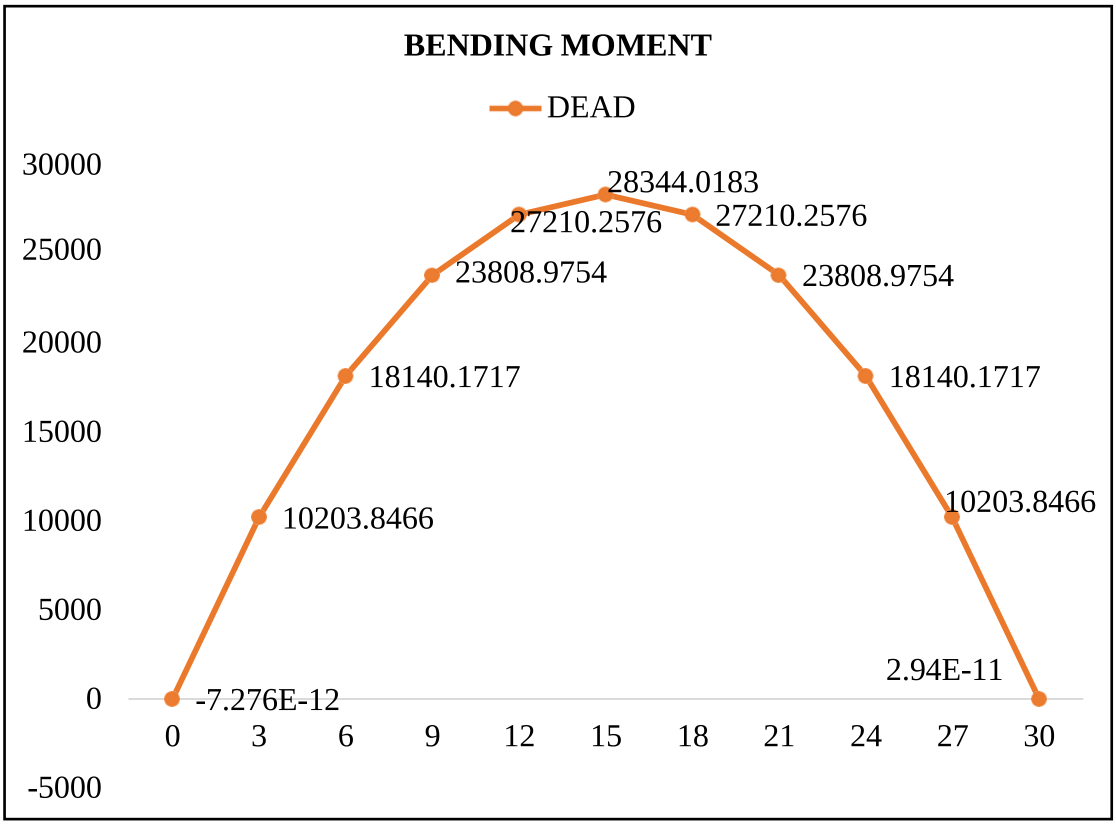

Fig. 4.5 **Bending Moment in 90 Degree Due to Dead Load**

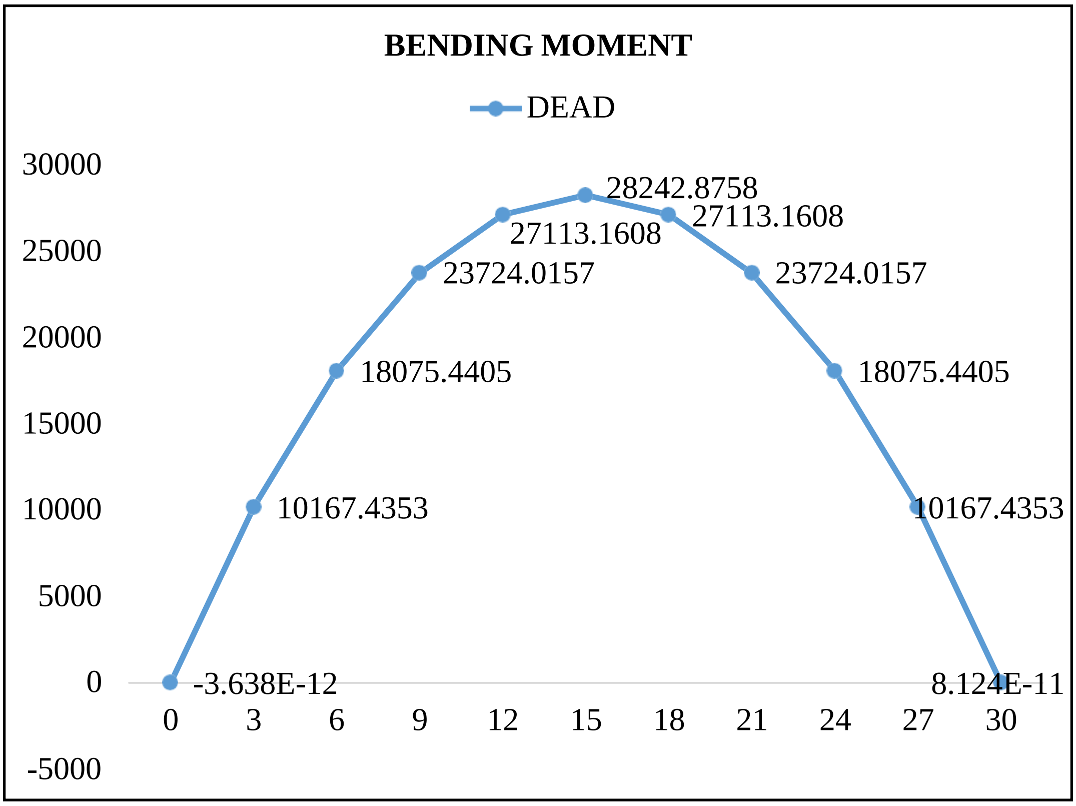

Fig. 4.6 **Bending Moment in (Inverted) Triangle Due to Dead Load**

4.2 Bending Moment Due to IRC load Class A

Table: 4.2 Bending Moment in Various Section Due to IRC load Class A

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	Box Cell of (Inverted) Triangle
0	0	0	0	0	0
3	1043.7414	1043.7414	1043.7414	1043.7414	1043.7412
6	1888.6039	1888.6039	1888.6039	1888.6039	1888.6037
9	2443.2386	2443.2386	2443.2386	2443.2386	2443.2385
12	2734.9767	2734.9767	2734.9767	2734.9767	2734.9766
15	2702.8599	2702.8599	2702.8599	2702.8599	2702.8599
18	2734.9767	2734.9767	2734.9767	2734.9767	2734.9766
21	2443.2386	2443.2386	2443.2386	2443.2386	2443.2385
24	1888.6039	1888.6039	1888.6039	1888.6039	1888.6037
27	1043.7414	1043.7414	1043.7414	1043.7414	1043.7412
30	0	0	0	0	0

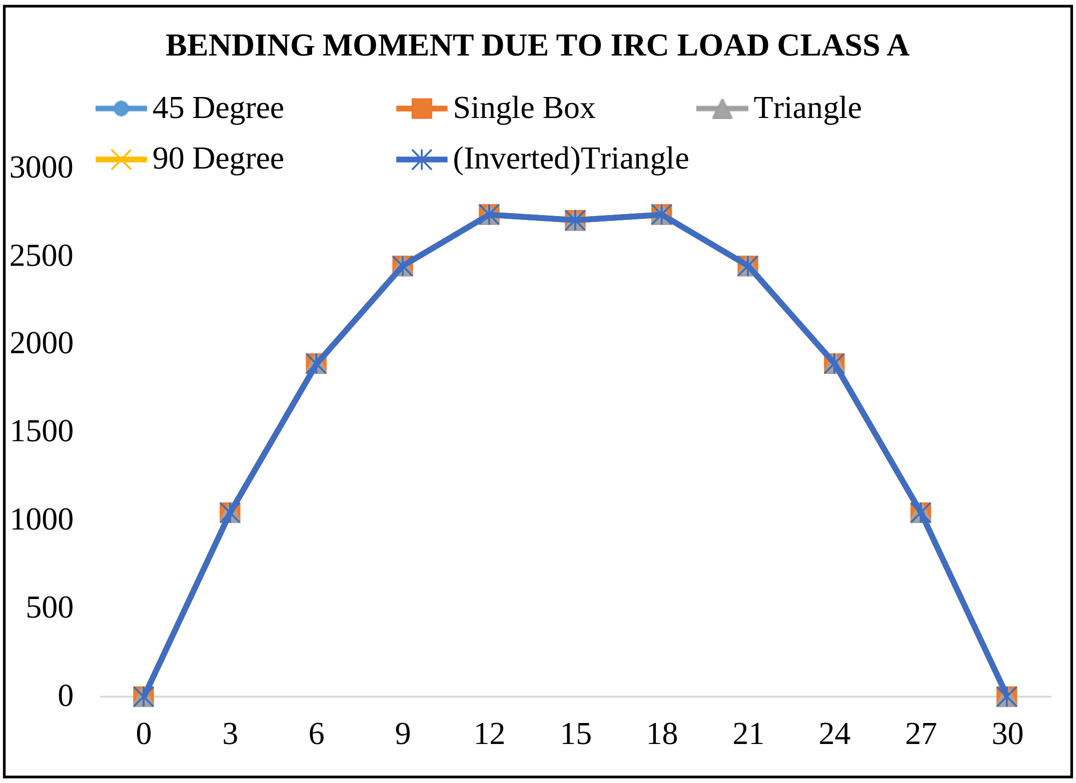

Fig. 4.7 **Bending Moment in Various Section Due to IRC load Class A**

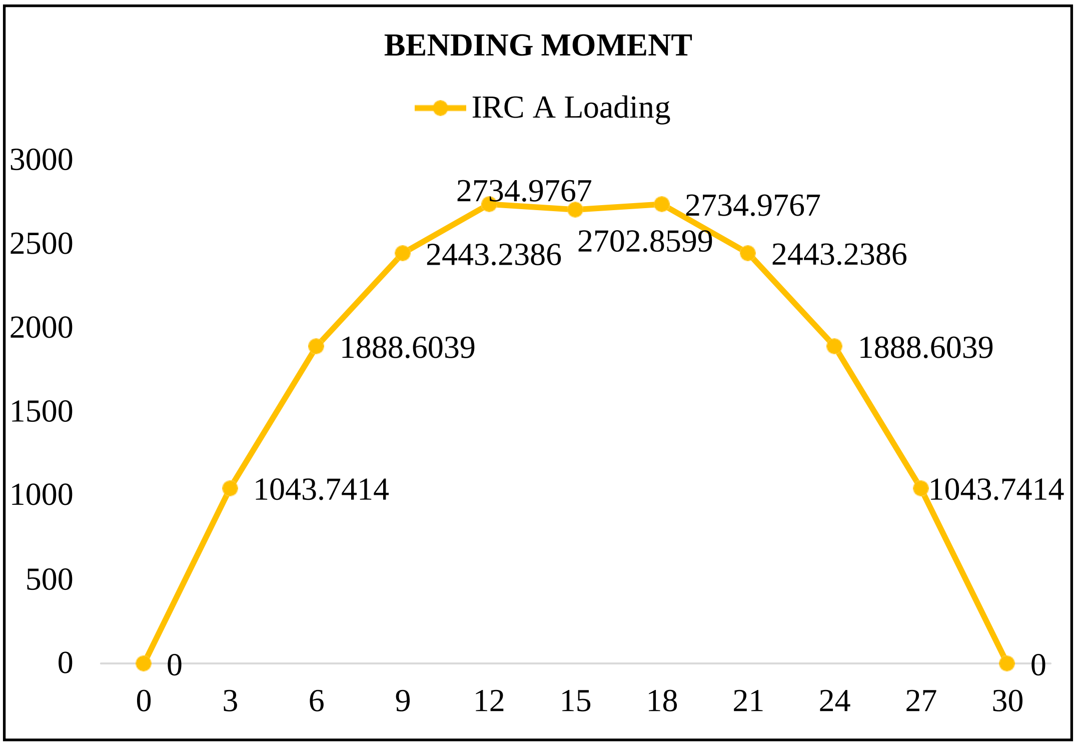

Fig. 4.8 **Bending Moment in 45 degree Due to IRC load Class A**

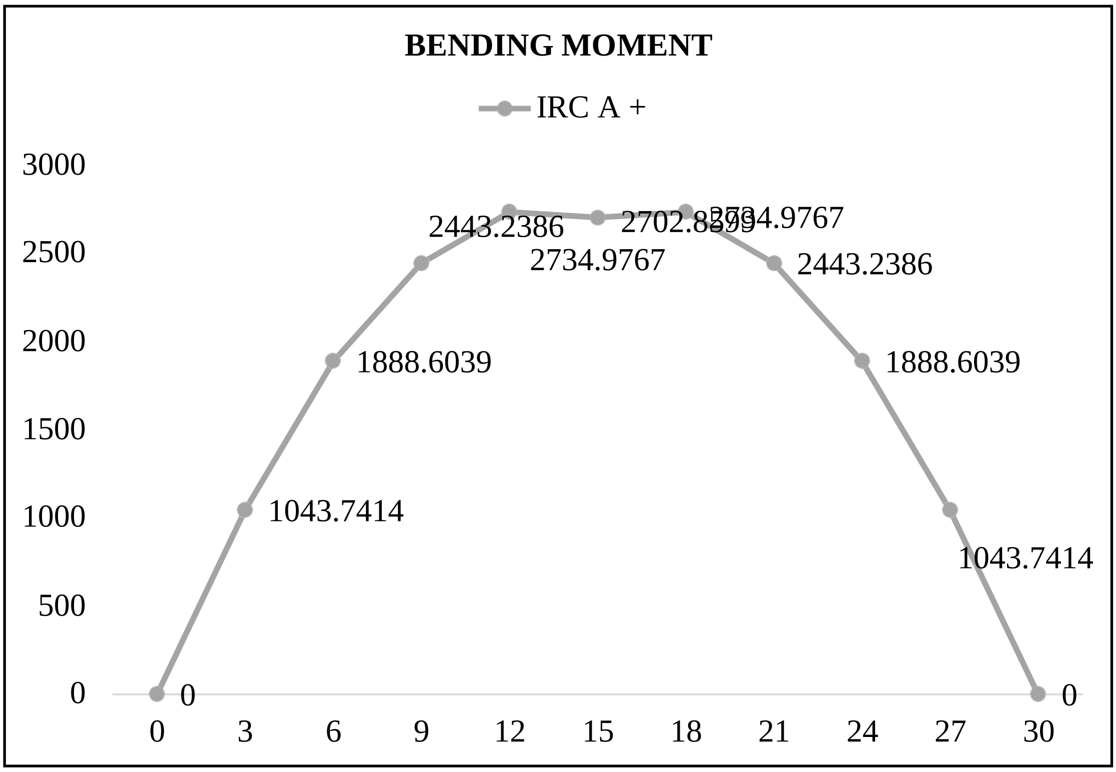

Fig. 4.9 **Bending Moment in Single Box Due to IRC load Class A**

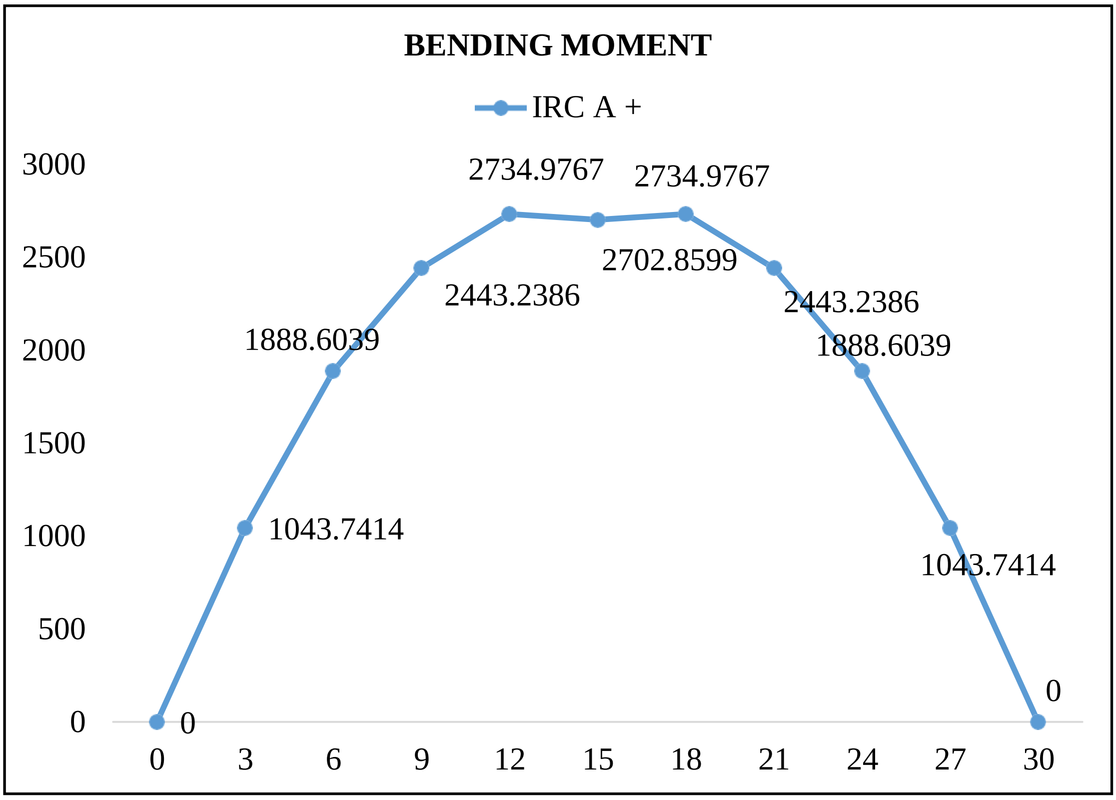

Fig. 4.10 **Bending Moment in Triangle Due to IRC load Class A**

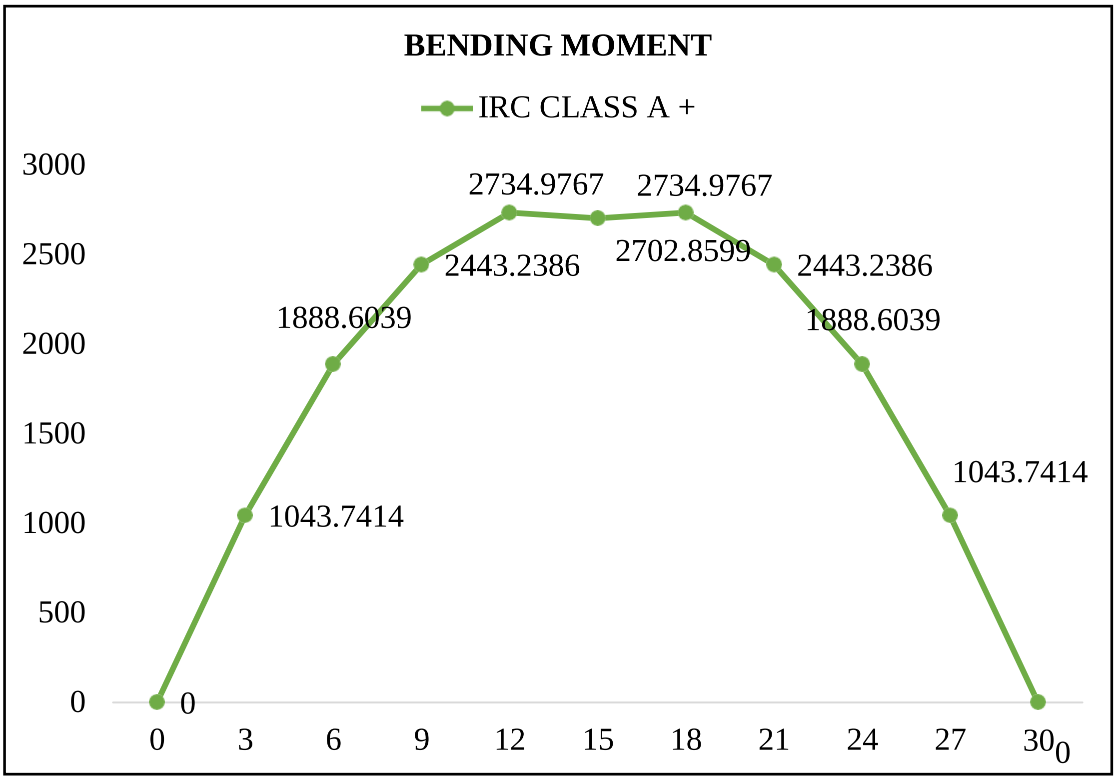

Fig. 4.11 Bending Moment in 90 degree Due to IRC load Class A

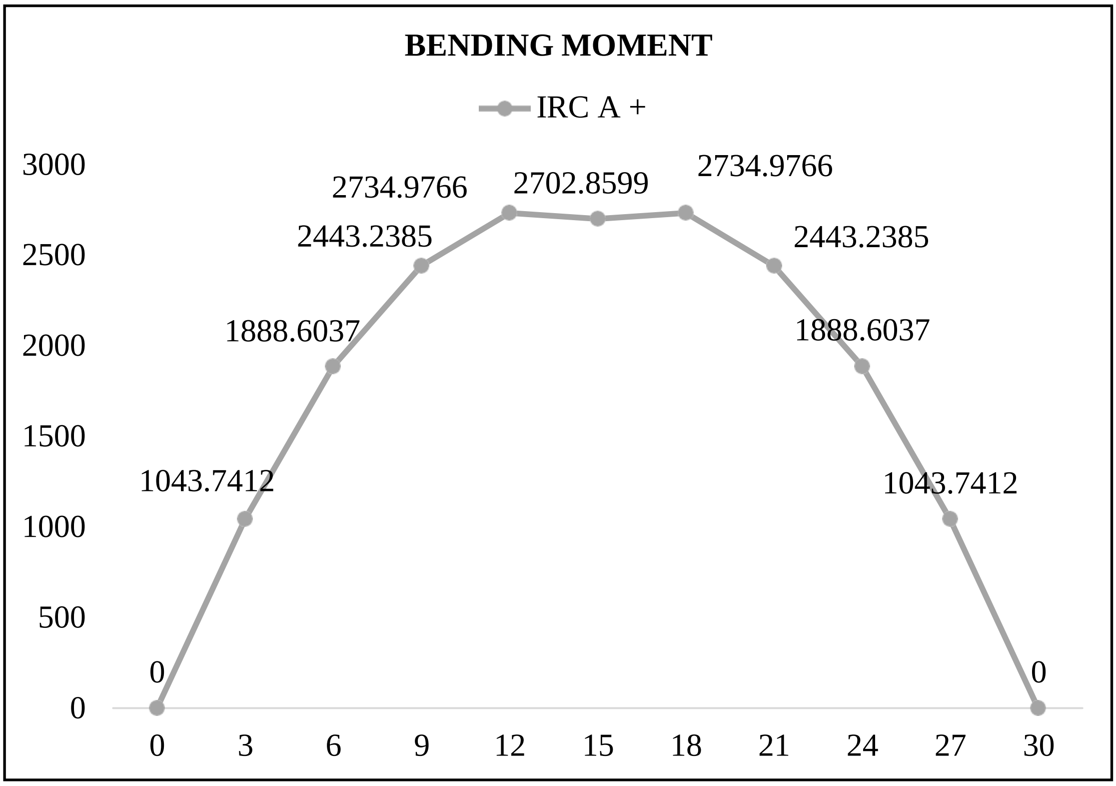

Fig. 4.12 Bending Moment in (Inverted) Triangle Due to IRC load Class A

4.3 Bending Moment Due to IRC load 70R

Table: 4.3 Bending Moment in Various Section Due to IRC load 70R

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	Box Cell of (Inverted) Triangle
0	0	0	0	0	0
3	2011.1772	2011.1772	2011.1772	2011.1772	2011.1777
6	3550.4585	3550.4585	3550.4585	3550.4585	3550.4592
9	4773.181	4773.181	4773.181	4773.181	4773.182
12	5496.9412	5496.9412	5496.9412	5496.9412	5496.9423
15	5691.9269	5691.9269	5691.9269	5691.9269	5691.928
18	5496.9412	5496.9412	5496.9412	5496.9412	5496.9423
21	4773.181	4773.181	4773.181	4773.181	4773.182
24	3550.4585	3550.4585	3550.4585	3550.4585	3550.4592
27	2011.1772	2011.1772	2011.1772	2011.1772	2011.1777
30	0	0	0	0	0

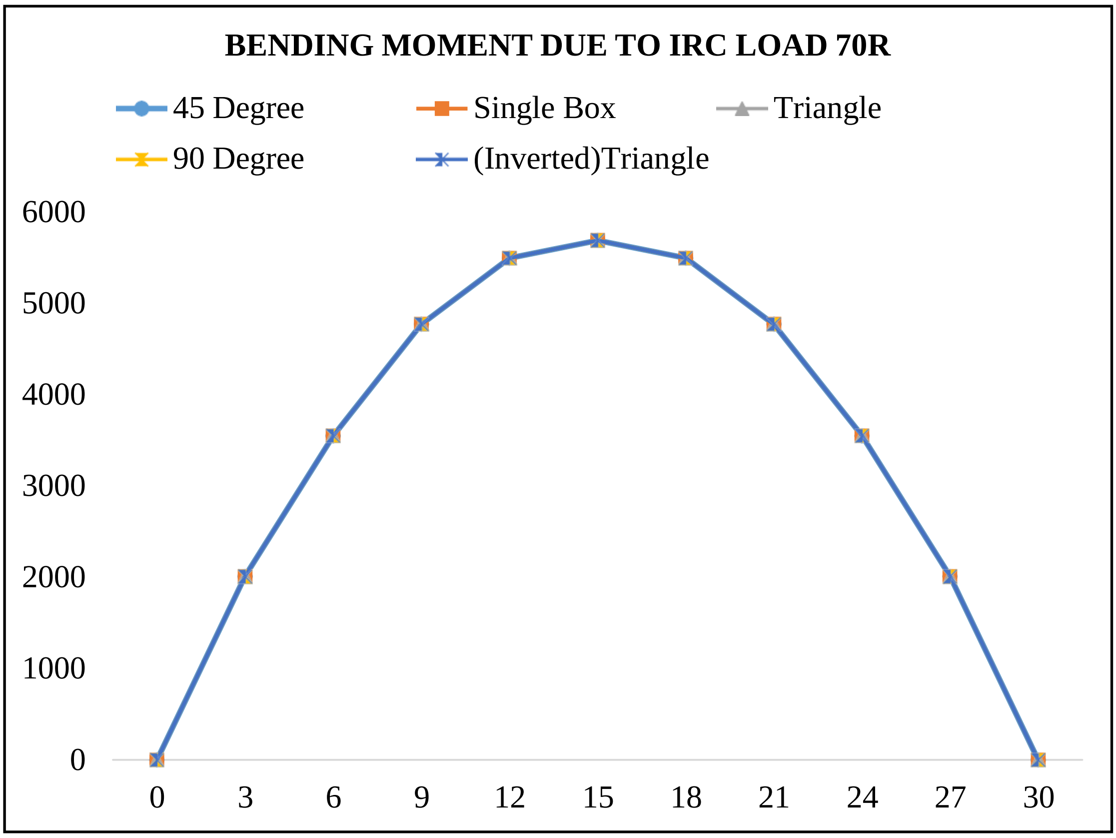

Fig. 4.13 Bending Moment in Various Section Due to IRC load 70R

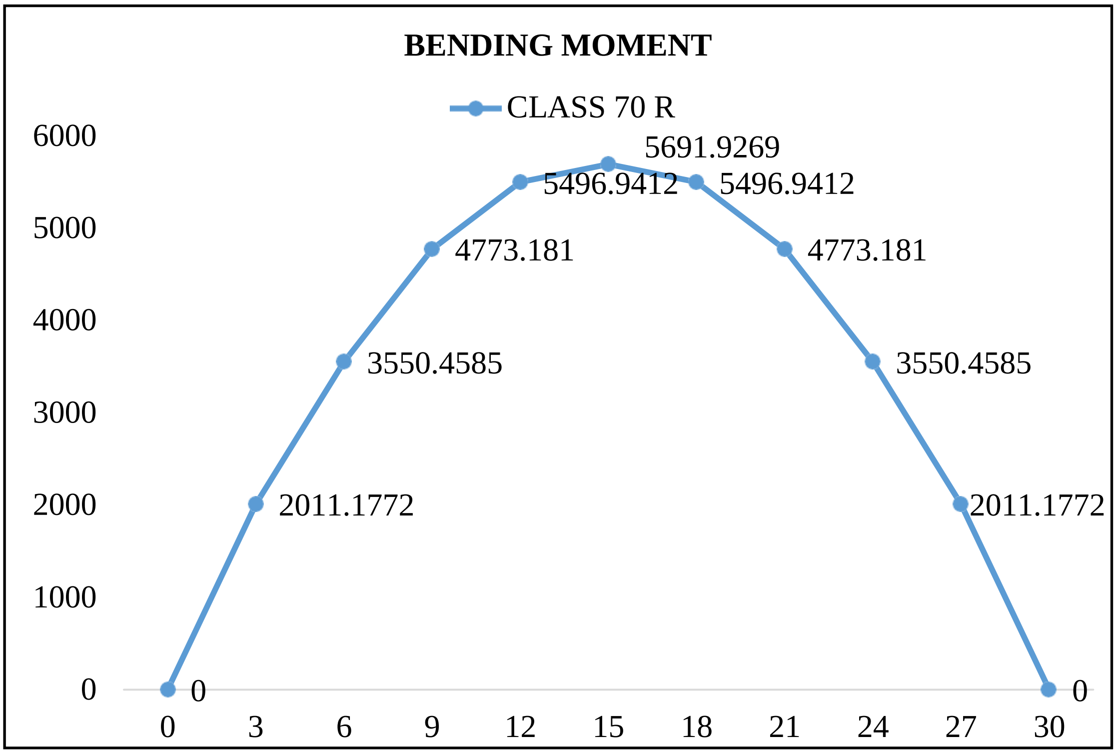

Fig. 4.14 Bending Moment in 45 Degree Due to IRC load 70R

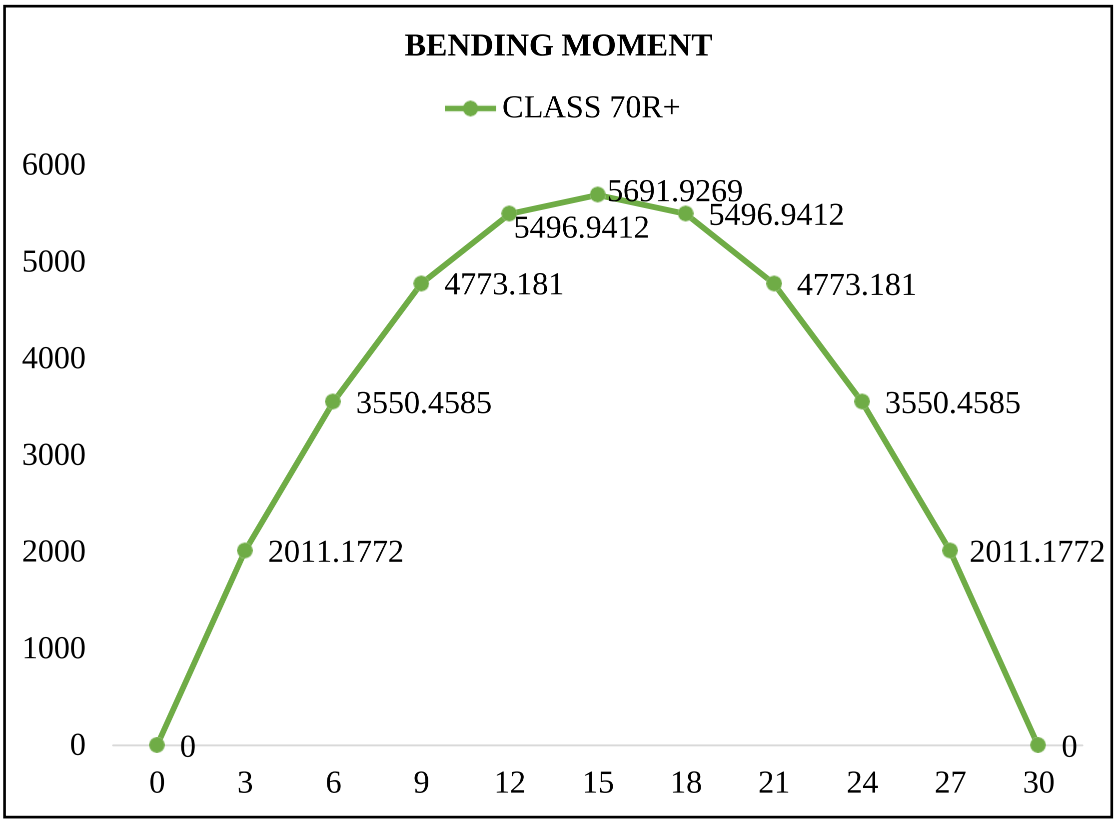

Fig. 4.15 Bending Moment in Single Box Due to IRC load 70R

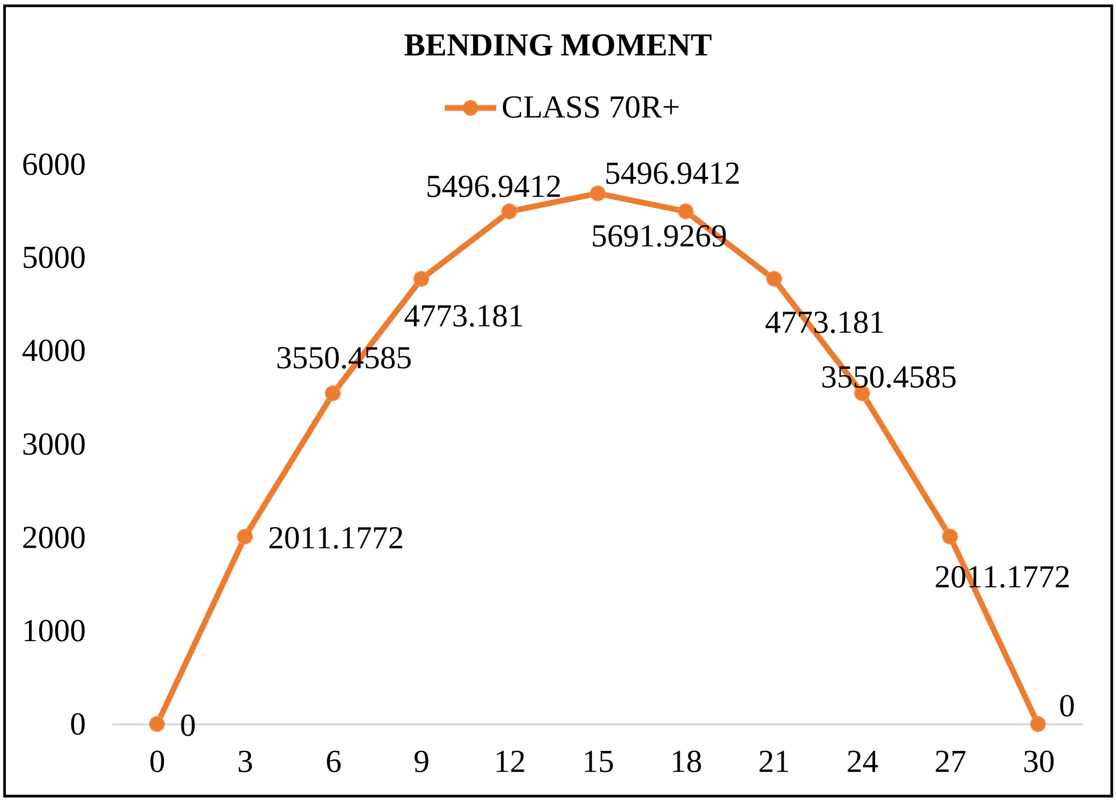

Fig. 4.16 Bending Moment in Triangle Due to IRC load 70R

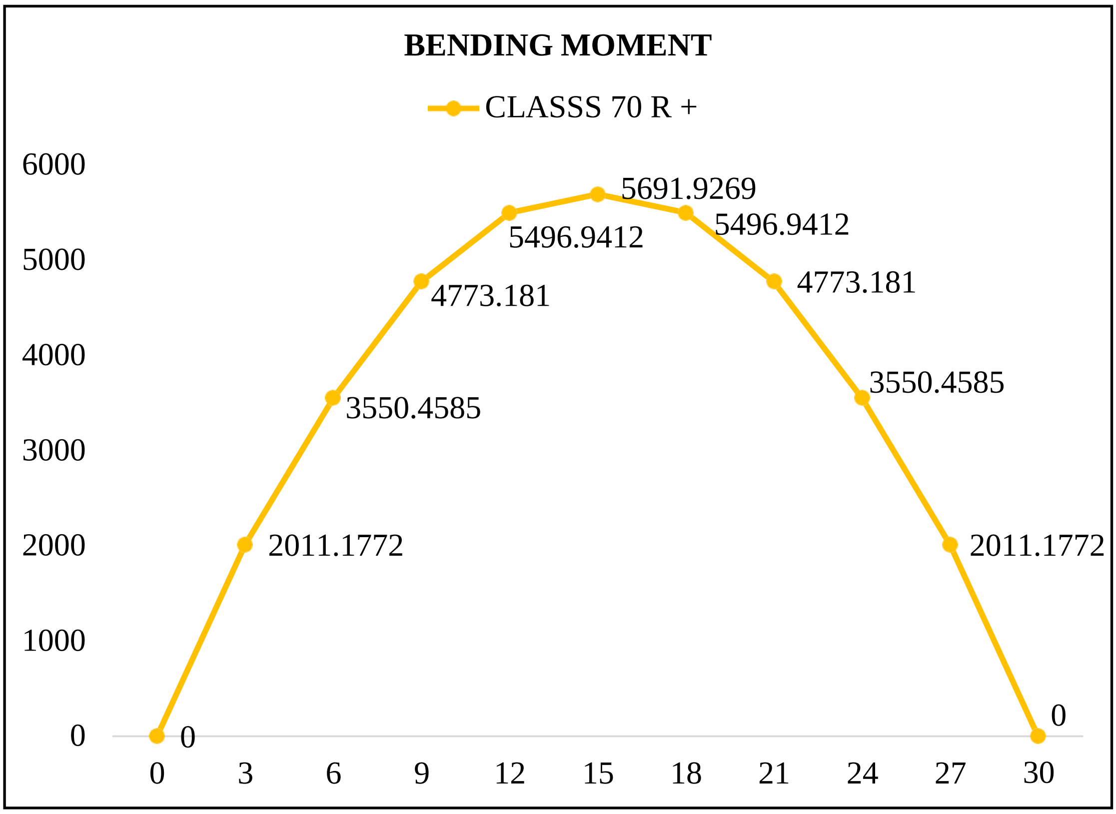

Fig. 4.17 Bending Moment in 90 Degree Due to IRC load 70R

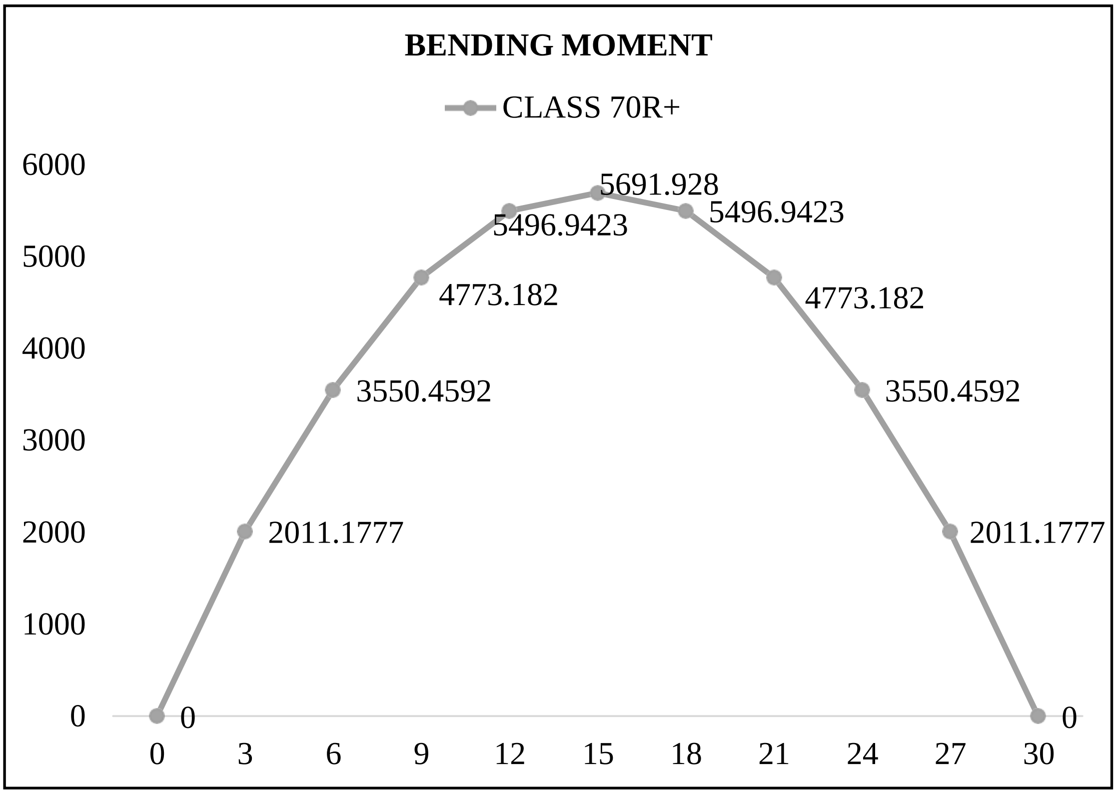

Fig. 4.18 Bending Moment in (Inverted) Triangle Due to IRC load 70R

4.4 Bending Moment Due to (Response Spectrum) 1.5(DL+EQL)

Table: 4.4 Bending Moment in Various Section Due to (Response Spectrum) 1.5 (DL+EQL)

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	(Inverted) Triangle
0	2.728E-12	-1.09E-11	-5.46E-12	2.728E-12	-5.46E-12
5	19982.587	23620.015	23535.73	21331.264	22984.613
10	31972.14	37792.025	37657.168	34130.022	36775.381
15	35968.657	42516.028	42364.314	38396.275	41372.304
20	31972.14	37792.025	37657.168	34130.022	36775.381
25	19982.587	23620.015	23535.73	21331.264	22984.613
30	1.507E-11	4.41E-11	1.219E-10	5.655E-11	1.045E-10

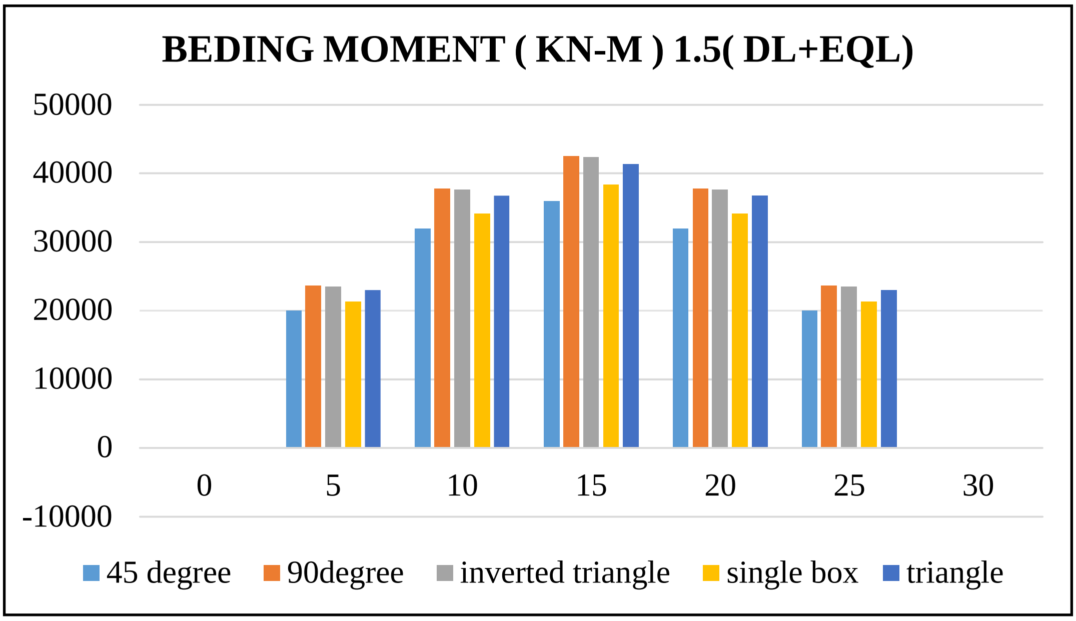

Fig. 4.19 Bending Moment in Various Section Due to (Response Spectrum) 1.5 (DL+EQL)

4.5 Bending Moment Due to (Response Spectrum and IRC Load) 1.5(DL+70R)

Table: 4.5 Bending Moment in Various Section Due to (Response Spectrum and IRC Load) 1.5(DL+70R)

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	Box Cell of (Inverted) Triangle
0	2.728E-12	-1.091E-11	-5.457E-12	2.728E-12	-5.457E-12
5	24538.6344	28176.0624	28091.7769	25887.3109	27540.6604
10	39493.7914	45313.6761	45178.8194	41651.6738	44297.033
15	44506.5475	51053.9178	50902.204	46934.1652	49910.1943
20	39493.7914	45313.6761	45178.8194	41651.6738	44297.033
25	24538.6344	28176.0624	28091.7769	25887.3109	27540.6604
30	1.507E-11	4.41E-11	1.219E-10	5.655E-11	1.045E-10

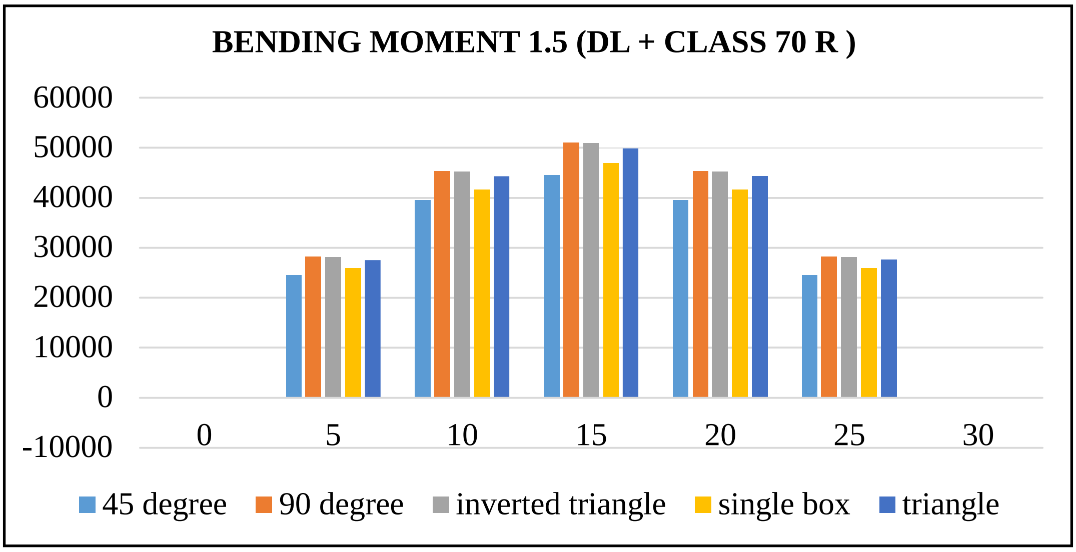

Fig. 4.20 Bending Moment in Various Section Due to (Response Spectrum and IRC Load) 1.5(DL+70R)

4.6 Shear Force Due to Dead Load

Table: 4.6 Shear Force in Various Sections Due to Dead Load

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	Box Cell of (Inverted) Triangle
0	-3197.214	-3413.002	-3677.538	-3779.202	-3765.717
3	-2557.771	-2730.402	-2942.031	-3023.362	-3012.573
6	-1918.328	-2047.801	-2206.523	-2267.521	-2259.43
9	-1278.886	-1365.201	-1471.015	-1511.681	-1506.287
12	-639.443	-682.6	-735.508	-755.84	-753.143
15	6.537E-13	-9.38E-13	-5.4E-13	-1.88E-12	-1.39E-12
18	639.443	682.6	735.508	755.84	753.143
21	1278.886	1365.201	1471.015	1511.681	1506.287
24	1918.328	2047.801	2206.523	2267.521	2259.43
27	2557.771	2730.402	2942.031	3023.362	3012.573
30	3197.214	3413.002	3677.538	3779.202	3765.717

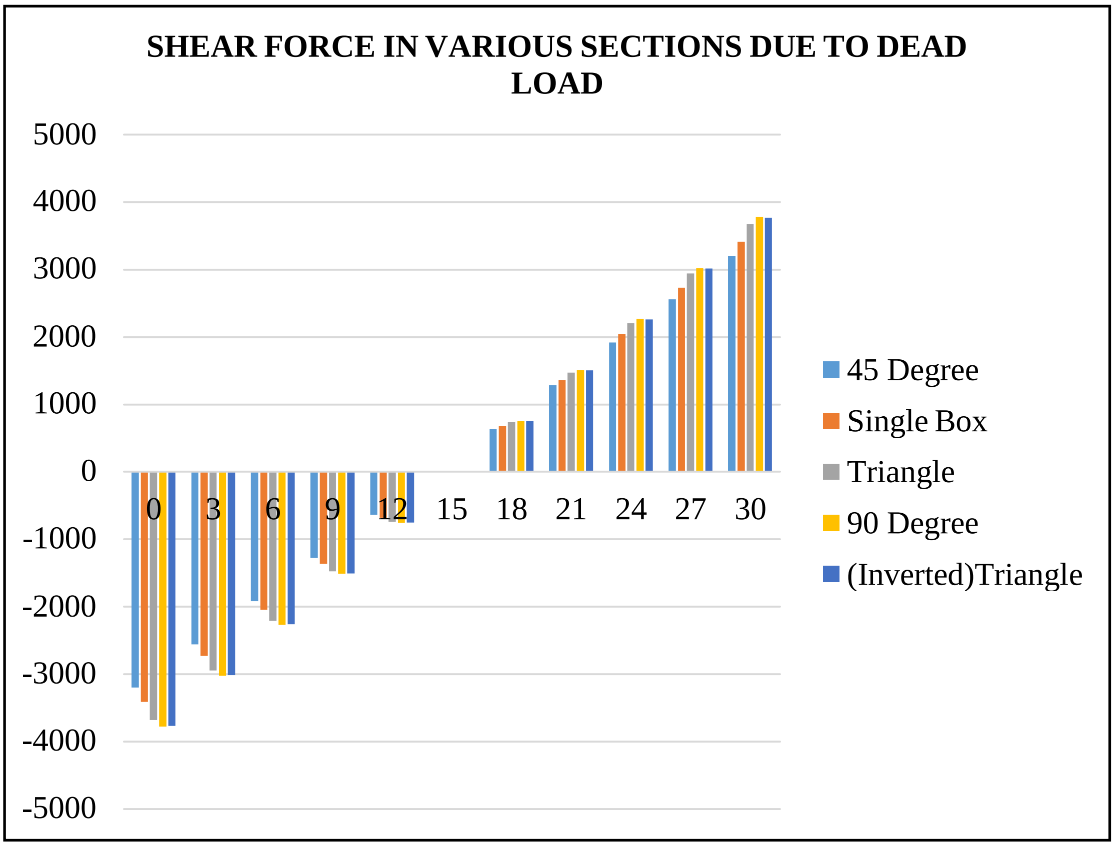

Fig. 4.21 Shear Force in Various Sections Due to Dead Load

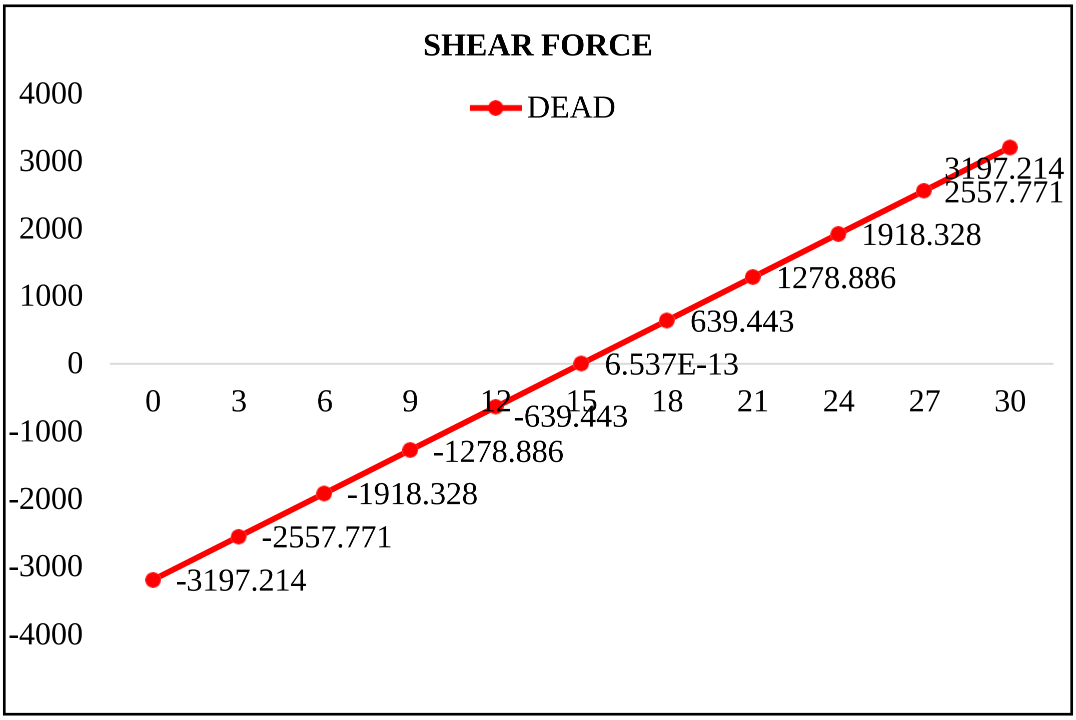

Fig. 4.22 Shear Force in 45 Degree Due to Dead Load

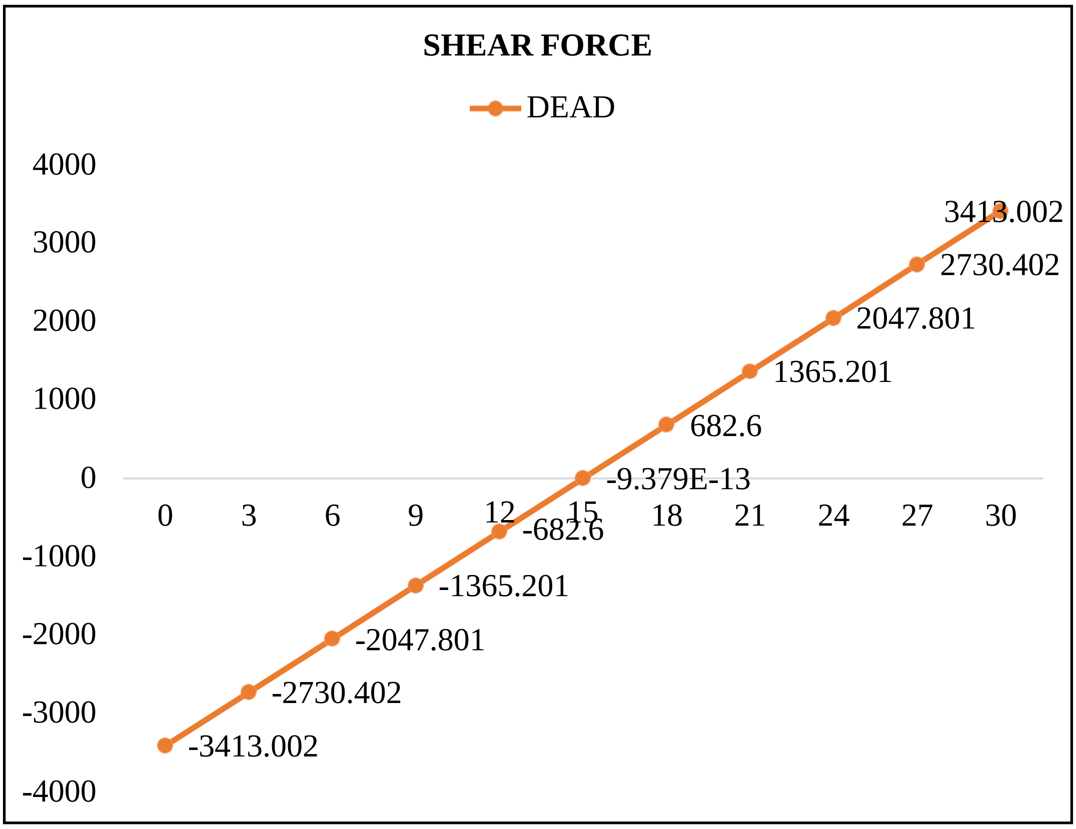

Fig. 4.23 Shear Force in Single Box Due to Dead Load

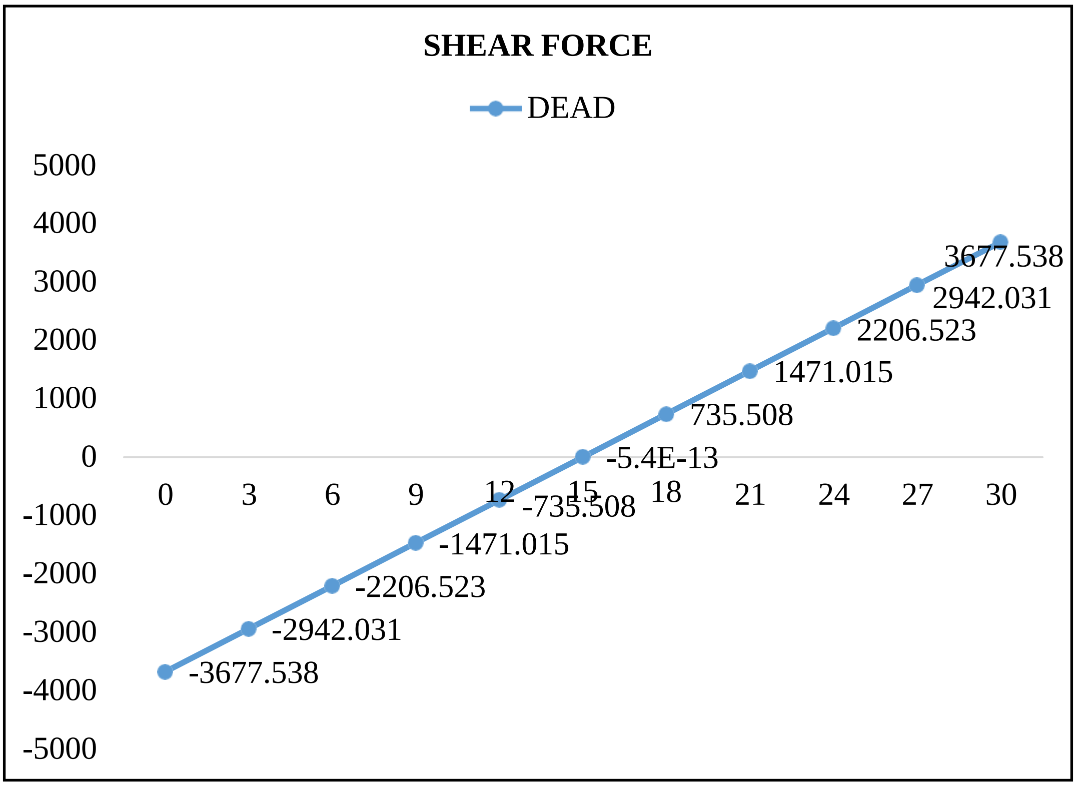

Fig. 4.24 Shear Force in Triangle Due to Dead Load

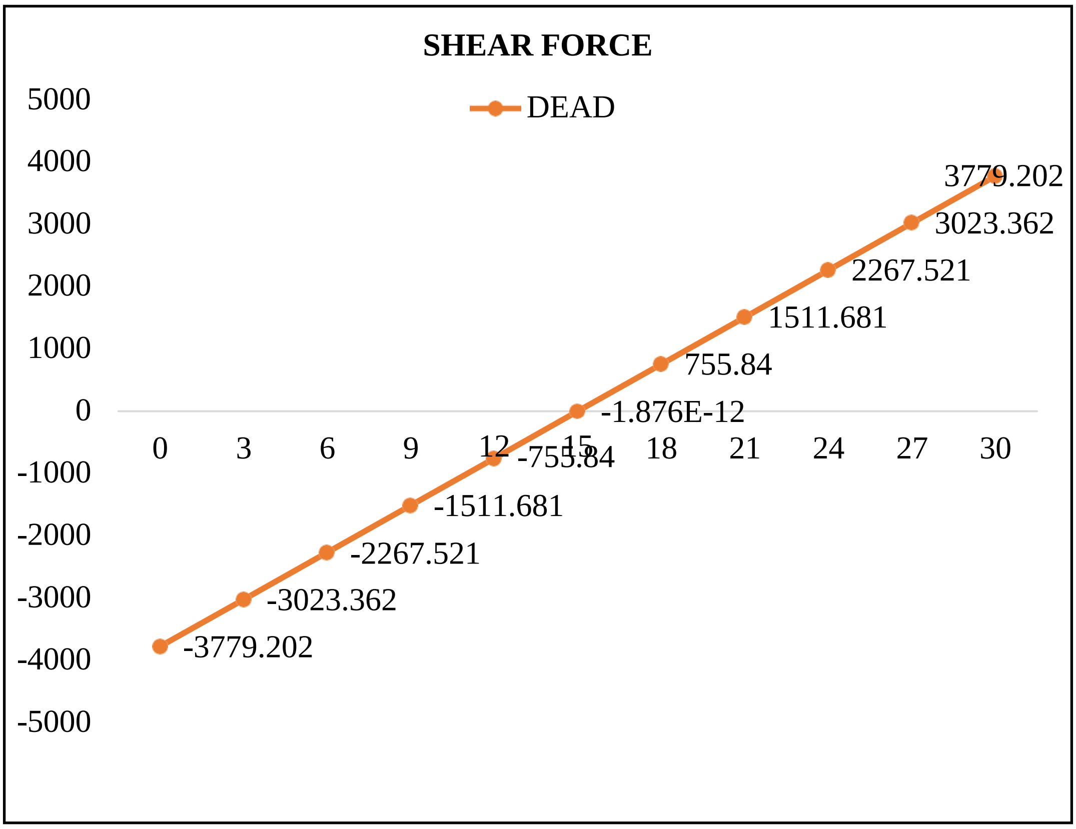

Fig. 4.25 **Shear Force in 90 degree Due to Dead Load**

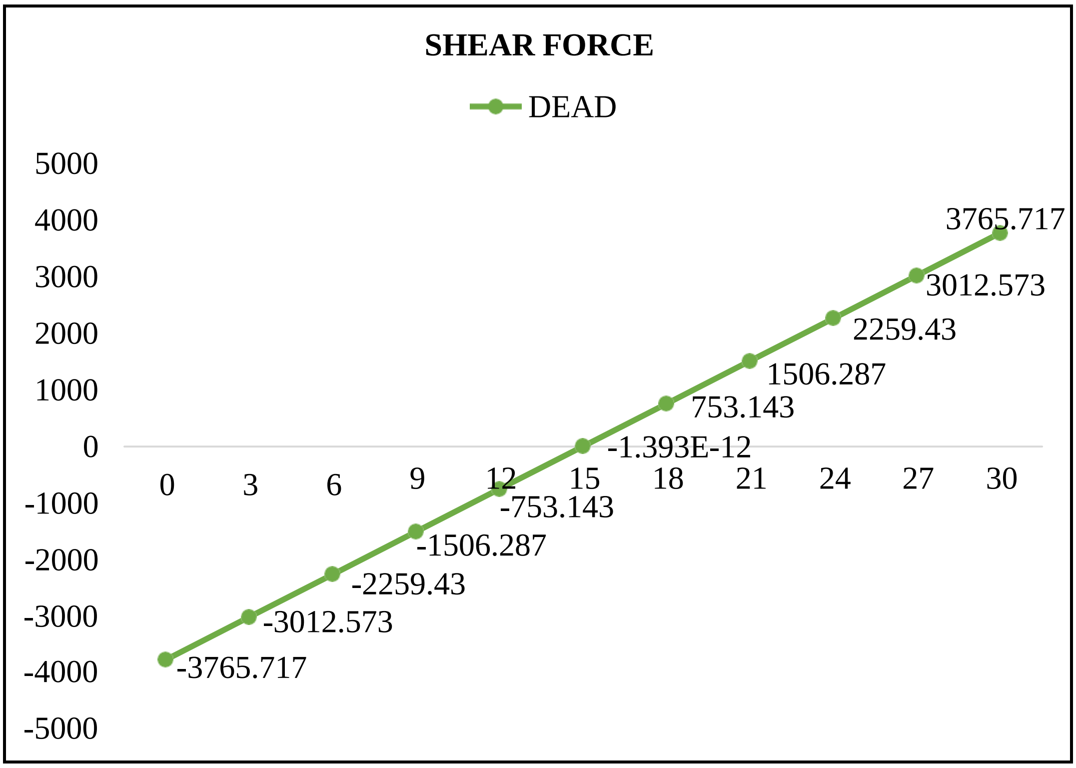

Fig. 4.26 **Shear Force in (Inverted) Triangle Due to Dead Load**

4.7 Shear Force Due to IRC load Class A

Table: 4.7 Shear Force in Various Section Due to IRC load Class A

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	Box Cell of (Inverted) Triangle
0	0	0	0	0	0
3	17.887	17.887	17.887	17.887	17.887
6	42.1	42.1	42.1	42.1	42.1
9	71.497	71.497	71.497	71.497	71.497
12	108.305	108.305	108.305	108.305	108.305
15	151.781	151.781	151.781	151.781	151.781
18	200.814	200.814	200.814	200.814	200.814
21	249.847	249.847	249.847	249.847	249.847
24	298.881	298.881	298.881	298.881	298.88
27	347.914	347.914	347.914	347.914	347.914
30	396.947	396.947	396.947	396.947	396.947

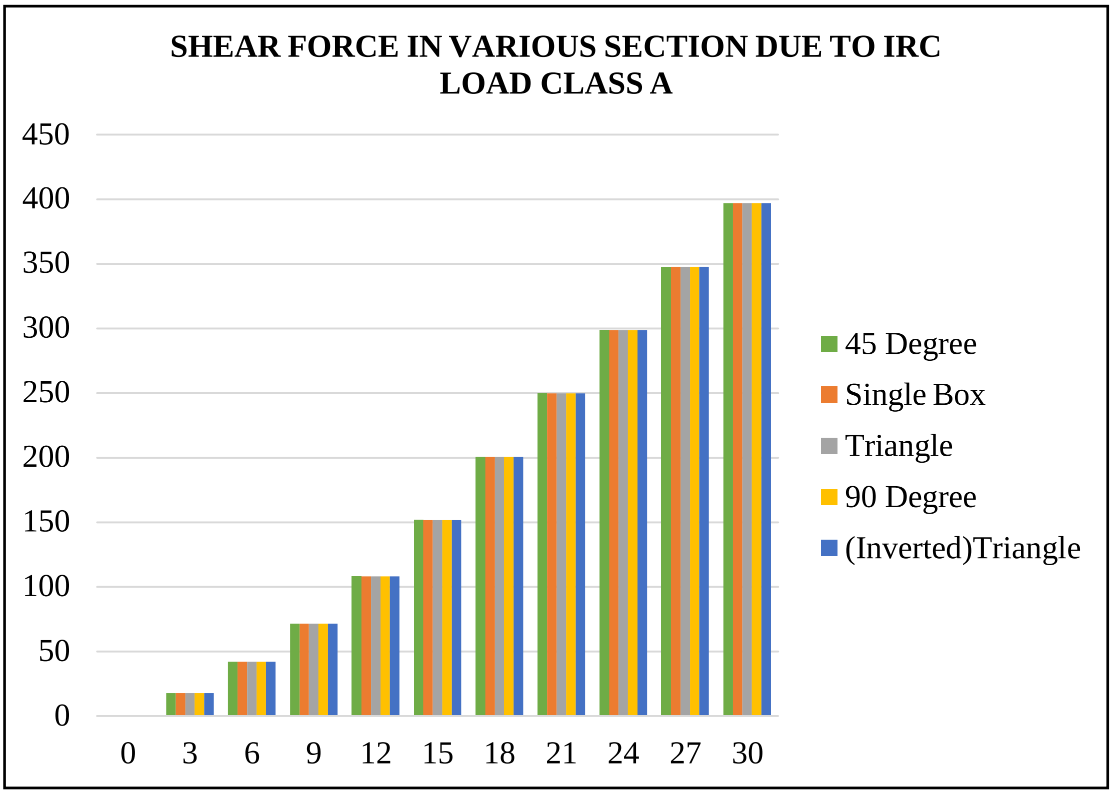

Fig. 4.27 **Shear Force in Various Section Due to IRC load Class A**

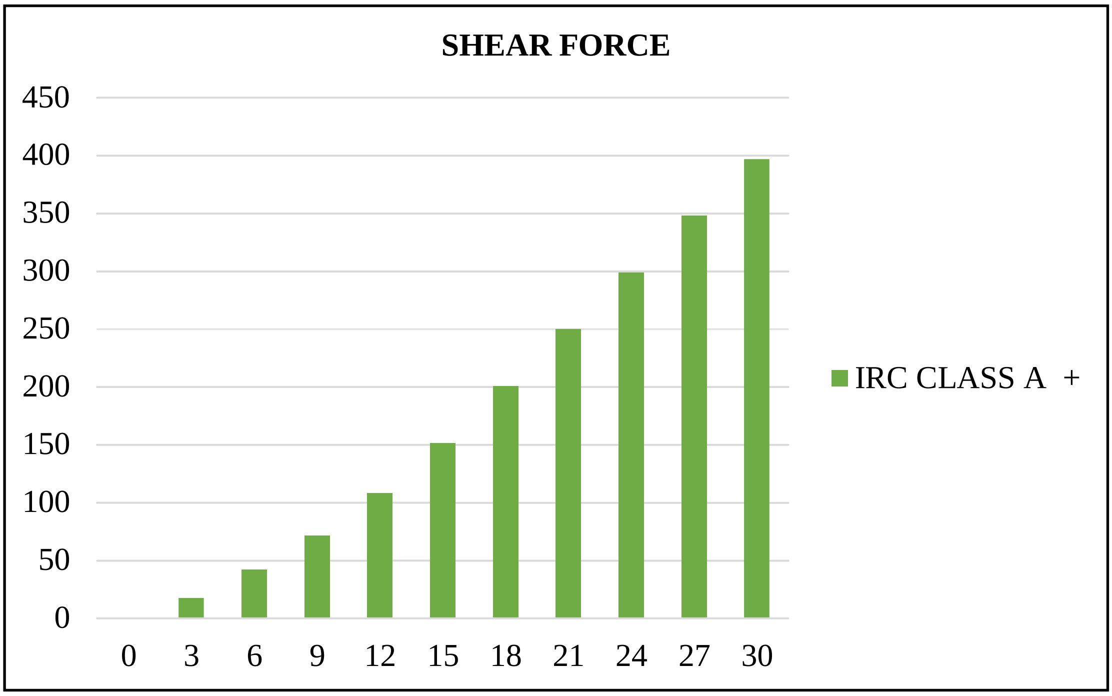

Fig. 4.28 **Shear Force in 45 Degree Due to IRC load Class A**

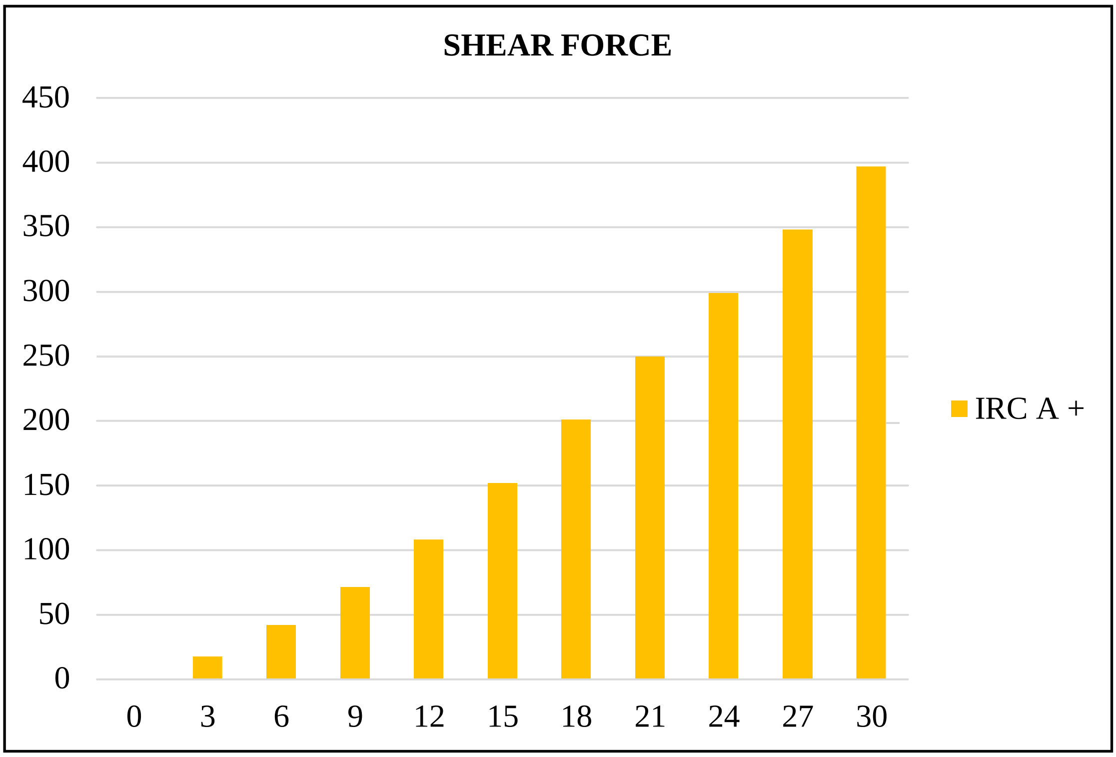

Fig. 4.29 Shear Force in Single Box Due to IRC load Class A

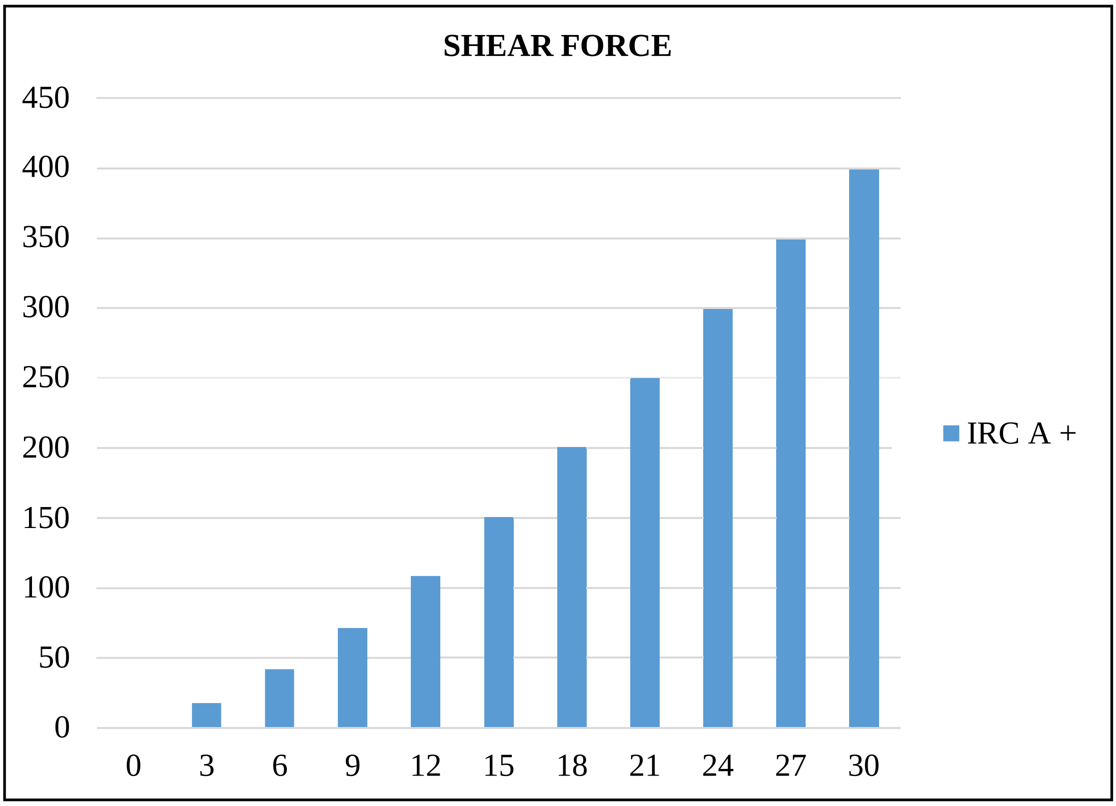

Fig. 4.30 Shear Force in Triangle Due to IRC load Class A

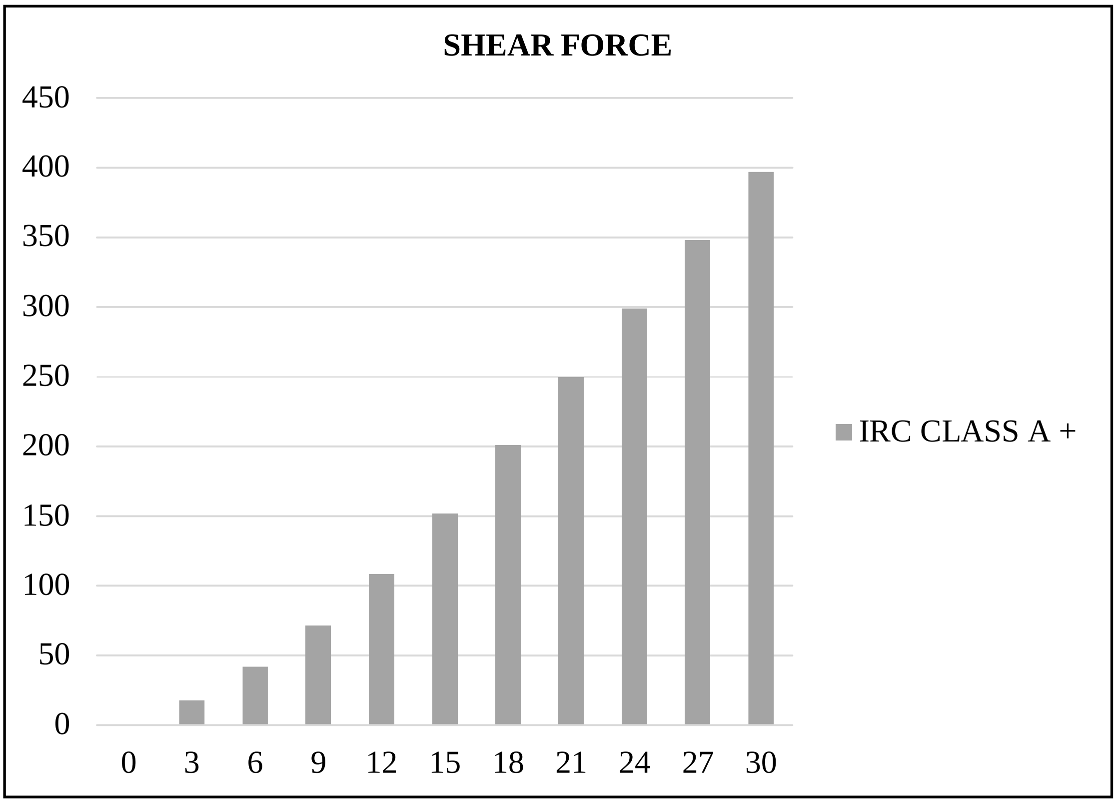

Fig. 4.31 **Shear Force in 90 Degree Due to IRC load Class A**

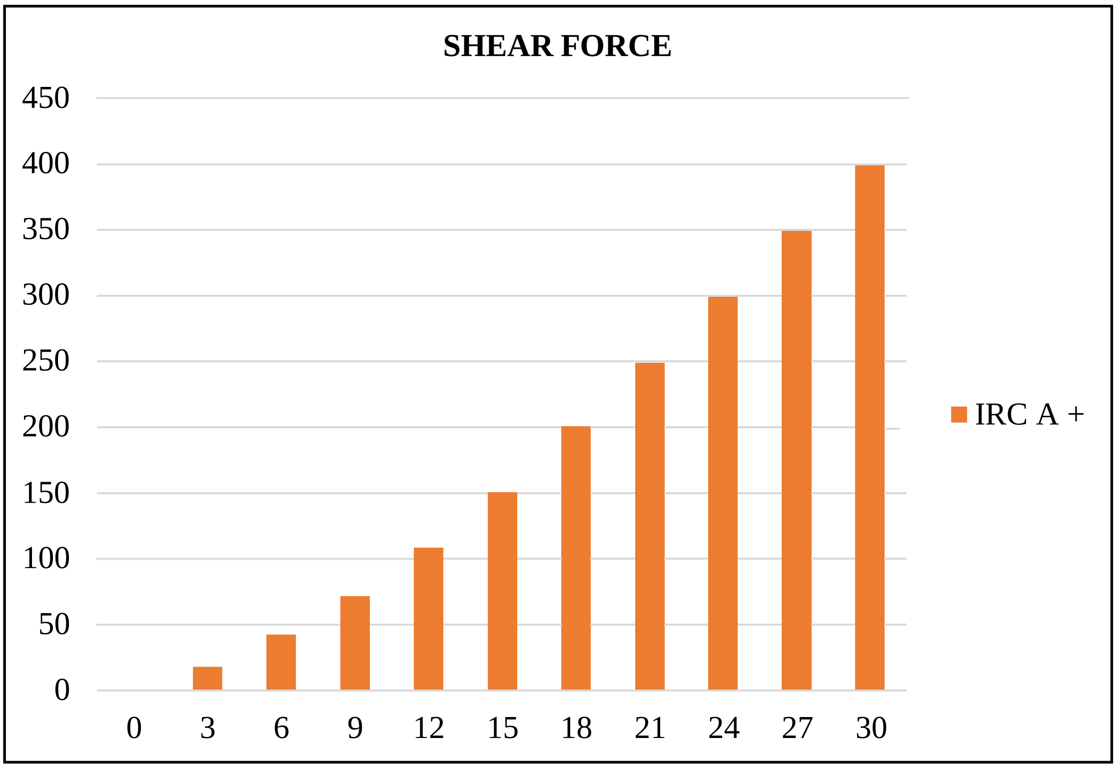

Fig. 4.32 Shear Force in (Inverted) Triangle Due to IRC load Class A

4.8 Shear Force Due to IRC load 70R

Table: 4.8 Shear Force in Various Section Due to IRC load 70R

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	Box Cell of (Inverted) Triangle
0	0	0	0	0	0
3	24.896	24.896	24.896	24.896	24.896
6	75.142	75.142	75.142	75.142	75.142
9	140.572	140.572	140.572	140.572	140.572
12	220.816	220.816	220.816	220.816	220.816
15	302.212	302.212	302.212	302.212	302.212
18	383.607	383.607	383.607	383.607	383.607
21	474.259	474.259	474.259	474.259	474.26
24	572.326	572.326	572.326	572.326	572.326
27	670.392	670.392	670.392	670.392	670.393
30	768.459	768.459	768.459	768.459	768.459

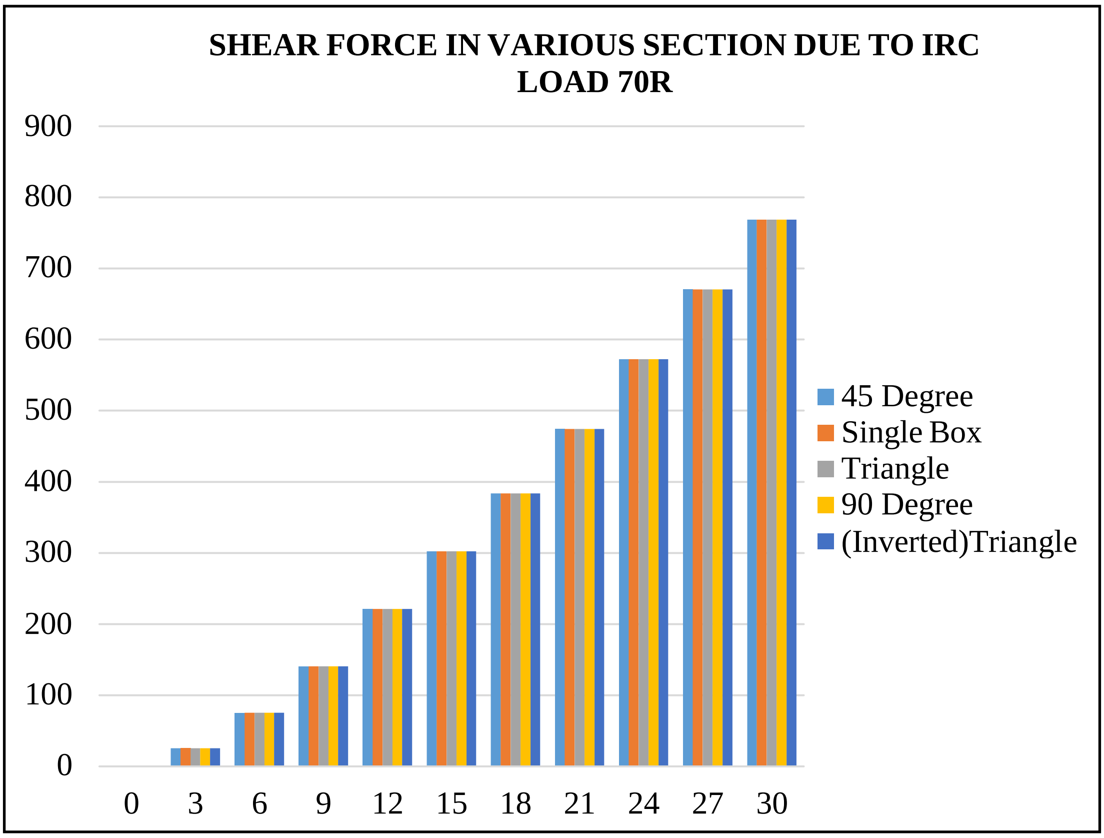

Fig. 4.33 **Shear Force in Various Section Due to IRC load 70R**

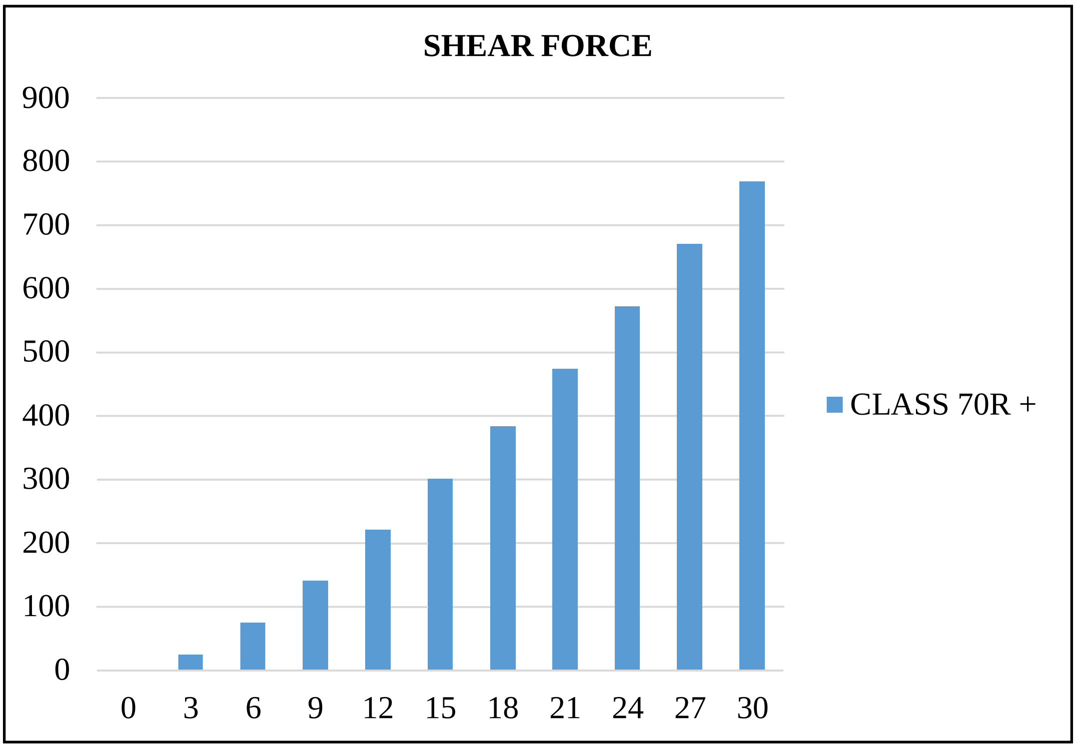

Fig. 4.34 **Shear Force in 45 degree Due to IRC load 70R**

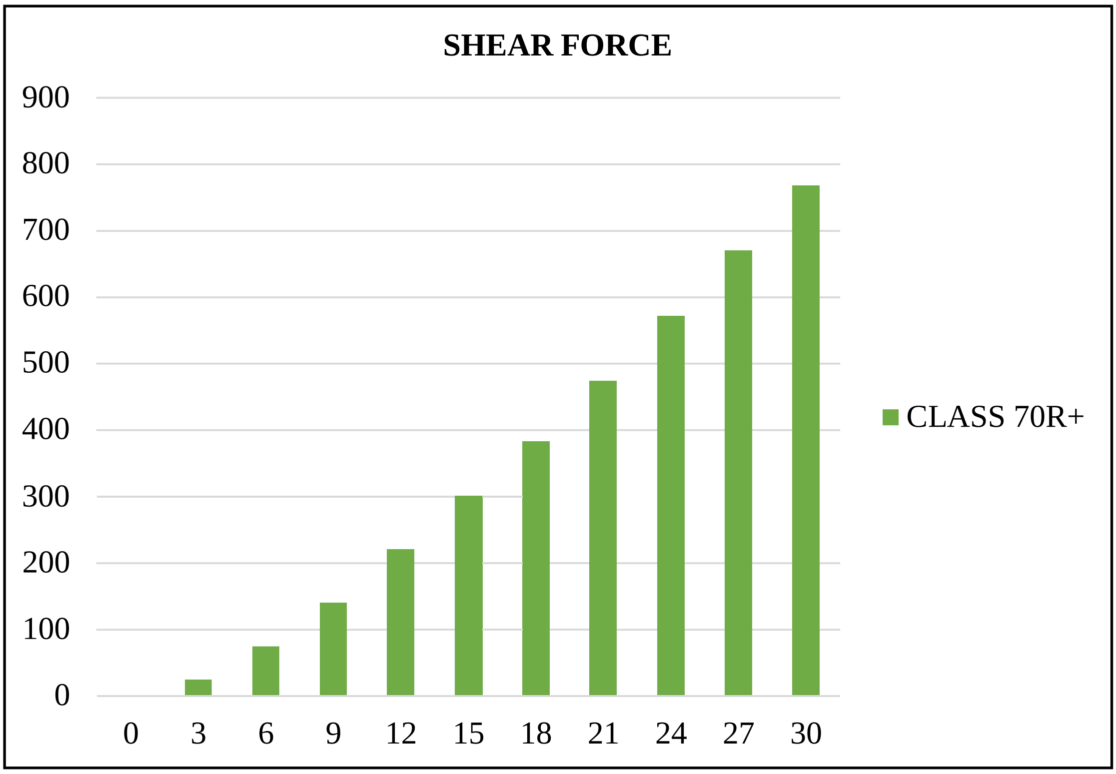

Fig. 4.35 Shear Force in Single Box Due to IRC load 70R

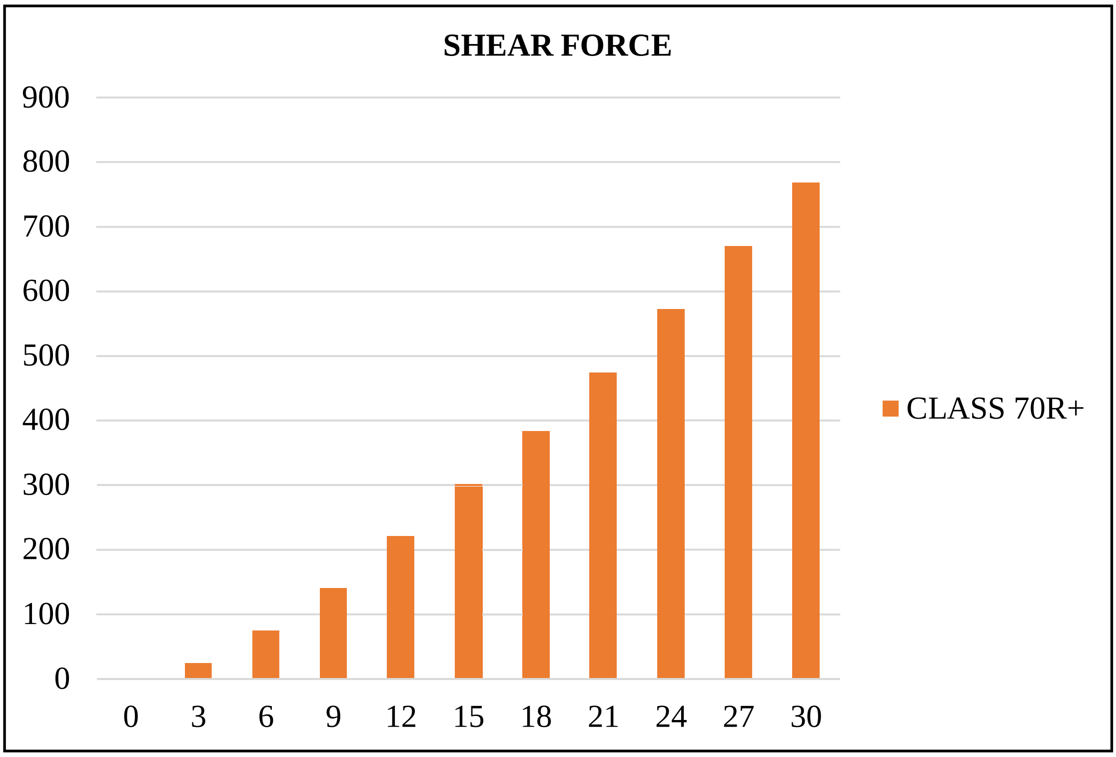

Fig. 4.36 Shear Force in Triangle Due to IRC load 70R

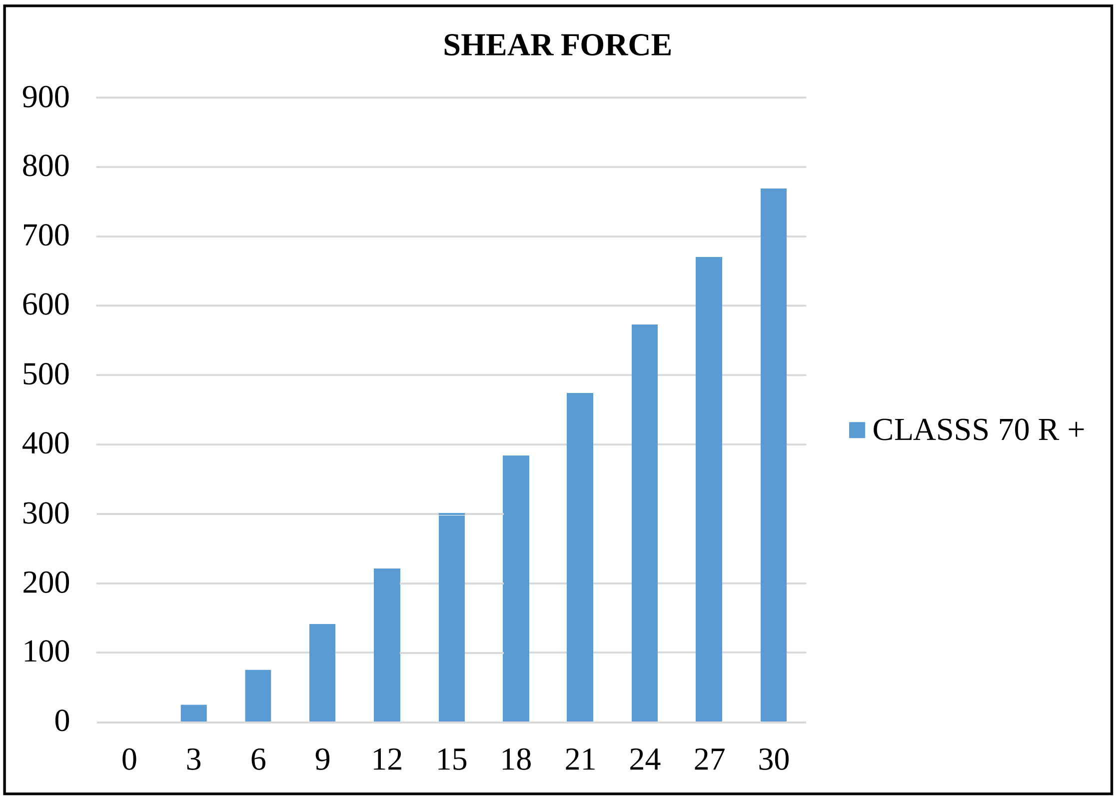

Fig. 4.37 Shear Force in 90 degree Due to IRC load 70R

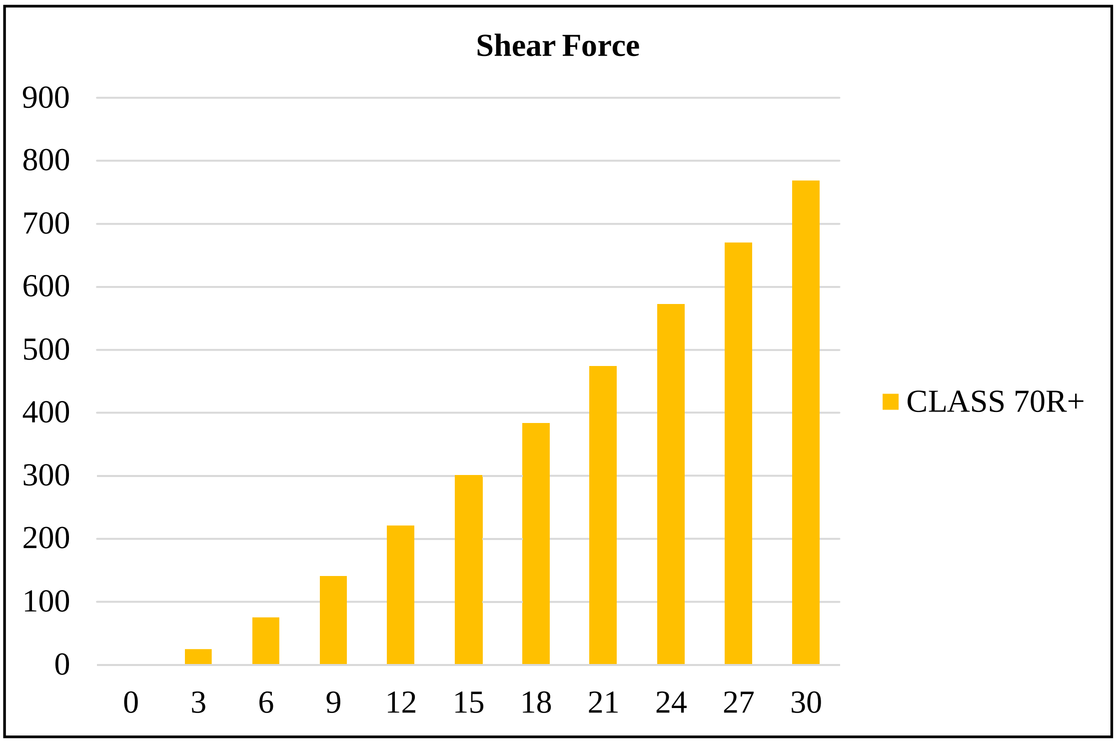

Fig. 4.38 Shear Force in (Inverted) Triangle Due to IRC load 70R

4.9 Shear Force Due to (Response Spectrum) 1.5(DL+EQL)

Table: 4.9 Shear Force in Various Section Due to (Response Spectrum) 1.5(DL+EQL)

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	Box Cell of (Inverted) Triangle
0	-4795.821	-5668.804	-5648.575	-5119.503	-5516.307
5	-3197.214	-3779.202	-3765.717	-3413.002	-3677.538
10	-1598.607	-1889.601	-1882.858	-1706.501	-1838.769
15	9.805E-13	-2.81E-12	-2.09E-12	-1.41E-12	-8.1E-13
20	1598.607	1889.601	1882.858	1706.501	1838.769
25	3197.214	3779.202	3765.717	3413.002	3677.538
30	4795.821	5668.804	5648.575	5119.503	5516.307

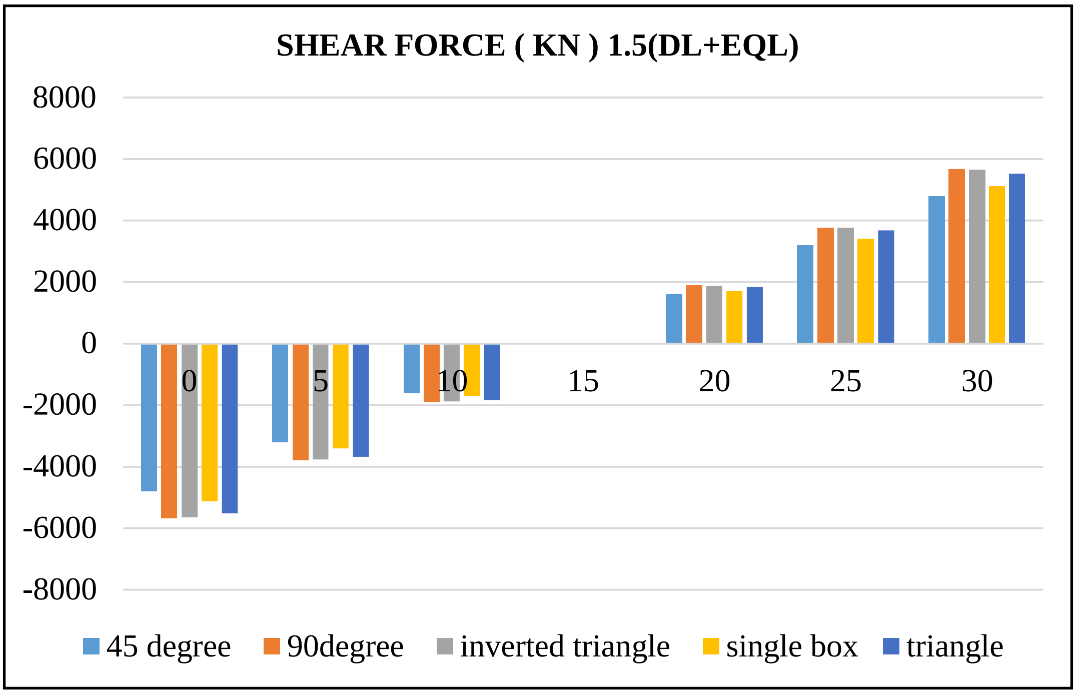

Fig. 4.39 Shear Force in Various Section Due to (Response Spectrum) 1.5(DL+EQL)

4.10 Bending Moment Due to (Response Spectrum and IRC Load) 1.5(DL+70R)

Table: 4.10 Bending Moment in Various Section Due to (Response Spectrum and IRC Load) 1.5(DL+70R)

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	Box Cell of (Inverted) Triangle
0	-4795.821	-5668.804	-5648.575	5119.503	-5516.307
5	-3109.624	-3691.613	-3678.127	3325.412	-3589.948
10	-1347.627	-1638.621	-1631.878	1455.521	-1587.789
15	453.317	453.317	453.317	453.317	453.317
20	2264.67	2555.664	2548.921	2372.564	2504.832
25	4104.736	4686.725	4673.239	4320.524	4585.06
30	5948.509	6821.492	6801.264	6272.192	6668.996

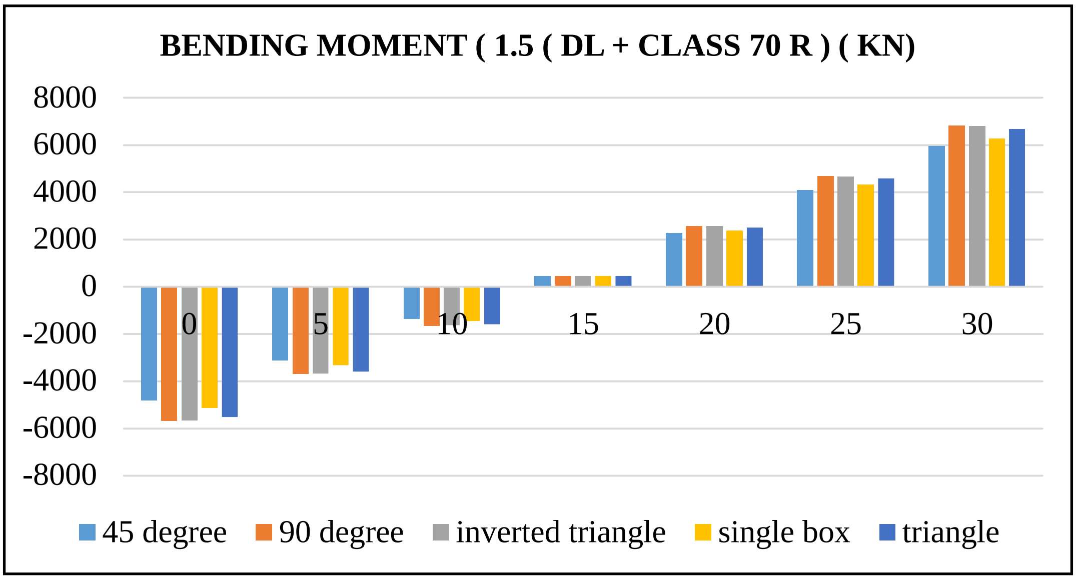

Fig. 4.40 Bending Moment in Various Section Due to (Response Spectrum and IRC Load) 1.5(DL+70R)

4.11 Torsion Due to IRC load Class A

Table: 4.11 Torsion in Various Section Due to IRC load Class A

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	Box Cell of (Inverted) Triangle
0	1071.757	1071.757	1071.757	1071.757	1071.7568
3	939.3673	939.3673	939.3673	939.3673	939.3671
6	806.9775	806.9775	806.9775	806.9775	806.9773
9	674.5877	674.5877	674.5877	674.5877	674.5876
12	542.1979	542.1979	542.1979	542.1979	542.1978
15	409.8081	409.8081	409.8081	409.8081	409.8081
18	292.4225	292.4225	292.4225	292.4225	292.4225
21	193.0419	193.0419	193.0419	193.0419	193.0419
24	113.6699	113.6699	113.6699	113.6699	113.6699
27	48.2958	48.2958	48.2958	48.2958	48.2958
30	16.0986	0	0	0	0

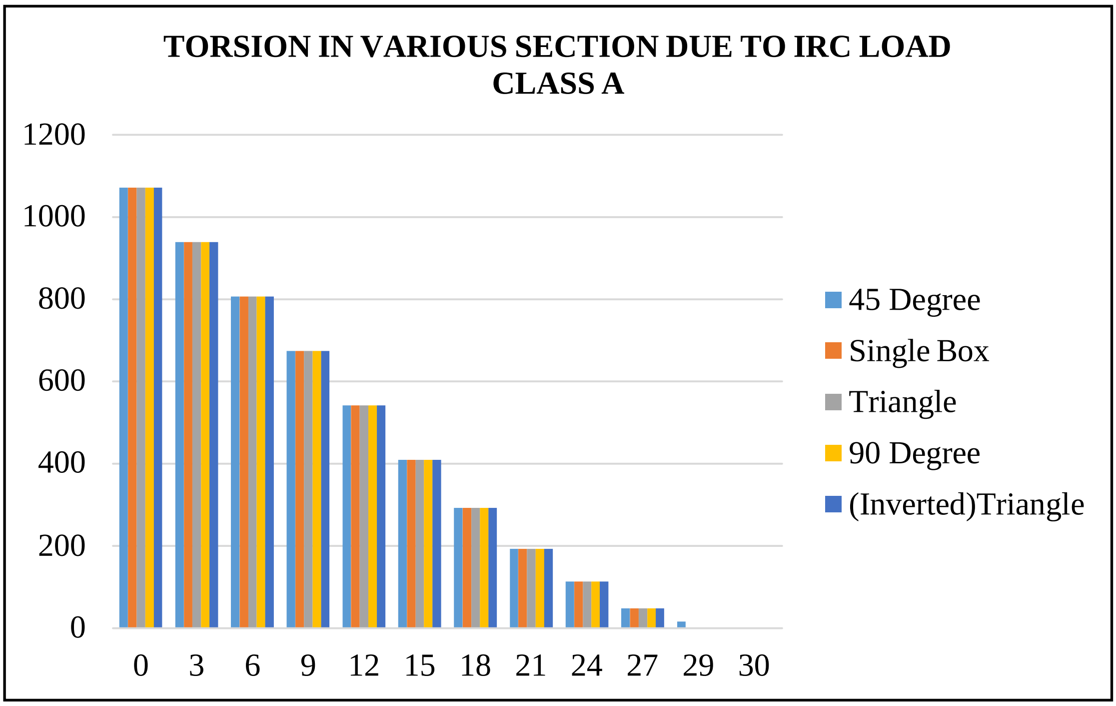

Fig. 4.41 Torsion in Various Section Due to IRC load Class A

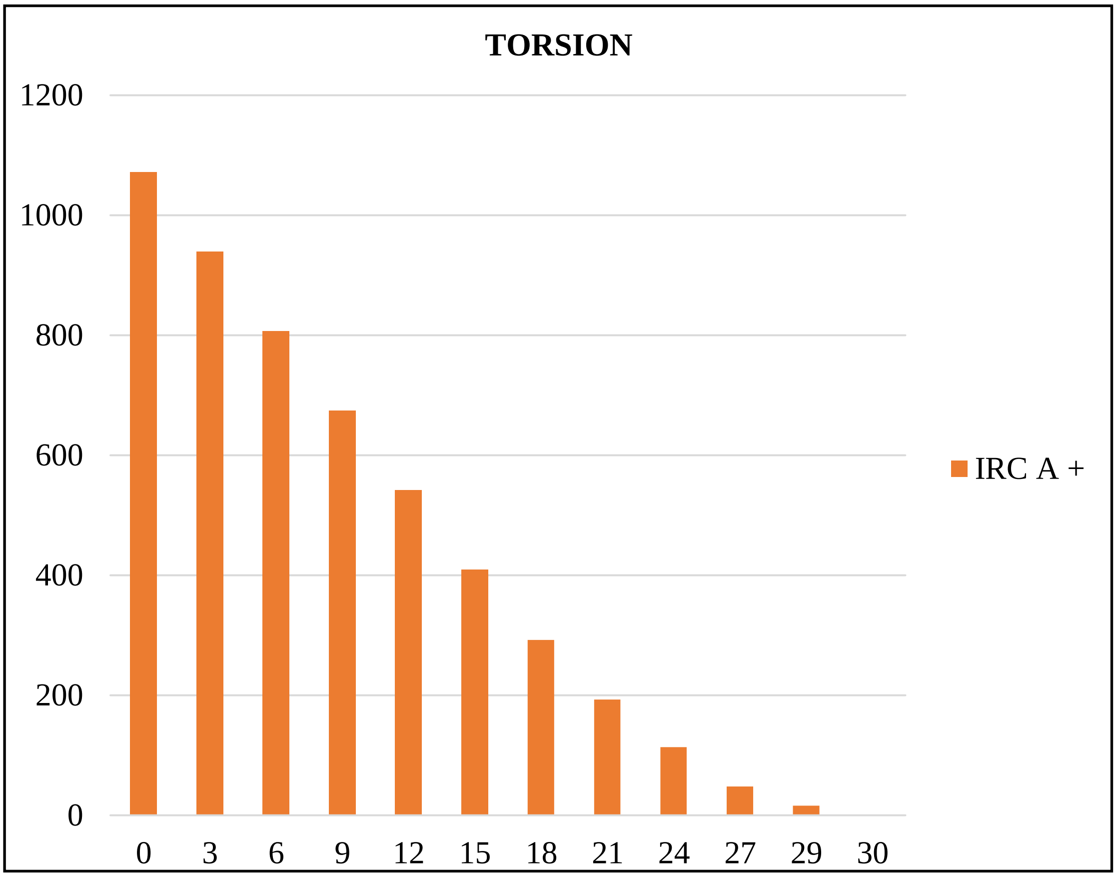

Fig. 4.42 Torsion in 45 Degree Due to IRC load Class A

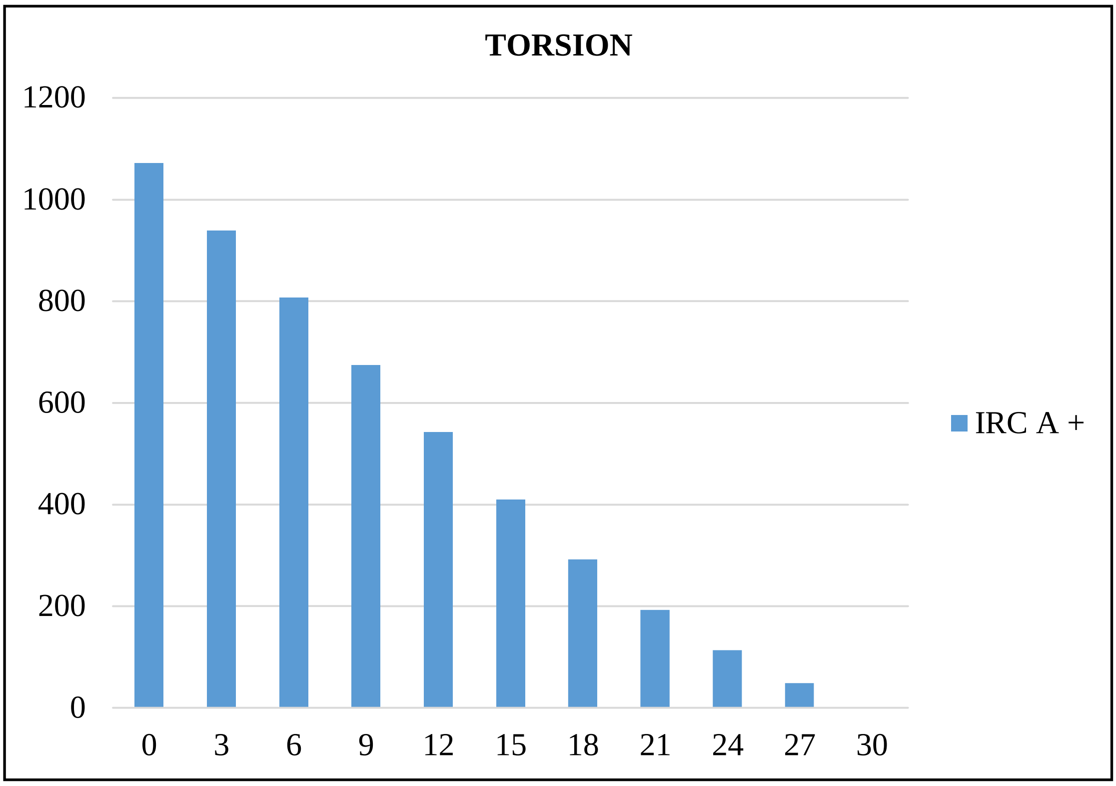

Fig. 4.43 Torsion in Single Box Due to IRC load Class A

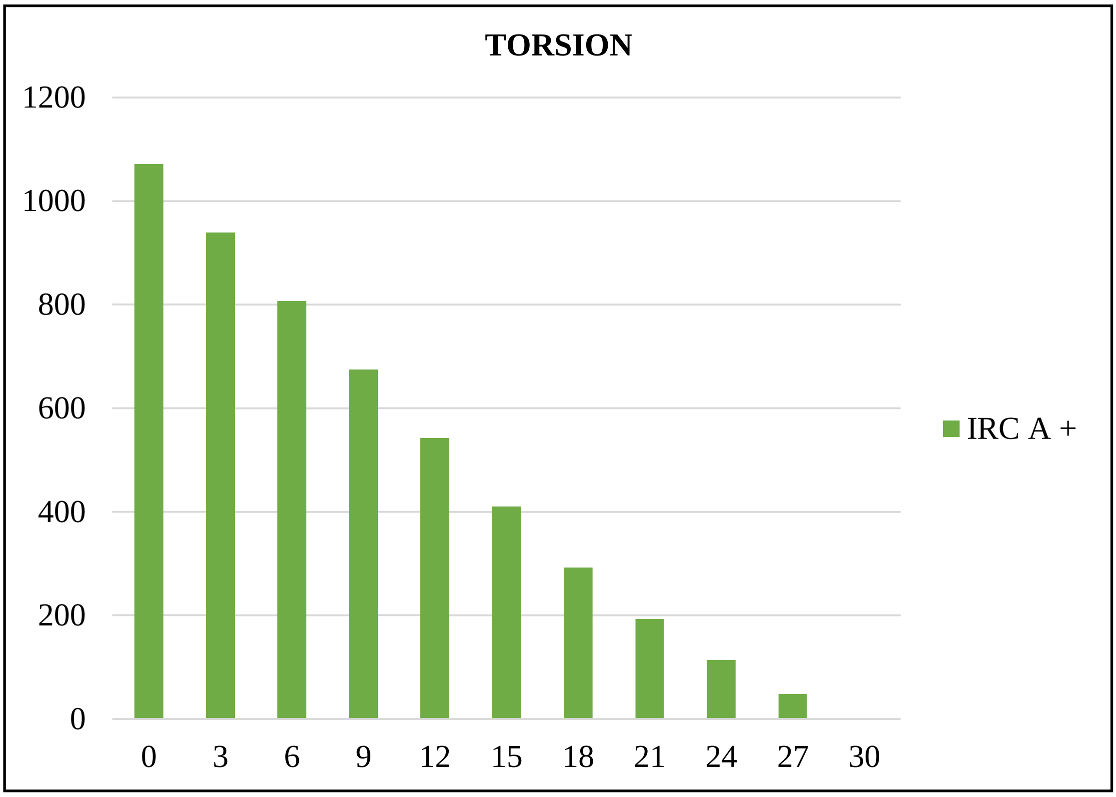

Fig. 4.44 Torsion in Triangle Due to IRC load Class A

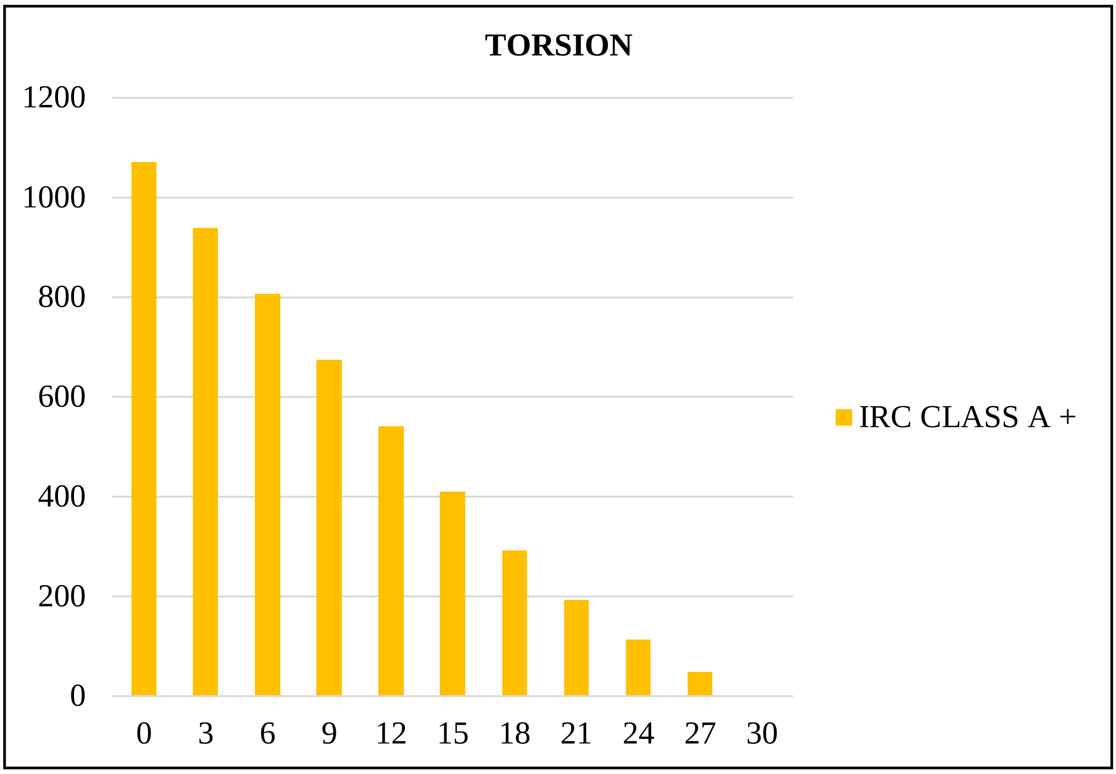

Fig. 4.45 Torsion in 90 Degree Due to IRC load Class A

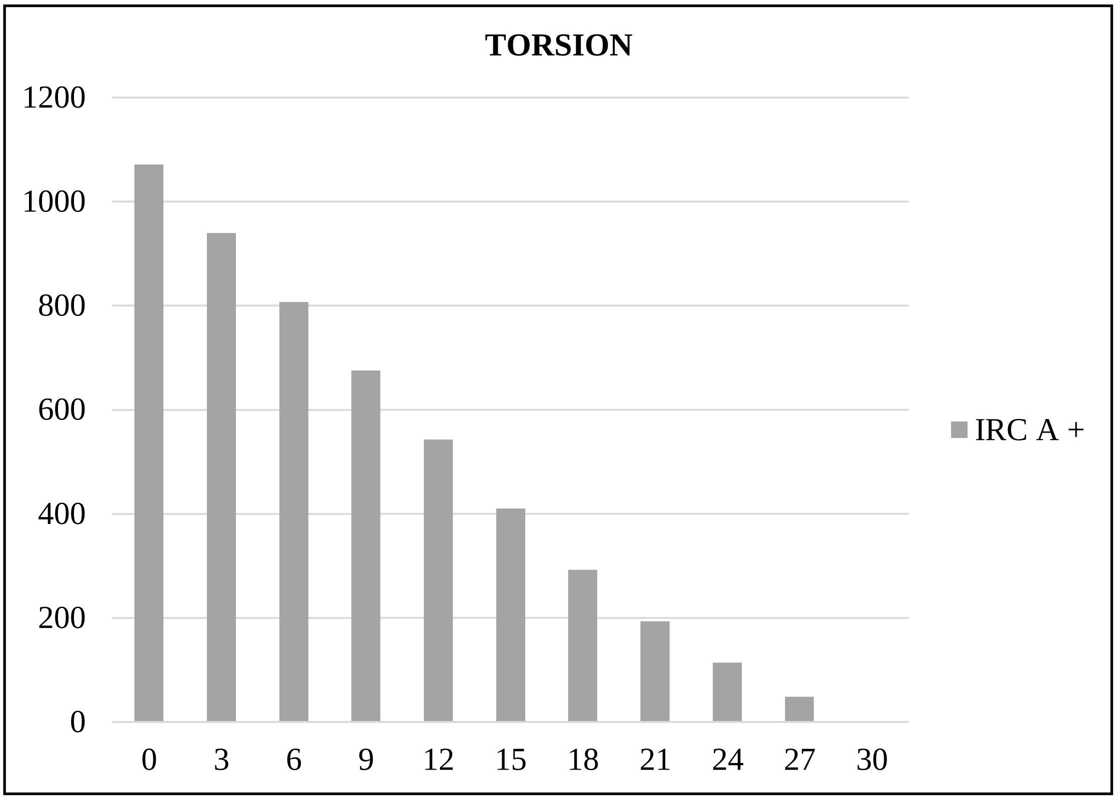

Fig. 4.46 Torsion in (Inverted) Triangle Due to IRC load Class A

4.12 Torsion Due to IRC load 70R

Table: 4.12 Torsion in Various Section Due to IRC load 70R

Station (m)	At 45 Degree	Cell of Single-Box	Cell of Box With Strap	At 90 Degree	(Inverted) Triangle
0	1267.9572	1267.9572	1267.9572	1267.9572	1267.9575
3	1106.1475	1106.1475	1106.1475	1106.1475	1106.1477
6	944.3378	944.3378	944.3378	944.3378	944.338
9	782.528	782.528	782.528	782.528	782.5282
12	632.9511	632.9511	632.9511	632.9511	632.9512
15	498.649	498.649	498.649	498.649	498.6491
18	364.347	364.347	364.347	364.347	364.347
21	231.9435	231.9435	231.9435	231.9435	231.9435
24	123.984	123.984	123.984	123.984	123.984
27	41.0781	41.0781	41.0781	41.0781	41.0781
30	13.6927	0	0	0	0

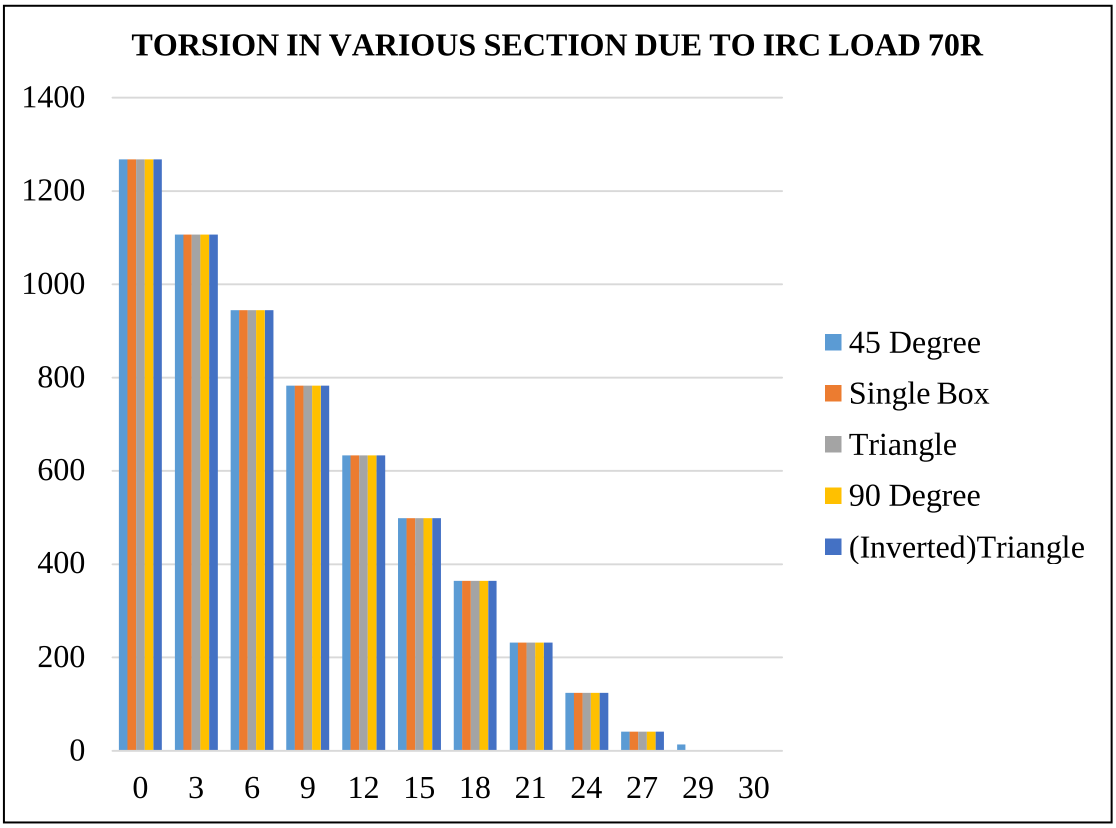

Fig. 4.47 Torsion in Various Section Due to IRC load 70R

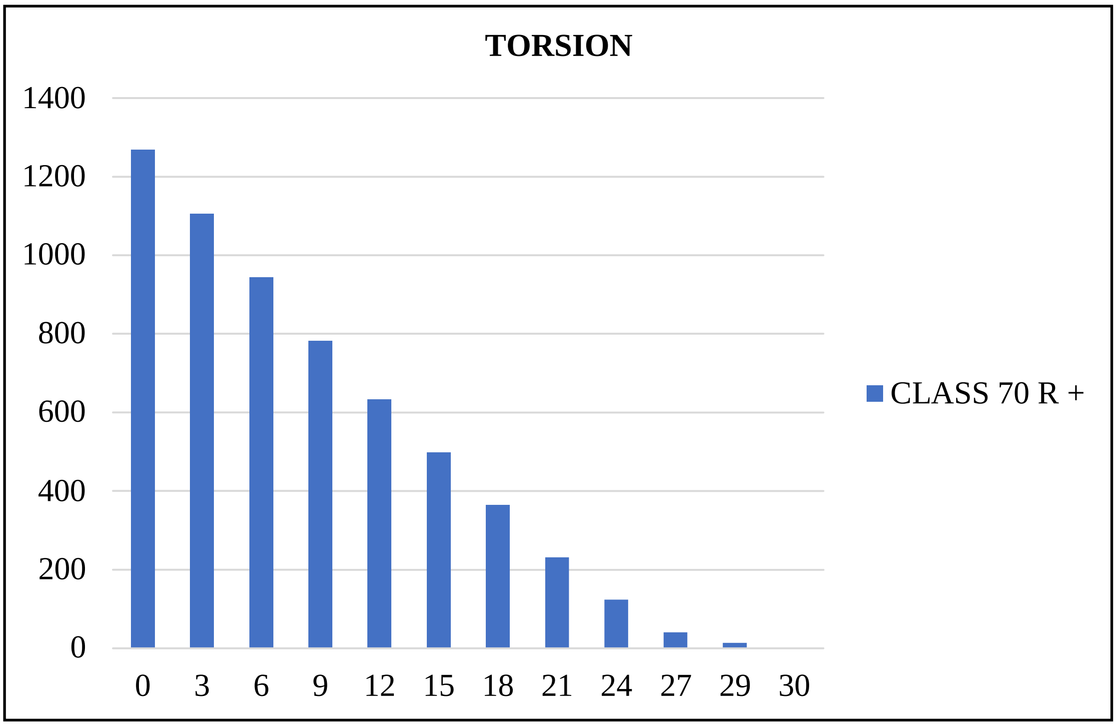

Fig. 4.48 Torsion in 45 Degree Due to IRC load 70R

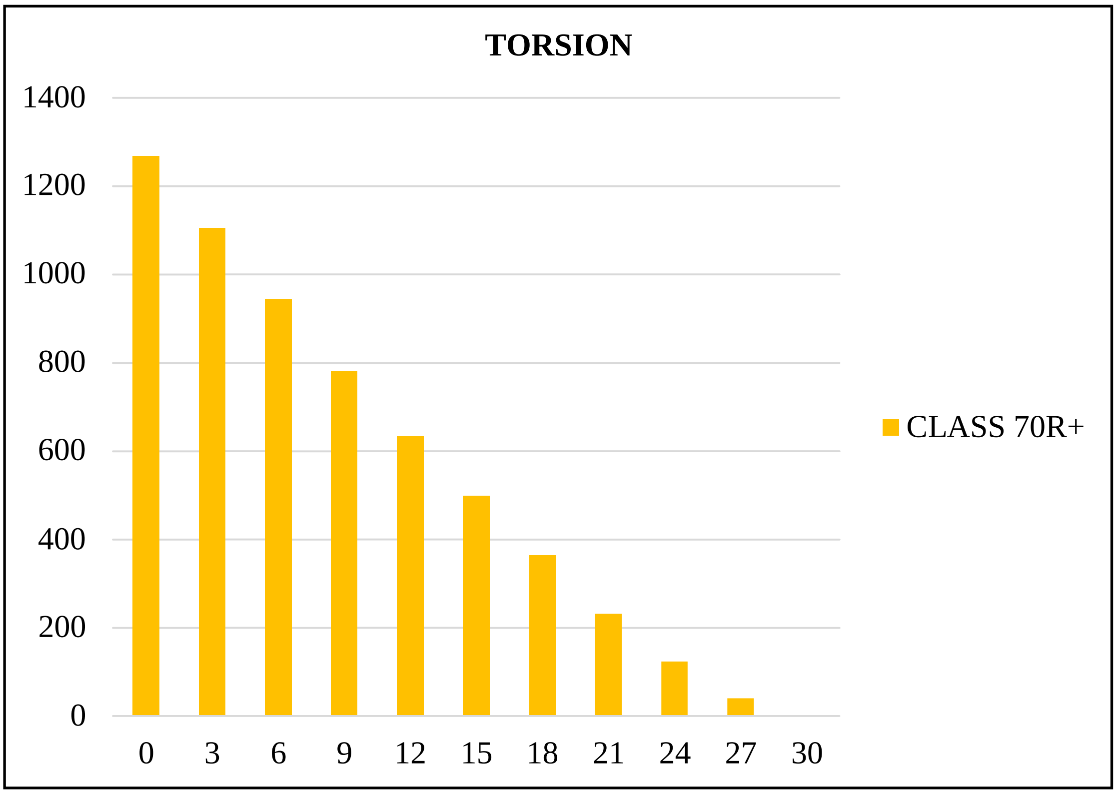

Fig. 4.49 Torsion in Single Box Due to IRC load 70R

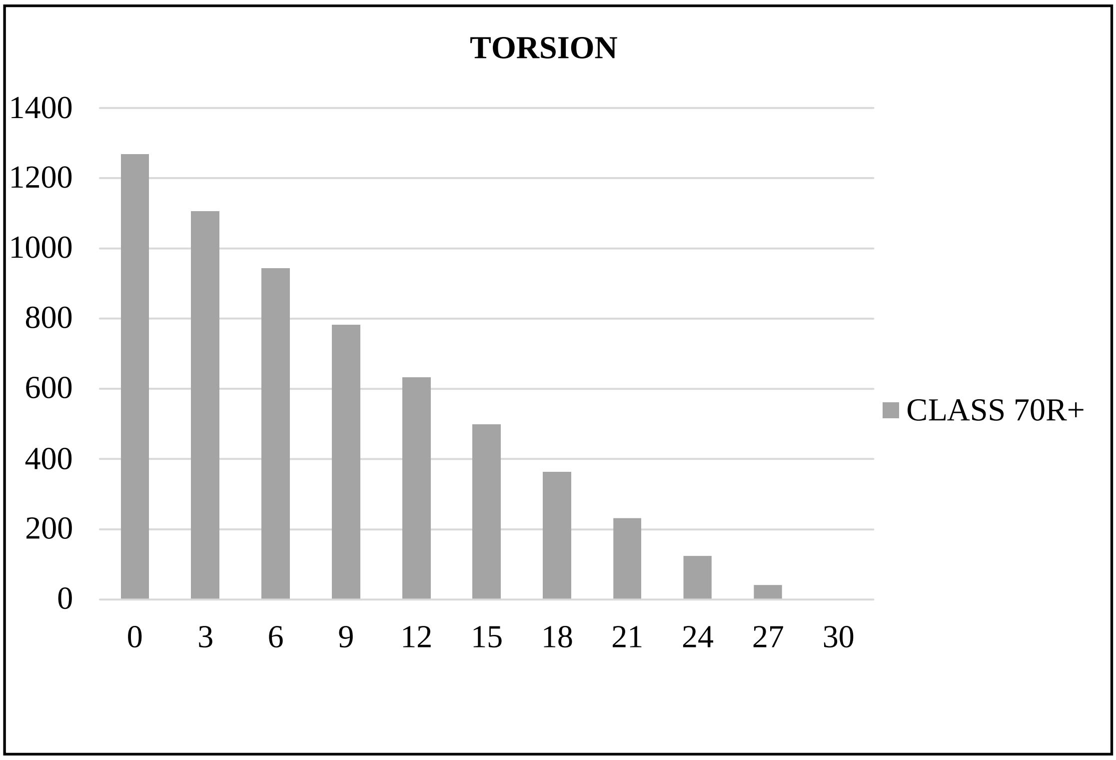

Fig. 4.50 Torsion in Triangle Due to IRC load 70R

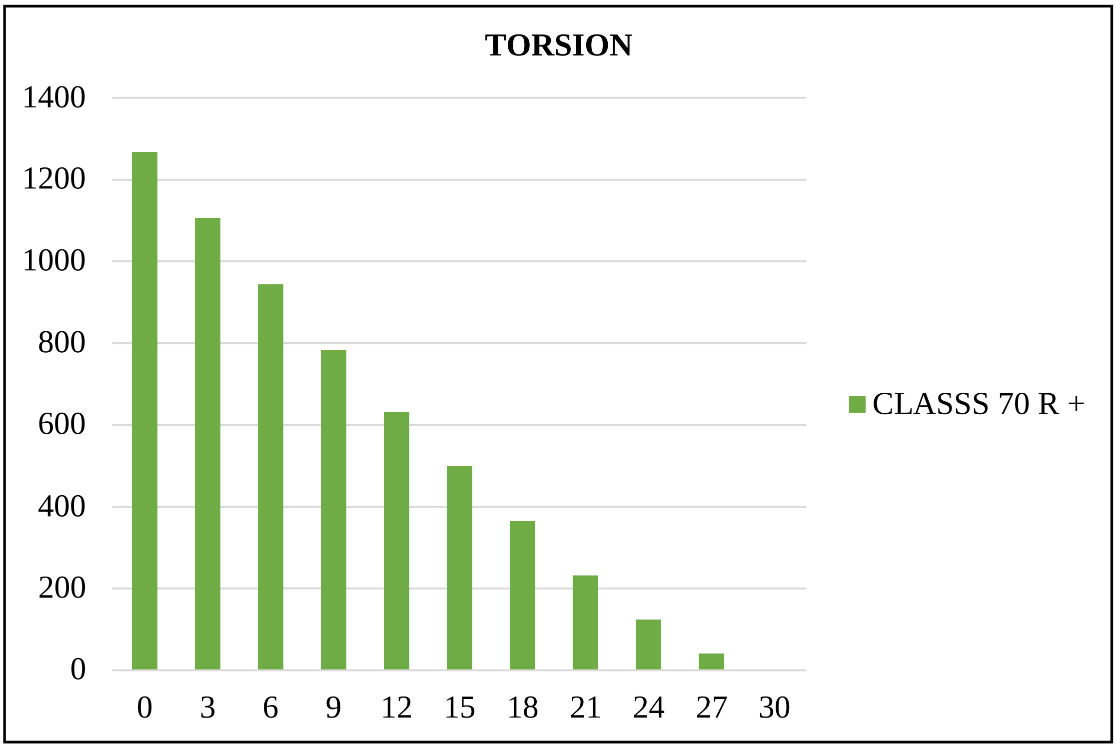

Fig. 4.51 Torsion in 90 Degree Due to IRC load 70R

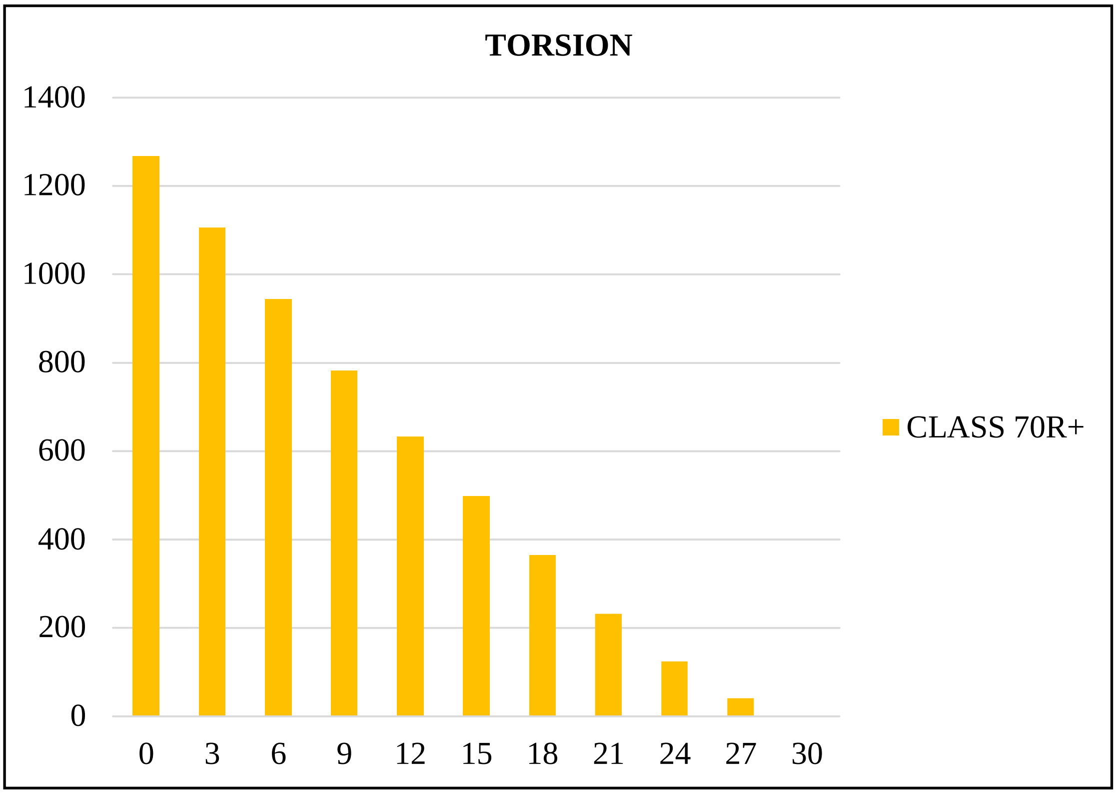

Fig. 4.52 Torsion in (Inverted) Triangle Due to IRC load 70R

4.13 Deflection Due to Dead Load

Table: 4.13 Deflection Due to Various Sections Due to Dead Load

Sections	Deflection (mm)
45 degree	18.919
90 degree	13.964
inverted triangle	15.839
single box	15.587
triangle	15.606

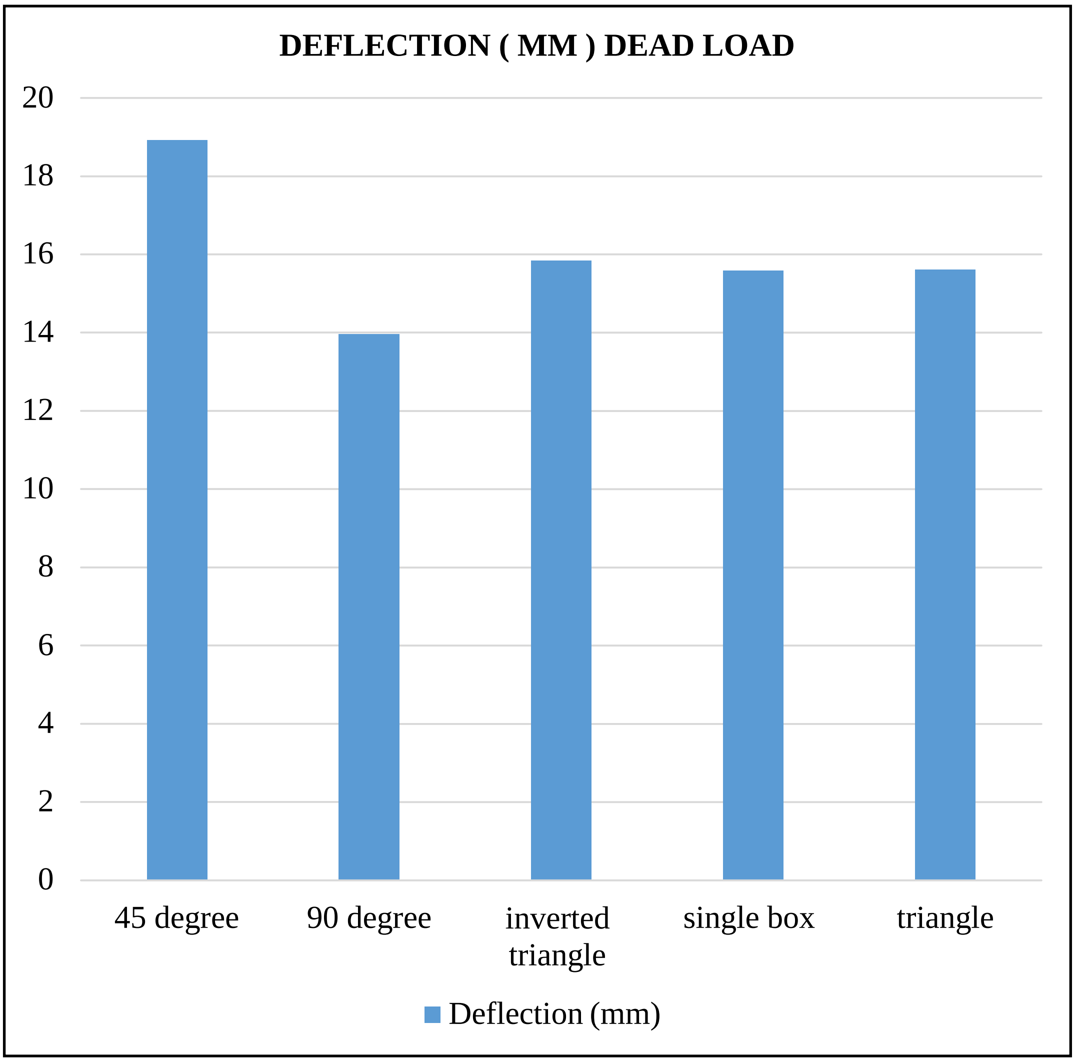

Fig. 4.53 Deflection Due to Various Sections Due to Dead Load

4.14 Base Reaction Due to Load Combination 1.5(DL+EQL)

Table: 4.14 Base Reaction Due to Various Sections Due to Load Combination 1.5(DL+EQL)

Sections	Base Reaction (mm)
45 degree	28.343
90 degree	33.502
inverted triangle	33.383
single box	30.256
triangle	32.601

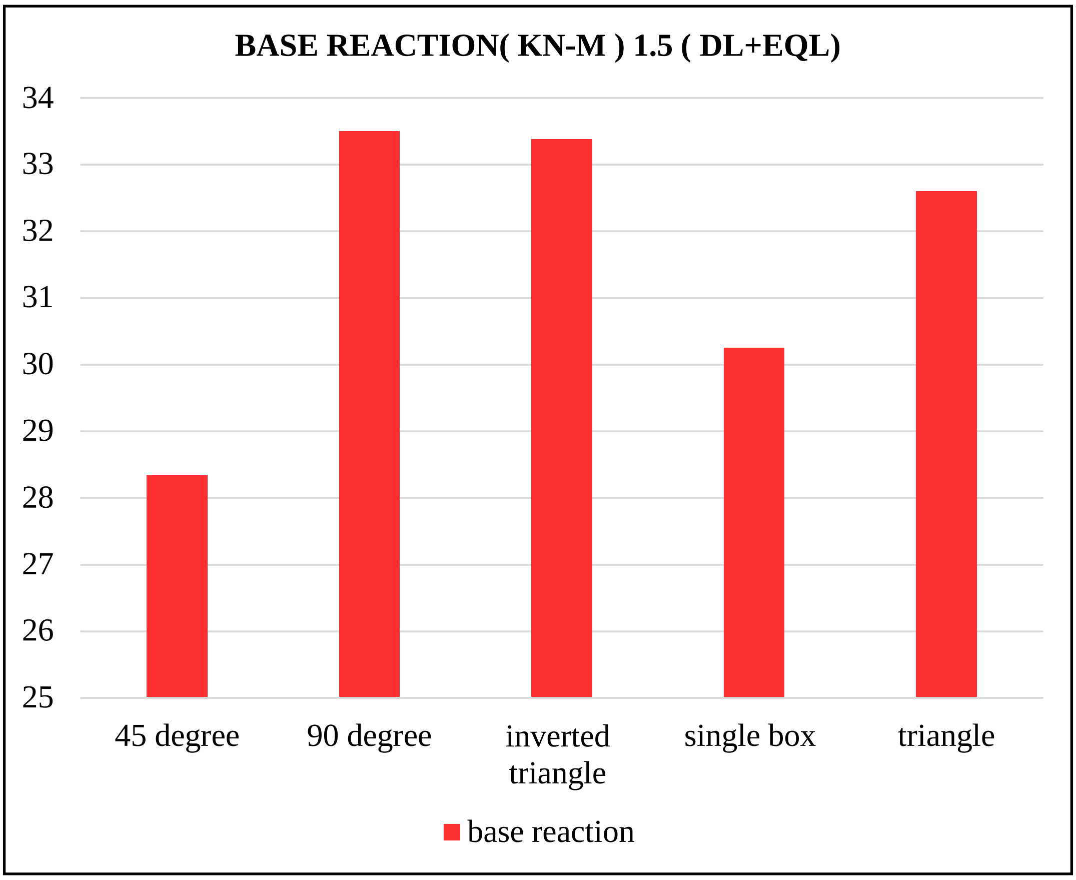

Fig. 4.54 Base Reaction Due to Various Sections Due to Load Combination 1.5(DL+EQL)

Chapter 5

CONCLUSION

5.1 Bending Moment Results

- **Bending Moment Results Due to Dead Load**

  The single box modified box(45) has the smallest bending moment and the 90 degree box has the largest bending moment. The bending moment results are calculated in the table and displayed graphically.

- **Bending Moment Due to IRC load 70R**

  The bending moment is the same for all angles with an IRC load of 70R. The bending moment results are calculated in the table and displayed graphically. Note that the bending moment is clearly zero on both supports and maximum in the center.

- **Bending Moment Due to (Response Spectrum) 1.5 (DL+EQL)**

  This is the smallest bending moment for a box drum (45) converted to a single box drum and the largest for a box tape drum(90). The bending moment results are calculated in the table and displayed graphically. We can see that the support has a clear bending moment of zero and a maximum in the middle.

- **Bending Moment Due to (Response Spectrum and IRC Load) 1.5(DL+70R)**

  The bending moment is the smallest for modified single box (90) and the largest for 90 degree. The results of the bending minutes are calculated in a table and displayed in a graph. It can be noted that the support has zero and maximum bending moment in the center.

- **Bending Moments Results Due To Live Load**

  This is the minimum bending moment for modified cassette cells in a single box (90) and the maximum for strapped 90 degree cells. The bending moment results are calculated in the table and displayed graphically.

5.2 Shear Force Results

- **Shear Force Due to Dead Load**

  Additionally, the minimum and shear forces for mesh elements are changed to the largest single mesh element for double 90 degree mesh elements. The minimum (zero) shear force for the mid span is the maximum value at the support, which is positive and negative at the left support.

- **Shear Force Due to IRC load 70R**

  Shear force is same for all angles in IRC load 70R. Shear force is minimum (ZERO) at right support and its maximum at left support.

- **Shear Force Due to (Response Spectrum) 1.5(DL+EQL)**

  At least in the case of meshes, the transverse force is also modified by the largest individual mesh of the band mesh. The minimum SF (ZERO) is in the middle of the range, the support has a maximum value and the value is positive, and the left support is negative.

- **Shear Force Due to (Response Spectrum and IRC Load) 1.5(DL+70R)**

  Shear force is additionally to minimum for box cell (45) modified to single box cell maximum for box cell with strap(90). Shear force is minimum for at mid span and its maximum at support with positive value and negative value at left support.

- **Shear Force Result Due To Live Load**

  Shear force value is found to be maximum as 407.77KN for burden of car load Class A 5.65. Shear force value is found to be maximum 783.61Kn for loading of car 70R Path 6.7.

5.3 Deflection Results

Deflection value is obtained graph and data are shown in Figure Minimum deflection is found for box cell of 90 degree type. Maximum deflection is found for box cell of 45 degree type. Maximum value of deflection is found at center and minimum zero value is found at support.

5.4 Torsion Results

- **Torsion Due to IRC load Class A**

  "Torsion is same For All Angles in IRC load Class A. Torsion result computed in tables and shown in graph. It may be noticed that bending moment is zero at right support evidently and it's maximum at left support".

- **Torsion Due to IRC load 70R**

  "Torsion is same for all angles in IRC load Class A. It will be noticed that bending moment is zero at right support obviously and it's maximum at left support".

5.5 Base Reaction Due to Load Combination 1.5(DL+EQL)

Minimum Base Reaction is found for box cell of 45 degree type. "Maximum Base Reaction is found for box cell of 90 degree type. Maximum value of Base Reaction is found at center and minimum zero value is found at left support".

5.6 Future Scope of the Work

- Torsion effect due to live load with certain eccentricity is computed.
- "Manually analysis of bridge can be done with different section can be computed".
- "Parametric study with different Curvature effect by optimization of section canfurther be computed".
- "Analysis can be done with software csi-bridge and results can be computed with added facility in CSI bridge software".
- "FEM technique can be used to get move in sight into the stress patterns in the various configurations of sections and these can further be modified accordingly".

REFERENCE

1. Kaveh, A., L. Mottaghi, and A. Izadifard. “PARAMETRIC STUDY: COST OPTIMIZATION OF NON-PRISMATIC REINFORCED CONCRETE BOX GIRDER BRIDGES WITH DIFFERENT NUMBER OF CELLS.” Iran University of Science & Technology 12.1 (2022): 1-14.

2. Arora, Jyoti, Vishnu Sharma, and Er Sanjeev Sipani. “A PARAMETRIC STUDY OF BOX GIRDER WITH VARYING CROSS-SECTION AND CONSTANT SPAN 30M IN SAP2000.”

3. Sheikh, Wasim, Mayur Singi, and Nikita Thora. “COMPARATIVE ANALYSIS USING SAP SOFTWARE OF 2, 3 CELL RECTANGULAR BOX GIRDER AND 2, 3 CELL TRAPEZOIDAL BOX GIRDER.”

4. Wu, Fangwen, et al. “Mechanical Performance Analysis and Parametric Study of a Self-Anchored Suspension Bridge with Ultra-Wide Double-Sided Steel Box Girder.” Advances in Civil Engineering 2021 (2021).

5. Pal, Priyaranjan, Preeti Agarwal, and Nidhi Gupta. “Analysis of RCC curved box girder bridges.” Applied Innovative Research (AIR) 1.3-4 (2020): 153-159.

6. AS, Abdul Khader, and A. R. Pradeep. “Study on Parametric Behaviour of Box Girder Bridges under Different Radius of Curvature and Varying Span.” (2019).

7. Gaur, Abhishek, and Ankit Pal. “Parametric Study of RC Deck Slab Bridge with varying thickness: A Conceptual Review.” International Research Journal of Engineering and technology 6 (2019): 4978-4983.

8. Hassan, Md Nazmul. A Comparative Study between Single Plane and Double Plane Box Girder Extradosed Bridges. Diss. Ahsanullah University of Science and Technology, 2019.

9. Chithra, J., Praveen Nagarajan, and A. S. Sajith. “Simplified method for the transverse bending analysis of twin celled concrete box girder bridges.” IOP

Conference Series: Materials Science and Engineering. Vol. 330. No. 1. IOP Publishing, 2018.

10. MAHESH, NADAVALA, and G. TAMILANBAN. “A Technique Using Box Girder for Elevated Structures.”

11. Kalyanshetti, M. G., and S. A. Gosavi. “Analysis of box culvert-cost optimization for different aspect ratios of cell.” Int J Res Eng Technol 3 (2014): 508-514.

12. Saumya, E., and Biby Aleyas. “Analytical and Parametric Study of Double Box Girder.” Engineering and Science 2.2 (2017): 166-169.

13. Navarro-Manso, Antonio, et al. “New launching method for steel bridges based on a self-supporting deck system: FEM and DOE analyses.” Automation in construction 44 (2014): 183-196.

14. NAEINI, M. ARAB, et al. “Optimization of Post-Tensioned Concrete Box Girder Double-Track Railway Bridges Using Genetic Algorithm.”

15. Kulka, Felix, and S. J. Thoman. “Feasibility study of standard sections for segmental prestressed concrete box girder bridges.” Journal PO 28.5 (1983): 54-77.

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

PLAGIARISM VERIFICATION REPORT

Date: 24/05/2022

Type of Document (Tick): PhD Thesis | M.Tech Dissertation/ Report | B.Tech Project Report | Paper

Name: NAVEEN CHAUHAN Department: CIVIL Enrolment No 202655

Contact No. 8894267409 E-mail. 202655@juitsolan.in

Name of the Supervisor: Dr. SAURAV

Title of the Thesis/Dissertation/Project Report/Paper (In Capital letters): "PARAMETRIC STUDY OF DOUBLE BOX CELL TYPE BRIDGES BY CHANGING CONFIGURATION OF BOX CELL"

UNDERTAKING

I undertake that I am aware of the plagiarism related norms/ regulations, if I found guilty of any plagiarism and copyright violations in the above thesis/report even after award of degree, the University reserves the rights to withdraw/revoke my degree/report. Kindly allow me to avail Plagiarism verification report for the document mentioned above.

Complete Thesis/Report Pages Detail:

- Total No. of Pages = 79
- Total No. of Preliminary pages = 13
- Total No. of pages accommodate bibliography/references = 2

(Signature of Student)

FOR DEPARTMENT USE

We have checked the thesis/report as per norms and found Similarity Index at ....8........(%). Therefore, we are forwarding the complete thesis/report for final plagiarism check. The plagiarism verification report may be handed over to the candidate.

Saurav 24/5/22

(Signature of Guide/Supervisor)

Signature of HOD 27/5/22

FOR LRC USE

The above document was scanned for plagiarism check. The outcome of the same is reported below:

Copy Received on	Excluded	Similarity Index (%)	Generated Plagiarism Report Details (Title, Abstract & Chapters)	
	• All Preliminary Pages • Bibliography/Images/Quotes • 14 Words String		Word Counts	
Report Generated on			Character Counts	
		Submission ID	Total Pages Scanned	
			File Size	

Checked by
Name & Signature

Librarian

Please send your complete thesis/report in (PDF) with Title Page, Abstract and Chapters in (Word File) through the supervisor at plagcheck.juit@gmail.com