



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 11, November 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118

 9940 572 462

 6381 907 438

 ijirset@gmail.com

 www.ijirset.com



Comparative Analysis of BIPV System Building and Normal Building

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ABSTRACT:-The main intension of this project is to design the multistory building of BIPV System remaining are same.I have taken 10 story building in 3-D frame, design and analysis on the STAAD Pro Software for the design of the building. I have considered dead load, live load and wind load. On the STAAD Pro I have assign dead load, live load and generate wind load definition. For the generate of wind load definition I took help of IS code IS 875:Part 3 for the wind load case. I have use STADD Pro software for the analysis of the two building and did comparative analysis between these two building on the STAAD Pro software this STAAD Pro software under the Indian standard code of practice it adopt limit state design method. I have analyzed two building one with the BIPV system building and another is without BIPV system building after analyzing I have find out the extra load bending moment ,Shear force etc in the BIPV building and compare these force with the normal structural building compare between these two building. I will calculate extra load,shear force,bending moment and cost analysis etc.

KEYWORDS: - BIPV System, Cost analysis, Solar Panel,Solar energy, Environment

I. INTRODUCTION

Structure is the collection and arrangement of members together which forms proper meaningful purpose which effect the load of structure component vertically or laterally. There is different types of structure like concrete framed, truss , cables and arches , surface structure can be viewed in many models.These structure were using in our environment for different purpose like building, bridge,dam ,etc. Now a days structural building in which we are using for the living and we are bearing electric bills which building are consuming as per the building demand like residential building have the low demand of the electric but the institutional building and the official building have high demand of electricity which generate high electric bills .for saving electric bills we are installing solar panel on the roof that is short area of the roof .in this short area there can be very few solar panel cane adjust on the roof which is capable to bear the electric of the houses .but in the case of high rise building like residential official and institutional building ,there is the huge demand of electricity in the market small roof area that is not sufficient to full fill the utility of the electricity of the whole building. Now I have introduced BIPV structural building (with solar Panel).This building is the good for the environment and producing good electricity in the building which is sufficient for the bear of electricity .in the multistory building there is a large area of the floor side of the building in comparison of the roof area after utilizing this area in the solar solar panel installing we can install large number of solar panel and it produce large electricity from which we can utilize for the bear whole electricity of the structure .

BIPV system is the building integrated photovoltaic system it the system which integrate of the solar cells as a building envelope it can be use on the wall in the building as a envelope and it is use on the roof of building it convert solar energy into electrical energy mainly in our environment we are using BIPV system in building which save the cost of electric bill and make building cost free electric. General BIPV system is formed from the collection of the solar panel and it is many types which are given in below.

II. LITERATURE REVIEW

For analysis of high rise building with the BIPV system .I took two building of 10 storey (G+9) storey building one without the solar panel and one with the BIPV system and analyse both the building after coming result .I check 1st it is durable building in all Climate or not and after conformation it is durable in all climate. I compare the both building impact come on the building so I took two building and Calculate Live load ,dead load ,wind load in one building and in another building I implement Live load ,dead load ,wind load ,solar panel load.Perform analysis after analysis I find out the result of bending moment ,shear stress and sway in the stadd pro software of both building and check the



difference in both building along with this compare between two building .After Checking both building along with this compare between two building after checking both building along with that I have design beam , column and slab with the help of stadd pro software For the estimation and for other load calculation .I chose RCC framed structure with the various load Dead load ,live load ,wind load in both building in another building I choose along with all load solar panel load which I consider it in live load along with the solar panel .Little difference come in BIPV building which affect cost of building ,Shear force and banding moment of building.

III. DESIGN METHODOLOGY

I have Design two building of 10 story building one building I have design without BIPV system building and another building I have design with BIPV building. Without BIPV building that is normal building with no extra advancement in which every material and every load calculation is the like as normally 2nd building .in this building.I have considered all load and the parameter from according to the design and parameters from the IS code .I have selected structural building for analysis is the Delhi region in the wind speed is the 47m/s. In the without BIPV system building I have assigned wind speed in X-Z direction in both building. Building design of both building is similar and there is little difference in the design of BIPV system building there is live load, Dead load and wind load. I have considered as it is, I have also considered Live load, dead load,wind load in the without BIPV system of building but in the BIPV system. I have implemented extra load of the solar panel in whole building. It work like the envelope abruptly there is some external load for the envelop of the BIPV System. I have assigned all load on the building after that analyzed building with the zero error report .Found that load and support were ok and no any issue in the structure .After analyzing of the structure. I have made design of Beam, column of the building as well as slab of the building in which I have find out the quantity of the concrete and the quantity of the steel. I have find out the concrete and steel quantity separately and found the quantity of both the building is the different in the without BIPV system of building. I have found that that 7 m³ concrete have increase and in the without BIPV system of building quantity of steel is 6 ton of the steel have increased in the BIPV –system building there is the need of the extra strength is required .So for the strength of the building there is the need of the extra steel which occupied the space and volume of the column so that why the quantity of concrete is more in the BIPV system building but in the BIPV system of building there is need of more strength required and in the BIPV system of building but in the BIPV system of building there is need of more strength required and in the BIPV system there is the need of the more steel.

IV. DESIGN OF THE NORMAL BUILDING

Normal building :- I have took G+9 means 10 story building with floor height 3m and the height of the building 31.5 m width is 18 m and the length 21m with the different types of the load wind load, Live load ,dead load etc. For the wind load I have considered Delhi zone this zone have the wind speed in 47 m/sec of the Delhi region in which I have considered the different load with the different parameter. Various load I will assign. All the building details I have mention in the below table. After taking all the building data, I have mention details of size of the beam,column and Slab thickness.

Table 1: Building Data Details

Sr.no	Parameter	Design value
1	Number of stories	10 (G+9)
2	Floor height	3m
3	Material concrete	M 30
4	Reinforcement	Fe -500
5	Depth of slab	125 mm thick
6	Specific weight of RCC	25 kN/m ³ .
7	Wind direction	X and Z
8	Wind load	As Per IS: 875-2000 (Part-3)



CALCULATION OF LIVE LOAD AND DEAD LOAD

DEAD LOAD

i) Weight of wall

$$F = mg \text{ where } F = \text{force, } M = \text{mass, } G = \text{gravity}$$

$$\text{Dimension of wall} = 0.25 \times 3 \times 3$$

$$M_{\text{ass}} = 0.25 \times 3 \times 3 \times 2000 = 4500 \text{ kg}$$

$$\text{Force} = 4500 \times 10 = 45000 \text{ N} = 45 \text{ KN}$$

$$\text{Force per kilo newton} = 45/3$$

$$= 15 \text{ kN/m}^2$$

Now, Thickness of mortar = 15mm

$$\text{weight of mortar} = 0.015 \times 3 \times 3 = 2000 \times 0.135 = 270 \text{ kg}$$

$$\text{Force} = mg = 270 \times 10 = 2700 \text{ N} = 2.7 \text{ KN}$$

$$\text{Force per meter square} = 2.7/3$$

$$= 0.9 = 1 \text{ kn/m}$$

Now, the total unit weight of the wall is = 15+1 = 16 Kn/m

Total unit weight of wall with factor of safety = 1.5 x 16 = 24 Kn/m

ii) Self weight I consider 1 according to the code

So,

self weight is = -1

iii) Design of weight of slab with tile ,

$$\text{Dimension of slab} = 0.125 \times 3 \times 3$$

$$\text{Weight of slab} = \text{Mass} \times \text{gravity}$$

$$\text{mass of concrete} = 2400 \times 1.125$$

$$\text{weight of slab} = 2700 \times 10 = 27000 = 27 \text{ kn}$$

$$\text{weight of slab per meter square} = 27/9 = 3 \text{ kn/m}^2$$

Calculate Wind Force or Design wind force

$$V_z = V_b k_1 k_2 k_3 k_4$$

V_z = Design wind speed at any height Z in m/sec

K1 = Probability factor (risk Coefficient)

K2 = Terrain roughness and height factor

K3 = Topography Factor

K4 = Importance Factor for the cyclonic region

$$P_z = 0.6 V_z^2$$

P_z = Wind Speed

V_z = Design wind speed

Analysis of structural building

I have considered two building 10 storey (G+9) building 1st is without the BIPV system and 2nd is with BIPV building system both the building is same but load is different.

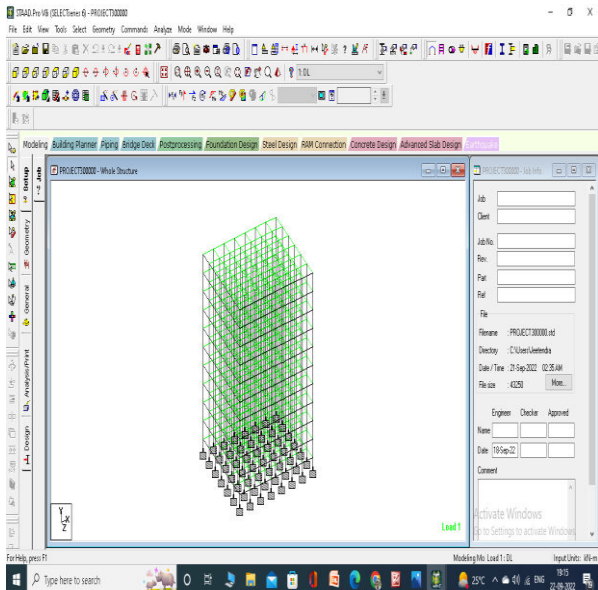


Fig. 1: Isometric view of structural building

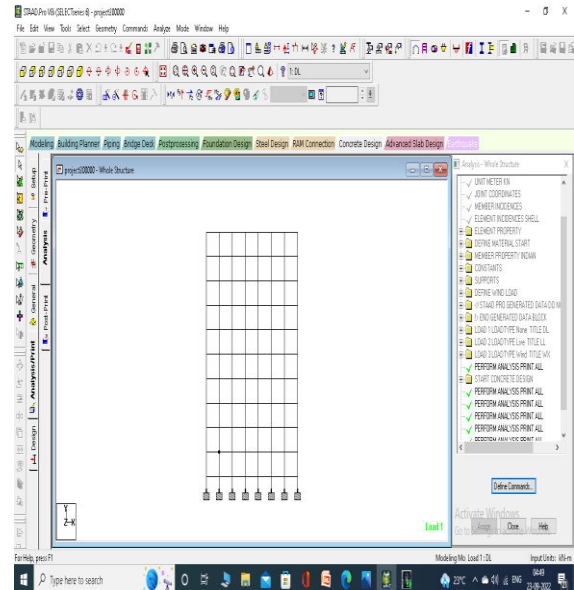


Fig. 2: Front view of structural building

Structural Building without BIPV system

According to the load calculation I have considered various load on the structure in every building. In 1st building I haven't considered BIPV system load (solar panel load). So I'm explaining 1st building in which I considered Live load, Dead load and wind load. In dead load I have implemented self-weight of structure and uniform load of the wall comes on the beam KN/m on the all beam with Safety of the factor which will be very safe. After that I considered floor load which is the permanent load of the motor and tiles KN/m². It was all the dead load which I have implemented on the structure. Dead load I consider after the wind load considering means 1st I considered wind load after that I considered dead load, wind load I will explain it in the last. After the dead load I have considered Live load. So in the live load I implement different types of load that 1st is floor and it implemented different types of load that 1st is floor and it implemented from ground floor to the 10th floor after that I implemented load on the floor due to the human moment that is the plate load pressure on full load. After implementing dead load and live load I implement wind load in x-direction and in z-direction according to the IS code wind load can be act in one direction either x direction or z-direction or in both direction x-z direction which is the corner of the building and vice versa. In the last in first step I made some definition in wind which was the first step. It was the very important for the wind force and so I made wind definition according to the IS code IS 875 (part-3) I choose Delhi region which comes in the 3rd region of wind zone and the speed is 47 m/sec. According to the common data of 2010 then I put main building data height is 31.5m, length is 21m and width is 18m after that I design building design pressure from wind load that is in windward direction next to it I took exposure factor 1 and analyse structure with the zero error which is in Figure 4.

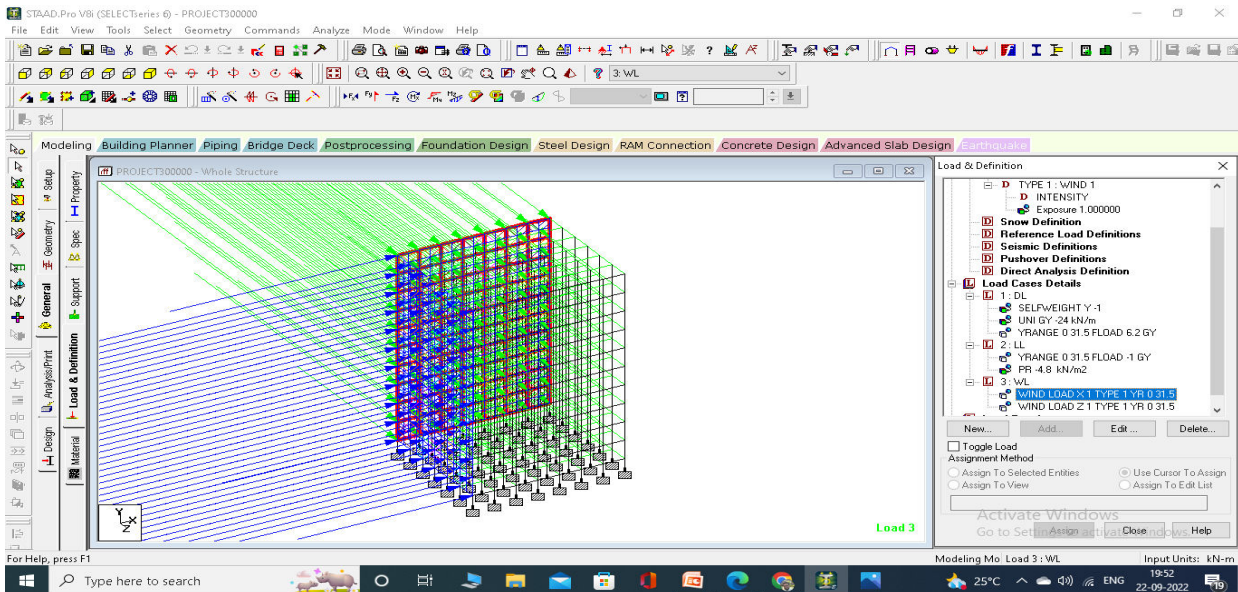


Fig. 3: Effect of wind force and all load on building.

After the analysing of structure I found shear force of the structure, bending moment, deflection etc then I design the structural building and found the quantity of the steel and concrete from this I find out every details of the each members of beam and column of building, shear bending, deflection etc, along with this structural is pass and each member of structure have passed and ok in above figure.

Structural building with BIPV system

In same manner in 2nd building I considered same load and all parameters only one load which increased that is the load of solar panel. I have considered it in live load because it change in every 25 years it comes around 0.5 KN/m² but I took 1 kN/m on the outer beam of the all sides of the building in this I also considered external load of the steel screw etc, for the installation of the building. This building calculation.

Load calculation of solar panel

size of solar panel = 196 x 99 x 3.5 cm

Wight = 5 kg (390 watt)

total surface area of building is = 2457 m²

total surface area of solar panel = 1.93 x 0.99 = 1.9107

total number of solar panel in whole building = 1286 nos

Now, the total weight of solar panel = 1286 x 5
 = 6430 kg = 64300N
 = 64.43 = 0.027 kn / m²

load with factor safety = 0.04

This load is negligible so I consider 1 kn/m² for solar panel with

Other steel which required for installation of solar panel

Hence total electric produce by solar panel = 350 x 1286

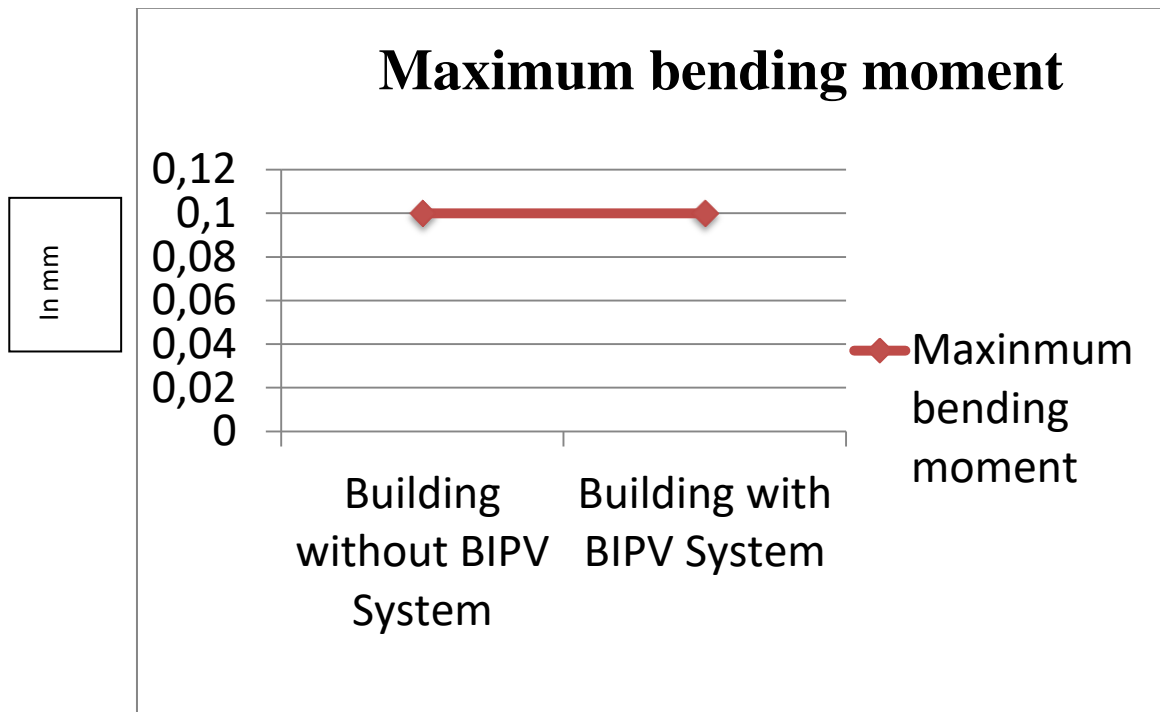
= 450 kilowatt

After the calculation of solar panel electric it produce 450.1 kilowatt of electricity from all face of the building. It is inspected in the same time only in two side of the building can receive the sunlight in the one time there is 225.05 kilowatt electric can be produce from the solar panel which is the sufficient for the utility of the building. So finally after implement of all load in BIPV building system. I analyse building and found 0 error after that I found little more deflection, bending moment, shear force etc. After that I design slab, beam, column and found proper quality of the steel and concrete.

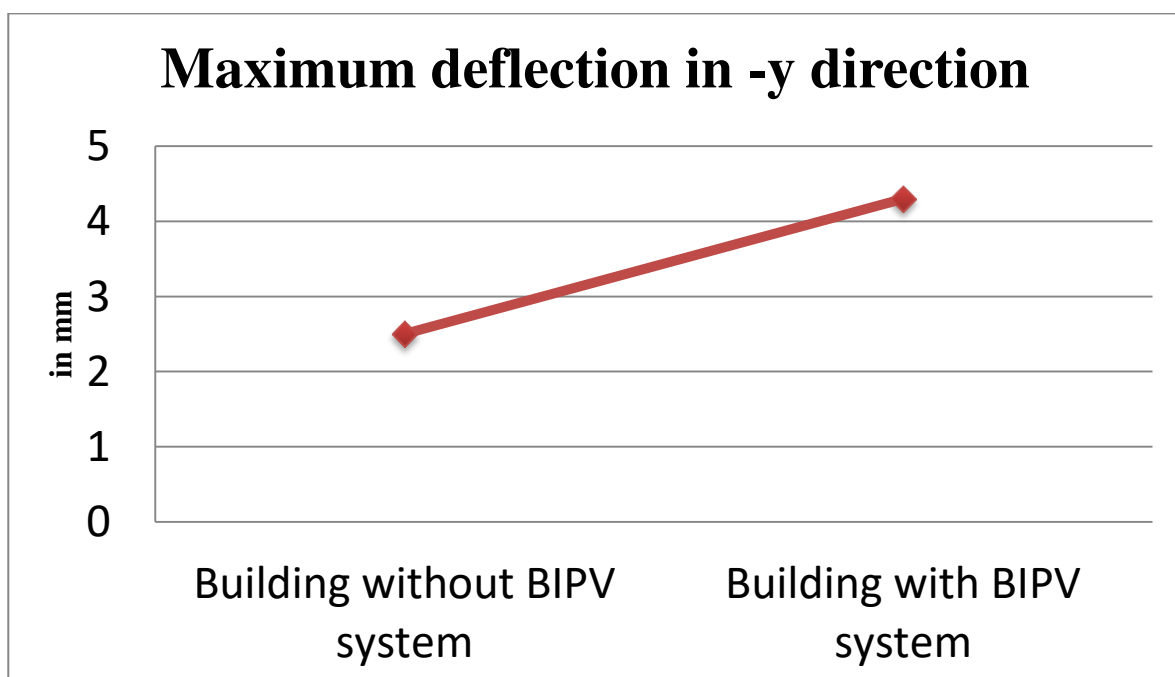


After analysing the structure with BIPV system building here is little difference in live load variation as compare to the previous building and little difference id deflection in beam ,banding moment of beam and shear force of beam which we will know from below figure .

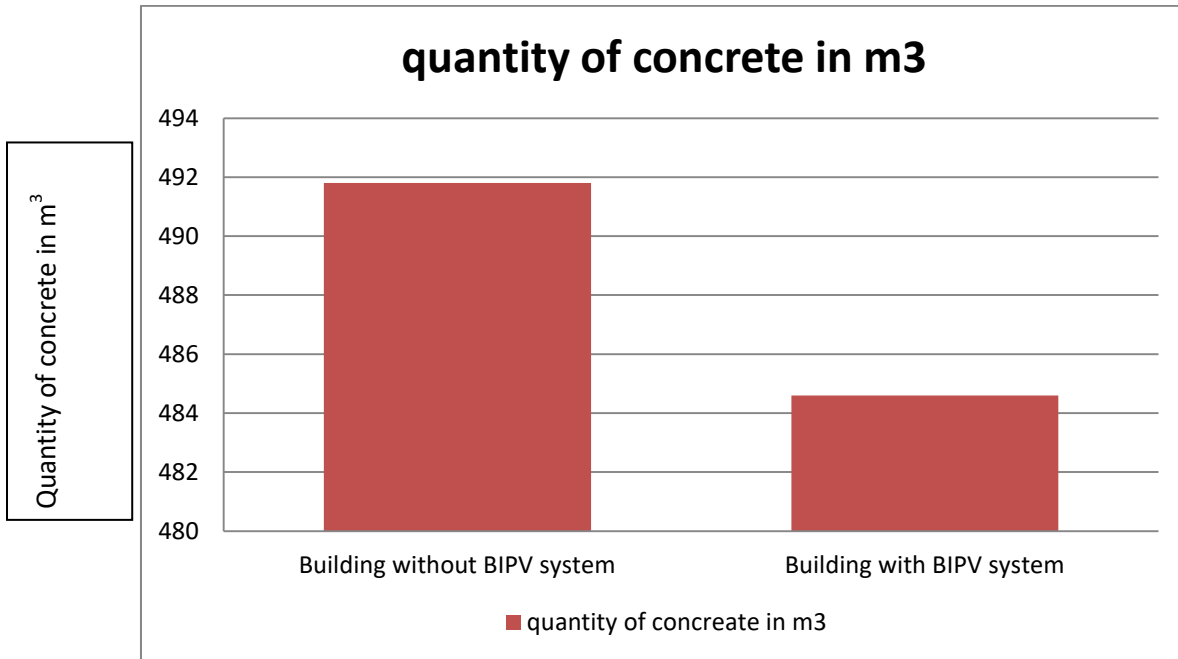
V. RESULTS



Graph-1

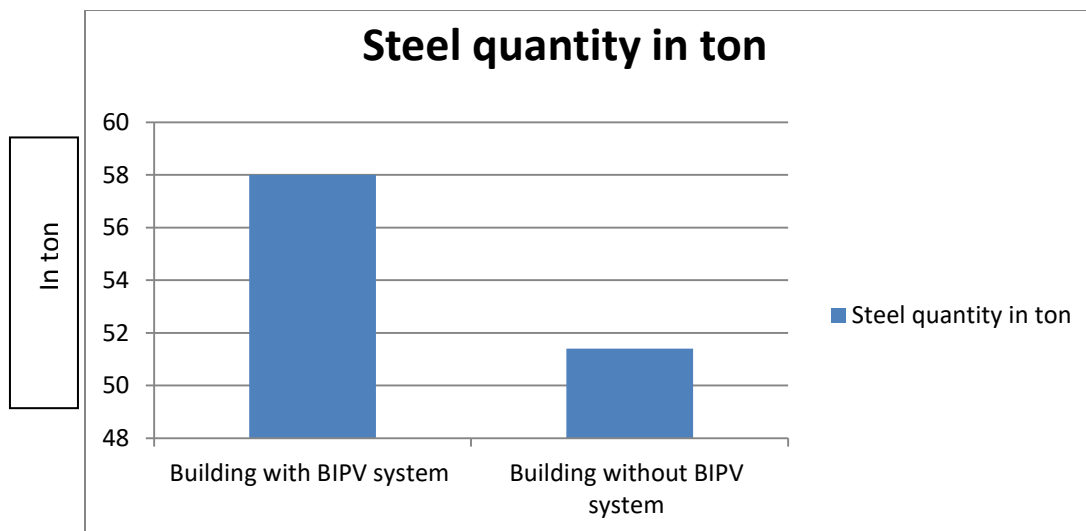


Graph -2



Graph – 3: Concrete quantity

Quantity of steel in the below graph have shown in below,



Graph-6 Quantity of steel

VI. CONCLUSION

After the analysis of both structural building we come on the conclusion

1. There is 4.1mm difference in deflection and there is 00 difference in bending moment
2. In the quantity of steel and concrete there is little difference in building in BIPV building there is 6.5ton steel is required and in without BIPV system building there is 7cum concrete is required
3. Over all very less difference in building both are the stable structure and almost strength and deflection is equal there is little more cost is required in BIPV building and the deflection and bending moment is almost same



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SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



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