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Comparative Study of Arch Roof Truss and Flat Roof Truss for Aircraft Hangar of Boeing 737

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ABSTRACT

This research attempts to perform a comparative study to identify better choice between the arch or flat roof truss for aircraft hangar. As growing trend of air buses, this research focuses to design and analyze the aircraft hangar for Boeing 737. The aircraft hangar with dimension 36 X 32 X 12 meters is considered for particular study Three model for both Arch and flat roof truss with varying depth of 2-meter, 4 meter and 6 meters are modelled in STAAD pro and analysis is performed. The final results conclude that arch roof truss is most suitable for over flat roof truss as arch roof truss gives very less value for deflection and fewer more steel as compare to flat roof truss. Hence arch roof truss is best suitable for construction of aircraft hangar because it gives less deflection.

INTRODUCTION

Airlines all over the world have been inducting larger and larger sizes of aircraft on a regular basis in recent years to meet the ever-increasing demands of air traffic. The provision of matching ground services frequently necessitates significant investment, the majority of which is accounted for the cost of long-span hangers. As a result, much thought has recently been given to make them more functionally efficient and cost-effective by -

(a) Arriving at dimensions that optimize the use of the area and volume required for servicing a specific aircraft.

(b) Choosing efficient structural forms to roof them, such as space frames, and optimizing these to minimize weight.

This review paper investigates the planning configuration which optimizes the area and volume requirement and secondly about the structural papers.

Boeing

Boeing	707	727	**737**	767
Length	46.61	46.69	**33.40**	8.51
Span	44.41	32.92	**28.88**	47.57
Height	12.93	10.36	**11.31**	15.85

Table 1 Boeing size chart for hangers

METHODOLOGY

(1) Abstracting the dimension from table -1, for Airbus
(2) Modelling the above-mentioned truss in STAAD pro.
(3) Performing analysis and comparing.

Model – 1	**Truss with 2-meter depth**
Model – 2	**Truss with 4-meter depth**
Model – 3	**Truss with 6-meter depth**

Table 2 General modal details

Design parameter –

Site location	Indore (M.P.)
Aircraft hangar for	Boeing 737
Maximum Dimension for single bay	Length = 36, Width = 32 , Height = 12 (meters)
Seismic Zone	II
Design Code	IS – 800, IS – 875, SP – 23 , SP – 38, IS - 1893
Load	Dead Load, Live load, wind load, seismic load
Type of structure	Steel (Tubular)

Table 3 Design Parameter

Design loads considerations

The following are the loads that have been taken into considerations.

Material used –

Material	GC Sheet
Weight per square meter	6.28 Kg
Gauge	19G (1 mm)

Table 4 Roof material details

1) Self-weight / Dead load calculations:

Dead load has been considered with density 6.28 Kg/m3

D.L = 36 X 1 X 6.28 (Kg)
= 226.08 Kg
= 2260.8 N
= 2.26 KN (acting at each load)

2) Live Load:

L.L. = 1 KN/m2 (As per IS 875 part - 2)
for 1-meter square area, load comes out to be 1 KN.

Hence,

Live load on roof has been considered as 1 KN (acting at each node)

3) Wind loads is calculated in STAAD pro with following parameters –
Location – Indore
Basic wind speed - 47 m/s

K1 = 1.07
K2 = 0.97
K3 = 1
K4 = 1

Design wind speed (Vz) = Vb X K1 X K2 X K3 X K4
= 47 X 1.07 X 0.97 X 1 X 1
= 48.8 m/s

Wind pressure (pz) = 0.6Vz^2 = 1.5 KN/m2

4) Auto Load combination in STAAD pro is considered as per IS 800

Table 2 Partial safety factors for loads for limit states

Combination	Limit State of Strength					Limit State of Serviceability			
	DL	LL[1]		WL/EL	AL	DL	LL[1]		WL/EL
		Leading	Accompanying				Leading	Accompanying	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
DL+LL+CL	1.5	1.5	1.05	—	—	1.0	1.0	1.0	—
DL+LL+CL+	1.2	1.2	1.05	0.6	—	1.0	0.8	0.8	0.8
WL/EL	1.2	1.2	0.53	1.2					
DL+WL/EL	1.5 (0.9)[2]	—	—	1.5	—	1.0	—	—	1.0
DL+ER	1.2 (0.9)[2]	1.2	—	—	—	—	—	—	—
DL+LL+AL	1.0	0.35	0.35	—	1.0	—	—	—	—

Figure 1 Load combination as per IS 800

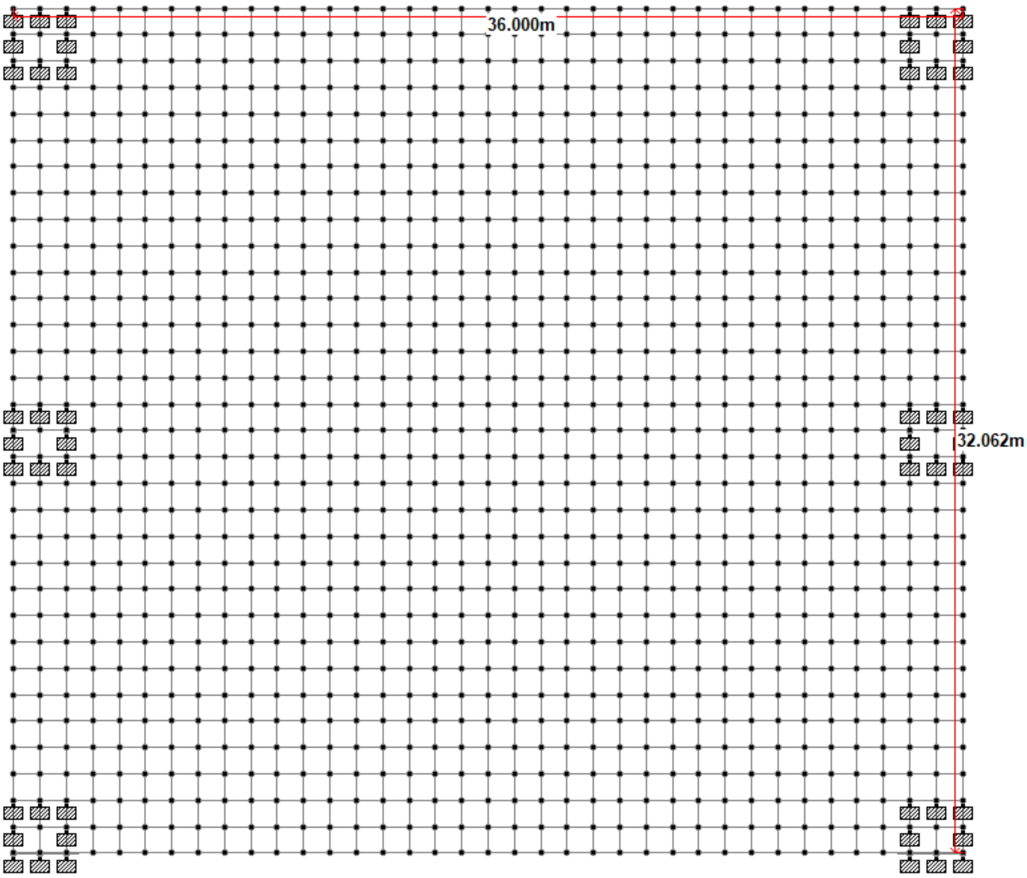

Figure 2 Nodal Plan for plan roof and arch roof truss

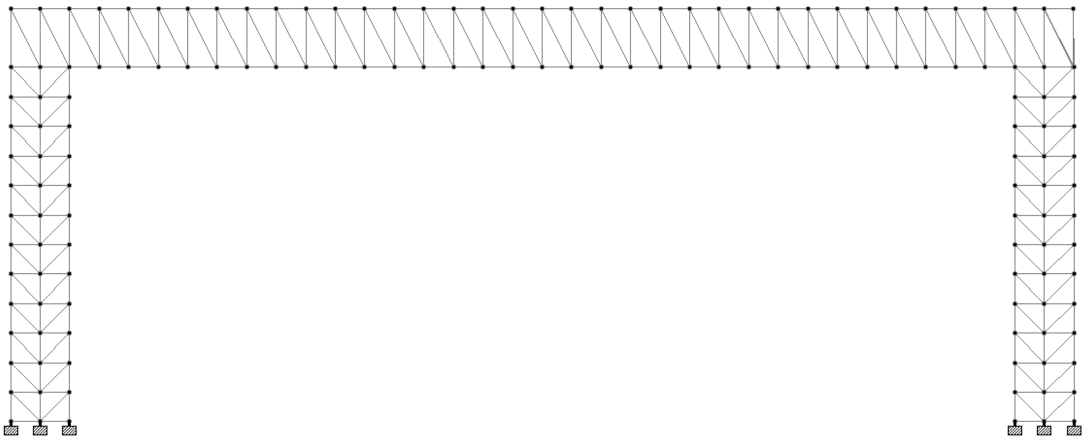

Figure 3 Flat roof truss general geometry

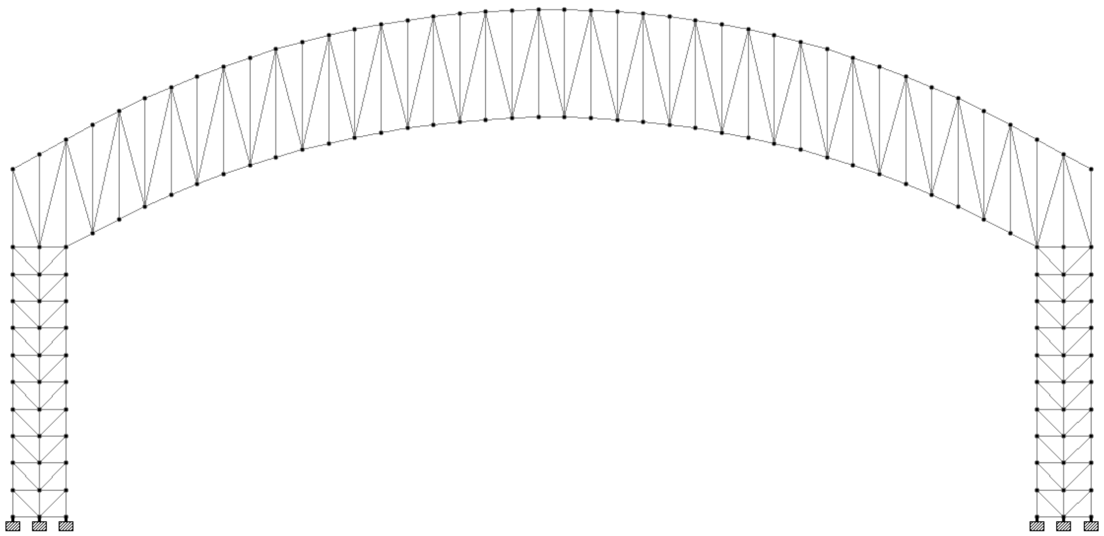

Figure 4 Arch roof truss general geometry

4.0 ANALYSIS RESULT –

The comparative study of analysis results is tabulated below -

	PLAIN TRUSS	ARCH TRUSS
	Axial force in plain roof truss (KN)	Axial force in Arch roof truss (KN)
Model 1	1141.65	1520.12
Model 2	795.585	1274.102
Model 3	799.8	1357.87

Table 5 Comparative table of Maximum Axial force

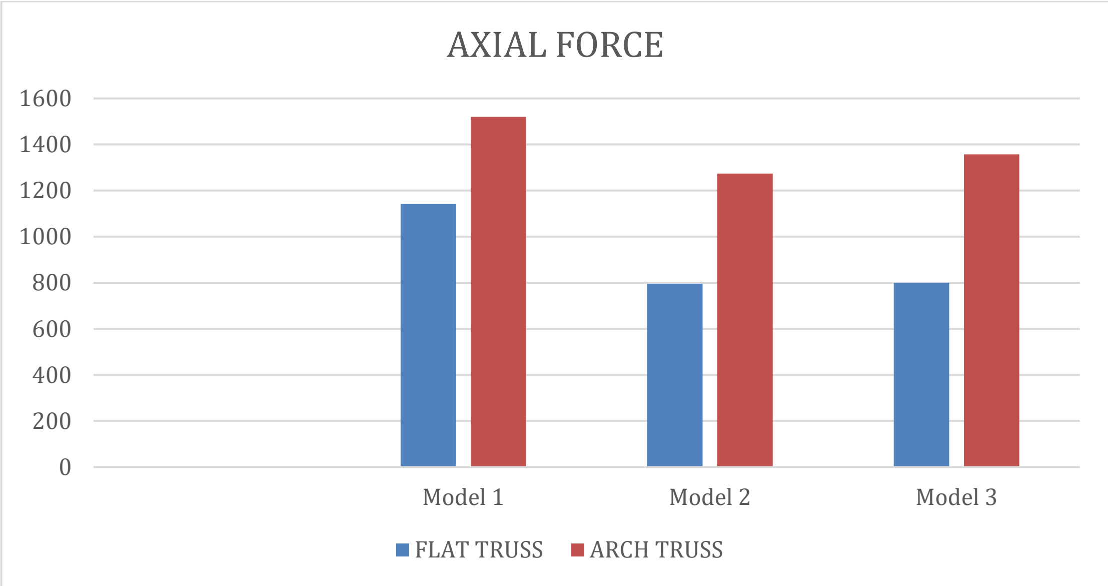

Figure 5 Comparative graph of Maximum Axial force

	PLAIN TRUSS	ARCH TRUSS
	Axial force in plain roof truss	Axial force in Arch roof truss
Model 1	55.49	9.451
Model 2	0.631	8.806
Model 3	13.568	13.318

Table 6 Comparative table of minimum axial force

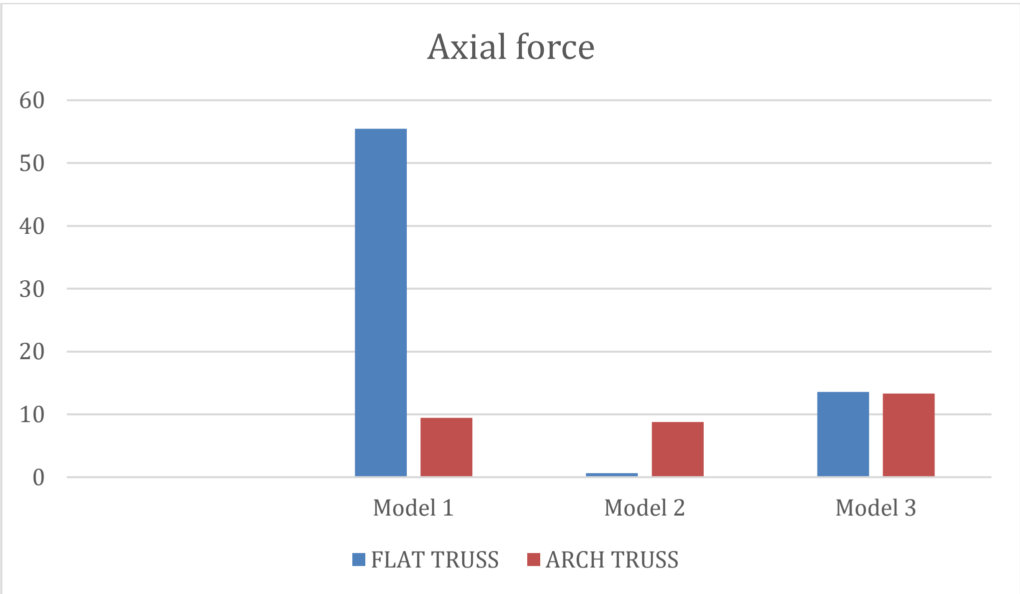

Figure 6 Comparative graph of minimum axial force

	PLAIN TRUSS	ARCH TRUSS
	Shear force in Y direction plain roof truss	Shear force in Y direction in Arch roof truss
Model 1	176.213	231.092
Model 2	134.474	230.226
Model 3	167.164	288.336

Table 7 Comparative table of Shear force in Y direction

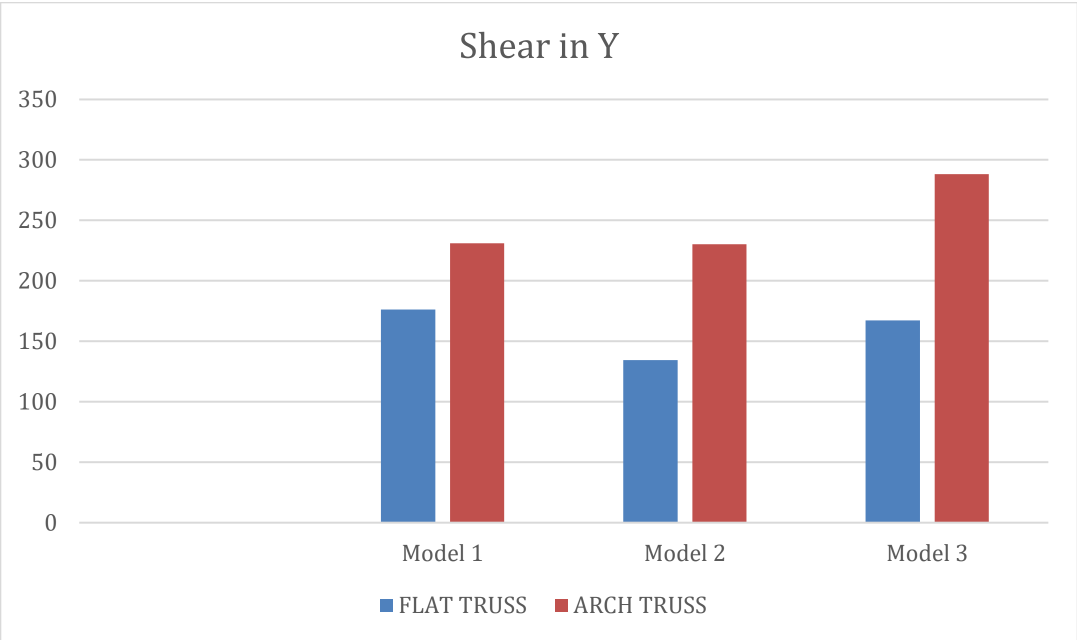

Figure 7 Comparative graph of shear force in Y direction

	PLAIN TRUSS	ARCH TRUSS
	Shear force in Z direction plain roof truss	Shear force in Z direction in Arch roof truss
Model 1	50.475	261.43
Model 2	25.728	95.232
Model 3	37.714	106.165

Table 8 Comparative table of Shear force in Z direction

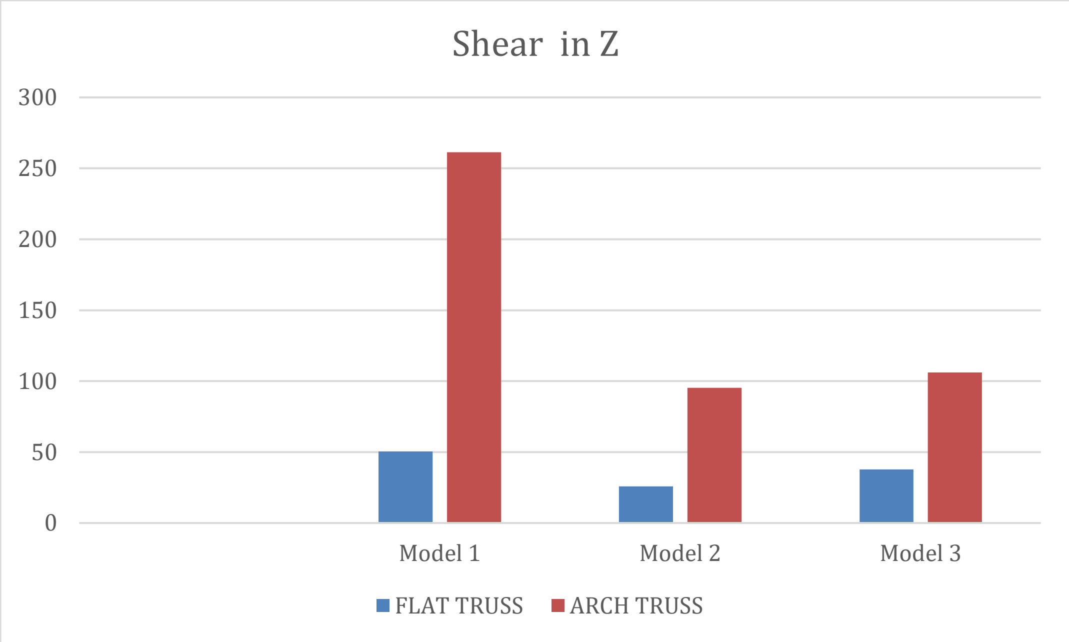

Figure 8 Comparative table of Shear force in Z direction

	PLAIN TRUSS	ARCH TRUSS
	Bending in Y direction plain roof truss	Bending in Y direction in Arch roof truss
Model 1	52.19	117.782
Model 2	32.688	116.0998
Model 3	34.641	99.59

Table 9 Comparative table of bending in Y direction

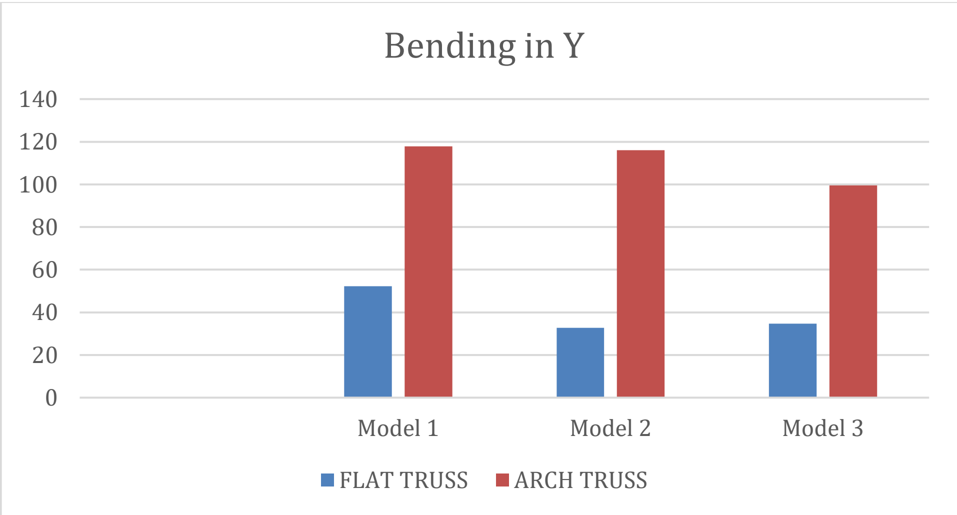

Figure 9 Comparative graph of bending in Y direction

	PLAIN TRUSS	ARCH TRUSS
	Bending in Z direction plain roof truss	Bending in Z direction in Arch roof truss
Model 1	101.88	164.699
Model 2	83.375	151.427
Model 3	109.29	199.107

Table 10 Comparative table of bending in Z direction

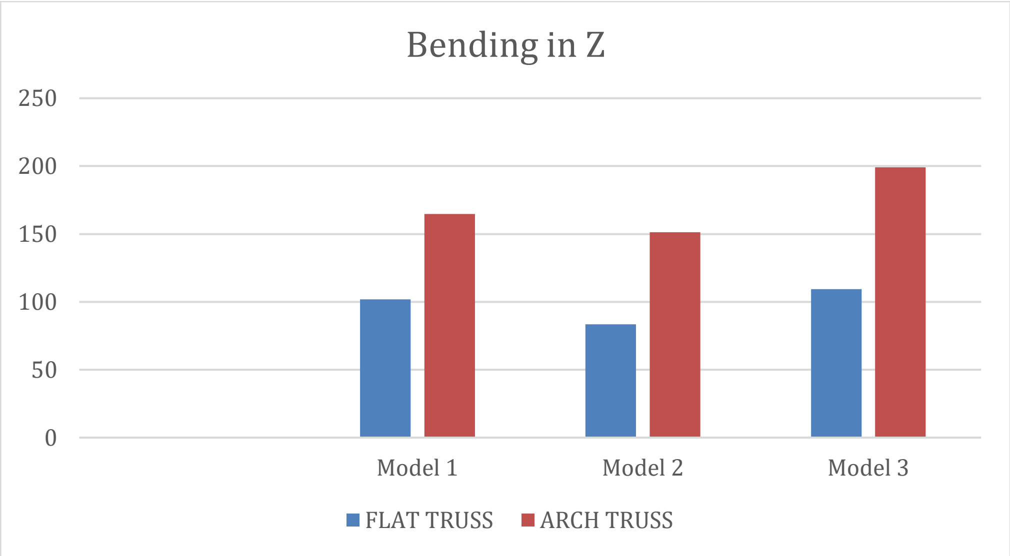

Figure 10 Comparative graph of bending in Z direction

	PLAIN TRUSS	ARCH TRUSS
	Torsion in plain roof truss	Torsion in Arch roof truss
Model 1	7.298	19.512
Model 2	4.502	41.577
Model 3	6.954	63.96

Table 11 Comparative table of torsion

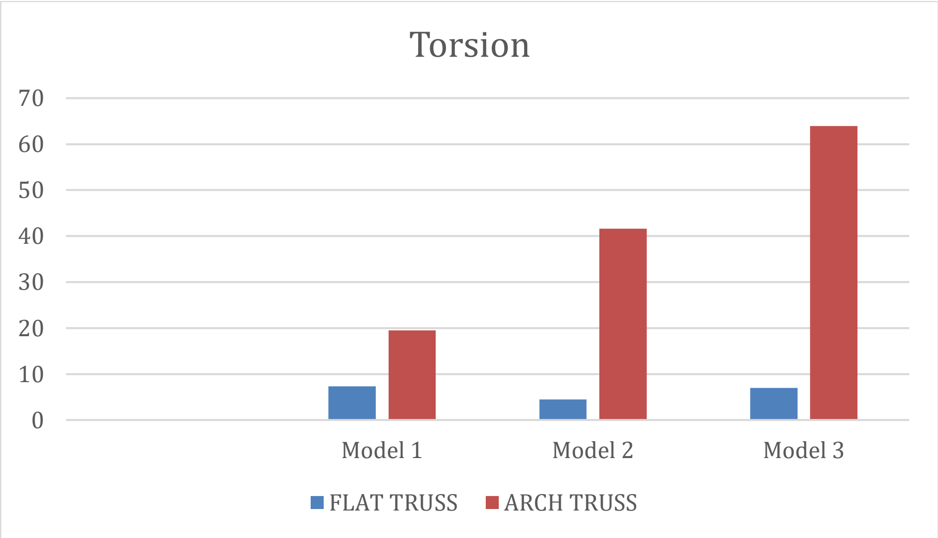

Figure 11 Comparative table of torsion

	Axial force	Shear force in Y direction	Shear force in Z direction	Bending in Y direction	Bending in Z direction	Torsion	Max deflection	Steel take off(KN)
Flat roof 2 m	1141.65	176.213	50.47	52.19	101.8	7.29	93.37	2842.89
Flat roof 4 m	795.585	134.47	25.728	32.68	83.37	4.5	95.3	3092.048
Flat roof 6 m	799.8	167.15	37.714	34.64	109.29	6.95	95.98	4017.112
Arch roof 2 m	1520.12	231.09	261.43	117.78	164.69	19.51	101.636	3724.72
Arch roof 4 m	1274.102	230.22	95.232	116.09	151.4	41.57	86.774	5131.6
Arch roof 6 m	1357.87	288.336	106.164	99.5	199.1	63.96	82.039	6973.3

Table 12 Combined table for all parameters

CONCLUSION

Analysis and design in this study yielded the following conclusions –

(1) The arch roof truss gives less deflection and better performance as compare to flat roof truss.

(2) The structural member of arch roof has higher value of forces as compare to flat roof, this may be due to the extra force due bending action or arch thrust.

(3) The increase in depth of truss induces the buckling phenomenon in vertical member hence this may be a reason that increasing the depth of truss results in increases the size of member.

(4) In this experiment arch roof truss is better than flat roof truss

(5) From this we can conclude that arch roof is suitable for large roof truss as compare to flat roof truss.

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