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Comparative study of Inverted "V" and "V" type RCC Braced and Steel Braced RCC Frame Structure

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Abstract—Due to the present increase in world population, people in this world tend to occupy available locations present in any zone which also include zones falling in the high seismic zone categories. The buildings constructed in such zones must be analysed and designed to withstand these earthquakes, along with the cost economy. Bracing systems is very efficient and unyielding lateral load resisting system. Bracing systems serves as one of the component in buildings for increasing stiffness and strength to guard buildings from incidence caused by natural forces like earthquake. Braced frames widen their resistance to lateral forces by the bracing action of inclined members. The braces stimulate forces in the associated beams and columns so that all works like a truss which results in smaller sizes of beam and column sections that turns out to be economical. In this study, G+14 storey building model has been analysed considering "Inverted V" and "V" type RCC bracing system and steel bracing system under seismic loadings using STADD PRO for analysis. Results are concluded by comparison of storey displacement, storey drift and base shear for fixed base building

Keywords— Economization, Inverted V" and "V" Bracing; Earthquake resisting structure; Braced Structure; RCC Bracing; steel bracing

I. INTRODUCTION

A building must have a complete structural system capable of carrying all gravity loads to its foundation in life span of building. An ideal multi-story building which is designed to resist lateral loads due to earthquake would be symmetric in distribution of mass and stiffness in plan at every story and as well as along the height of the building. In order to make multi-story structures stronger and stiffer, which are more susceptible to earthquake and wind forces, the cross sections of the member increases from bottom to top this makes the structure uneconomical owing to safety of structure.

Bracing is a highly efficient and economical method of resisting lateral forces, which stimulate forces in the associated beams and columns so that all work as one like a truss with all members subjected to stresses that ultimately results for minimum member sizes in providing stiffness and strength. Usually in all tall structure bracing system is preferable as it can be used for retrofitting to give maximum strength.

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II ANALYSIS OF RCC BRACED AND BARE FRAME STRUCTURE

2.1 Geometrical Data

No. Of bay in X – dir.:6,	Bottom Storey Height: 3.0 m,
No. Of bay in Y – dir.: 3,	Height of structure: 45 m,
Plan Dimension: 30 m x 15 m,	Number of storey: G +14,
Typical Storey Height: 3.0 m,	Type of Building: Residential building,
Grade of concrete :M25	Fe :415 ,Steel tube =240 X120 X 8mm

2.2 Loading Data :

2.2.1 Dead Load :

a. Self weight of Slab = 4.75 kN/m^2

b. Floor Finish load = 1 kN/m^2

c. Wall Load in X -Z direction= 11.75 kN/m

2.2.2 Live Load: 2 kN/m^2

2.2.3 Earthquake load in X direction and Y direction

Zone factor: IV, Importance factor: 1, Response reduction factor: 5

2.2.4 Wind Load

Basic wind speed: 47 m/sec, Terrain category : II, Class : C, Risk coefficient factor : 1.0, Topography factor k3 : 1.0

2.3 Member Size Data

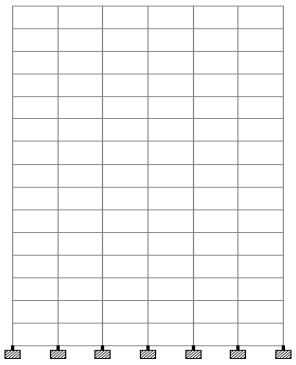
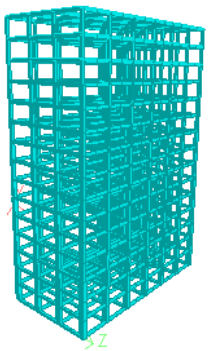
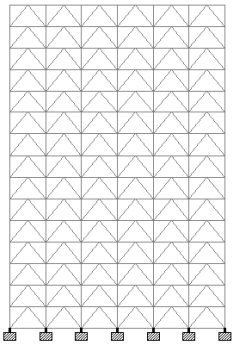
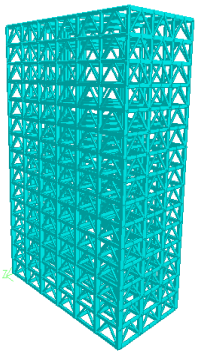
Table 1 G + 14 Story RCC Building Section Size

G + 14 Story RCC Building			
Storey	Column Size (mm)	Beam Size (mm)	Bracing Size (mm)
Story 1 to Story 3	900 X 450	300 X 450	230 X 230
Story 4 to Story 6	750 X 450	300 X 450	230 X 230
Story 7 to Story 9	600 X 450	300 X 450	230 X 230
Story 10 to Story 12	600 X 300	300 X 450	230 X 230
Story 13 to Story 15	450 X 300	300 X 450	230 X 230

II.

III. ANALYSIS OF RCC BRACED AND BARE FRAME STRUCTURE

2.3 Model Details :

Type	Front view	3D
Bare Frame		
Model I Inverted V RCC Braced **Model III Inverted V steel braced**		

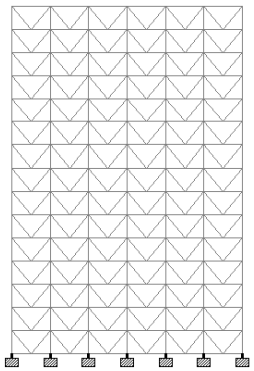
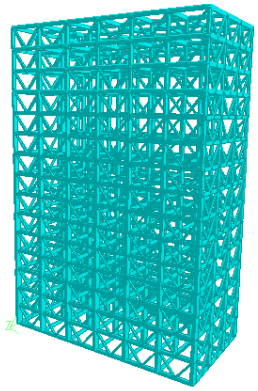
Model II V RCC Braced Model IV V steel braced		

Figure 2 Model Detailing

III. Analysis and Results

The static analysis is carried out considering wind loads and earthquake loads on structures. Wind analysis of structure is performed as per IS: 875(III) -1987 using STAAD Pro. V8i.

Here, the structure is symmetric so here we present the graphs for only one direction.

3.1. Base Shear :

Table 2: Base Shear Ratio

Base Shear Ratio					
Model of Structure	**Bare Model**	**Model I**	**Model II**	**Model III**	**Model IV**
ESA X Dir.	2520.03	2635.96	2635.96	2558.58	2558.58
ESA Y Dir.	1776.02	1857.73	1857.73	1857.83	1857.83
RSA X Dir.	2530.4	2632.47	2632.47	2559.96	2559.96

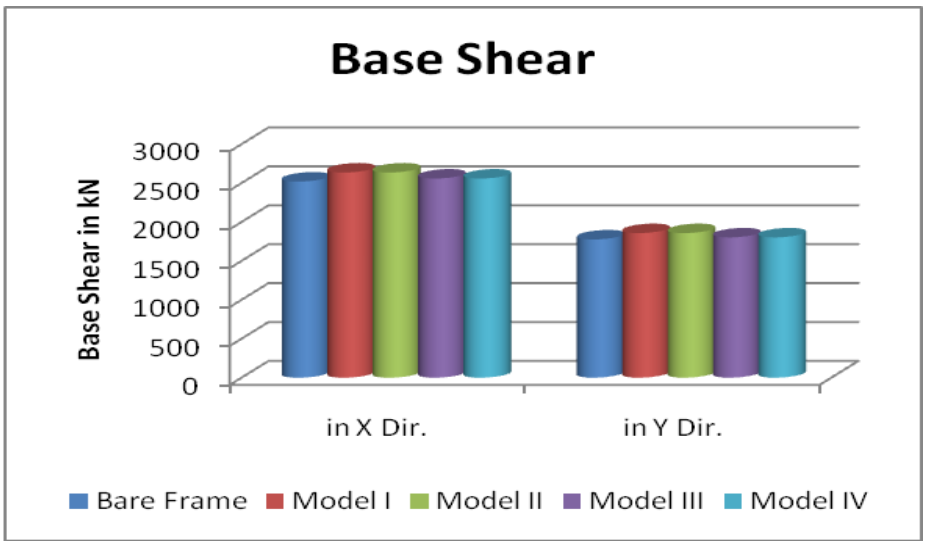


Figure 3 Base Shear

3.2. Story Displacement:

Table 3: Story Displacement in RCC Braced model

Story Displacement in RCC Braced model (mm)							
Story	Height (m)	Bare Frame		Model I		Model II	
		X Dir.	Y Dir.	X Dir.	Y Dir.	X Dir.	Y Dir.
Story 15	45	195.77	122.52	19.00	29.51	20.08	31.57
Story 14	42	190.41	118.90	18.30	28.09	19.34	30.06
Story 13	39	181.01	113.19	17.43	26.45	18.40	28.28
Story 12	36	168.00	105.48	16.39	24.56	17.29	26.24
Story 11	33	153.97	97.64	15.21	22.54	16.03	24.08
Story 10	30	137.68	88.76	13.91	20.37	14.66	21.76
Story 9	27	119.56	78.95	12.52	18.09	13.19	19.33
Story 8	24	106.15	68.97	11.11	15.78	11.72	16.88
Story 7	21	92.02	58.50	9.65	13.44	10.18	14.40
Story 6	18	77.30	47.70	8.16	11.10	8.63	11.92
Story 5	15	62.78	37.35	6.69	8.84	7.09	9.53
Story 4	12	48.02	27.16	5.22	6.65	5.57	7.19
Story 3	9	33.22	17.55	3.79	4.56	4.07	4.96
Story 2	6	19.20	9.26	2.42	2.64	2.63	2.90
Story 1	3	6.72	2.83	1.08	0.94	1.22	1.06
Base	0	0.00	0.00	0.00	0.00	0.00	0.00

Table 4 : Story Displacement in Steel Braced model

Story Displacement in Steel Braced model (mm)							
Story	Height (m)	Bare Frame		Model III		Model IV	
		X Dir.	Y Dir.	X Dir.	Y Dir.	X Dir.	Y Dir.
Story 15	45	195.77	122.52	19.05	29.80	20.13	31.39
Story 14	42	190.41	118.90	18.60	28.40	19.40	29.91
Story 13	39	181.01	113.19	18.20	27.10	18.46	28.14
Story 12	36	168.00	105.48	16.50	24.40	17.35	26.13
Story 11	33	153.97	97.64	15.60	23.41	16.09	23.98
Story 10	30	137.68	88.76	13.50	20.40	14.72	21.68
Story 9	27	119.56	78.95	12.10	19.12	13.25	19.27
Story 8	24	106.15	68.97	12.05	15.80	11.77	16.83
Story 7	21	92.02	58.50	9.86	13.50	10.24	14.36
Story 6	18	77.30	47.70	8.30	11.15	8.68	11.89
Story 5	15	62.78	37.35	3.90	8.98	7.13	9.51
Story 4	12	48.02	27.16	5.40	6.70	5.60	7.18
Story 3	9	33.22	17.55	3.60	4.60	4.09	4.95
Story 2	6	19.20	9.26	2.54	2.80	2.64	2.88
Story 1	3	6.72	2.83	1.15	0.96	1.22	1.05
Base	0	0.00	0.00	0.00	0.00	0.00	0.00

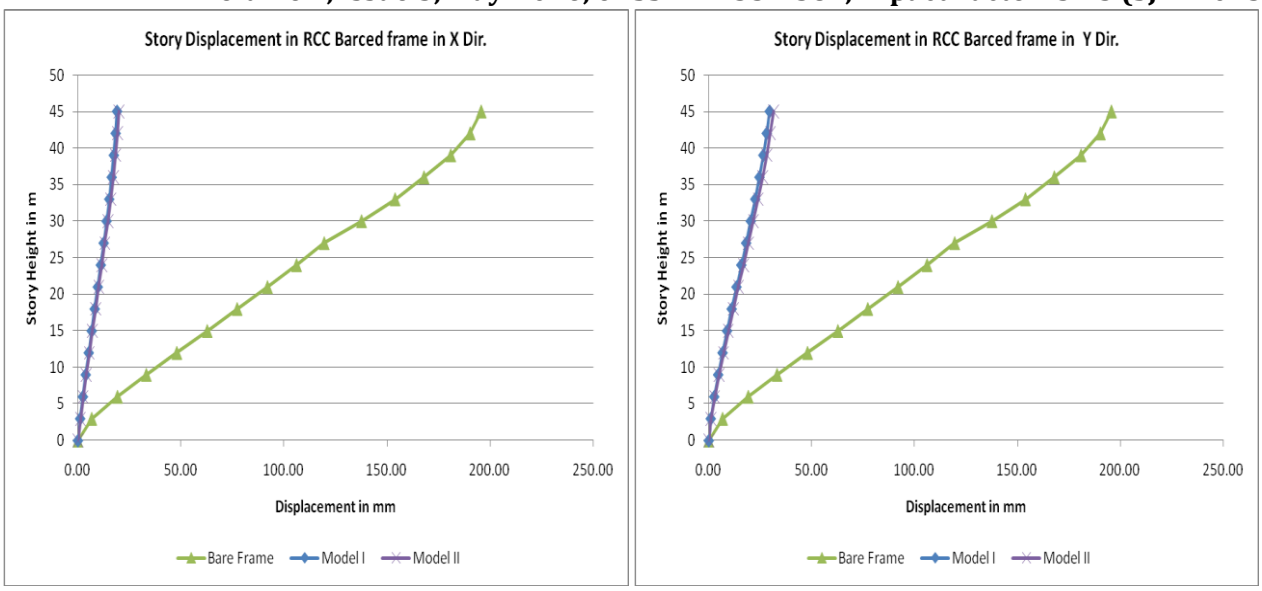


Figure 4 Story Displacement in RCC Braced model

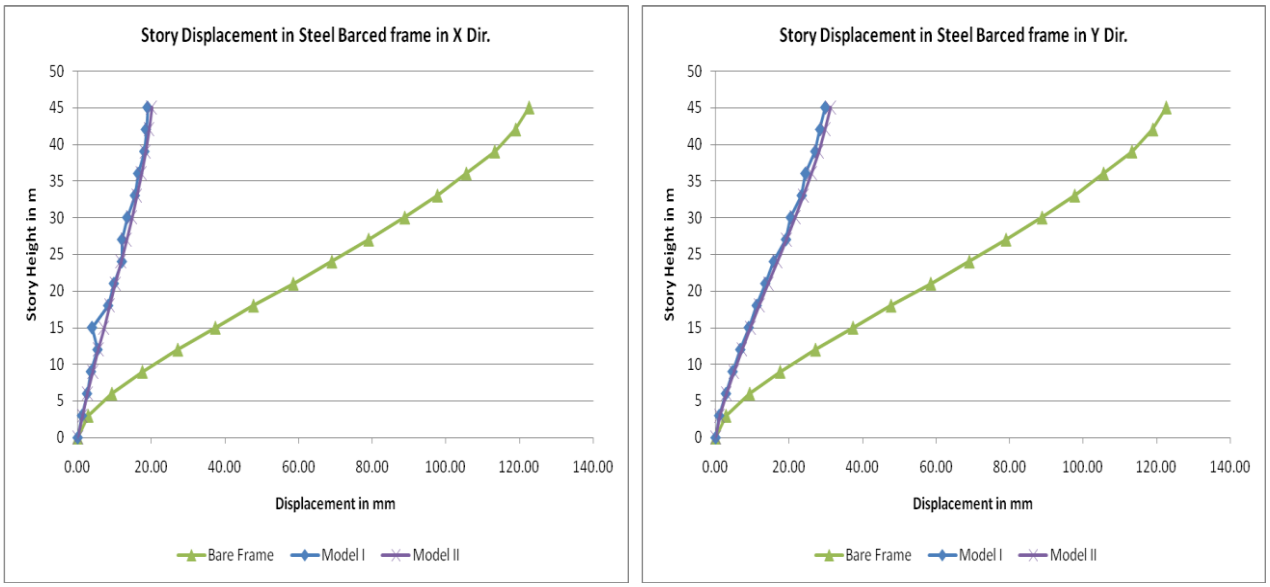


Figure 5 Story Displacement in Steel Braced model

3.3. Story Displacement:

Table 5 : Story Drift in RCC Braced model

Story Drift in RCC Braced model (mm)							
Story	Height (m)	Bare Frame		Model I		Model II	
		X Dir.	Y Dir.	X Dir.	Y Dir.	X Dir.	Y Dir.
Story 15	45	5.36	3.63	0.71	1.42	0.74	1.51
Story 14	42	9.40	5.71	0.87	1.64	0.94	1.78
Story 13	39	13.01	7.71	1.04	1.89	1.12	2.03
Story 12	36	14.03	7.84	1.18	2.02	1.25	2.17
Story 11	33	16.29	8.88	1.30	2.17	1.37	2.32
Story 10	30	15.33	9.81	1.39	2.28	1.47	2.43
Story 9	27	13.42	9.98	1.41	2.31	1.48	2.45
Story 8	24	14.12	10.47	1.46	2.34	1.53	2.48
Story 7	21	14.72	10.81	1.48	2.34	1.55	2.48

Story 6	18	14.52	10.34	1.48	2.26	1.54	2.39
Story 5	15	14.76	10.19	1.46	2.19	1.53	2.33
Story 4	12	14.81	9.61	1.43	2.09	1.50	2.23
Story 3	9	14.02	8.28	1.38	1.92	1.44	2.06
Story 2	6	12.48	6.44	1.34	1.69	1.42	1.84
Story 1	3	6.72	2.83	1.08	0.94	1.18	1.04
Base	0	0.00	0.00	0.00	0.00	0.00	0.00

Table 6: Story Drift In Steel Braced Model

Story Drift in Steel Braced model (mm)							
Story	**Height (m)**	**Bare Frame**		**Model III**		**Model IV**	
		X Dir.	**Y Dir.**	**X Dir.**	**Y Dir.**	**X Dir.**	**Y Dir.**
Story 15	45	5.36	3.63	0.73	1.45	0.73	1.49
Story 14	42	9.40	5.71	0.89	1.70	0.94	1.76
Story 13	39	13.01	7.71	1.13	1.92	1.11	2.02
Story 12	36	14.03	7.84	1.29	2.10	1.25	2.15
Story 11	33	16.29	8.88	1.31	2.21	1.37	2.30
Story 10	30	15.33	9.81	1.41	2.28	1.47	2.41
Story 9	27	13.42	9.98	1.45	2.33	1.48	2.43
Story 8	24	14.12	10.47	1.49	2.35	1.54	2.47
Story 7	21	14.72	10.81	1.48	2.40	1.56	2.47
Story 6	18	14.52	10.34	1.51	2.27	1.55	2.38
Story 5	15	14.76	10.19	1.47	2.23	1.54	2.33
Story 4	12	14.81	9.61	1.44	2.19	1.51	2.23
Story 3	9	14.02	8.28	1.45	1.95	1.45	2.06
Story 2	6	12.48	6.44	1.33	1.78	1.43	1.84
Story 1	3	6.72	2.83	1.09	0.96	1.19	1.04
Base	0	0.00	0.00	0.00	0.00	0.00	0.00

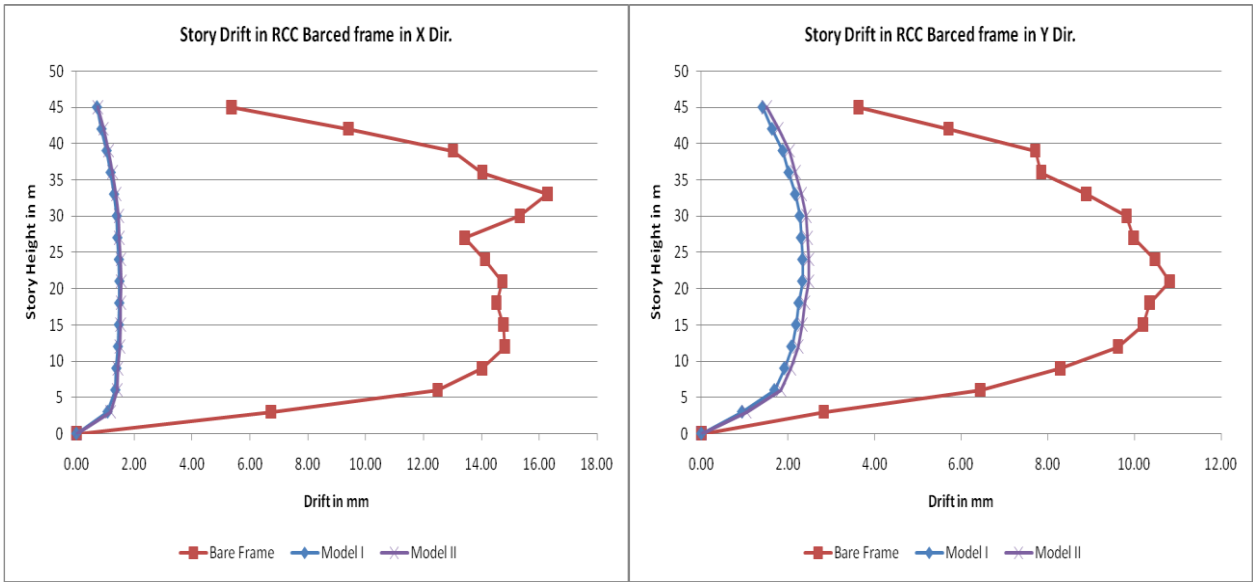


Figure 6 Story Drift in RCC Braced model

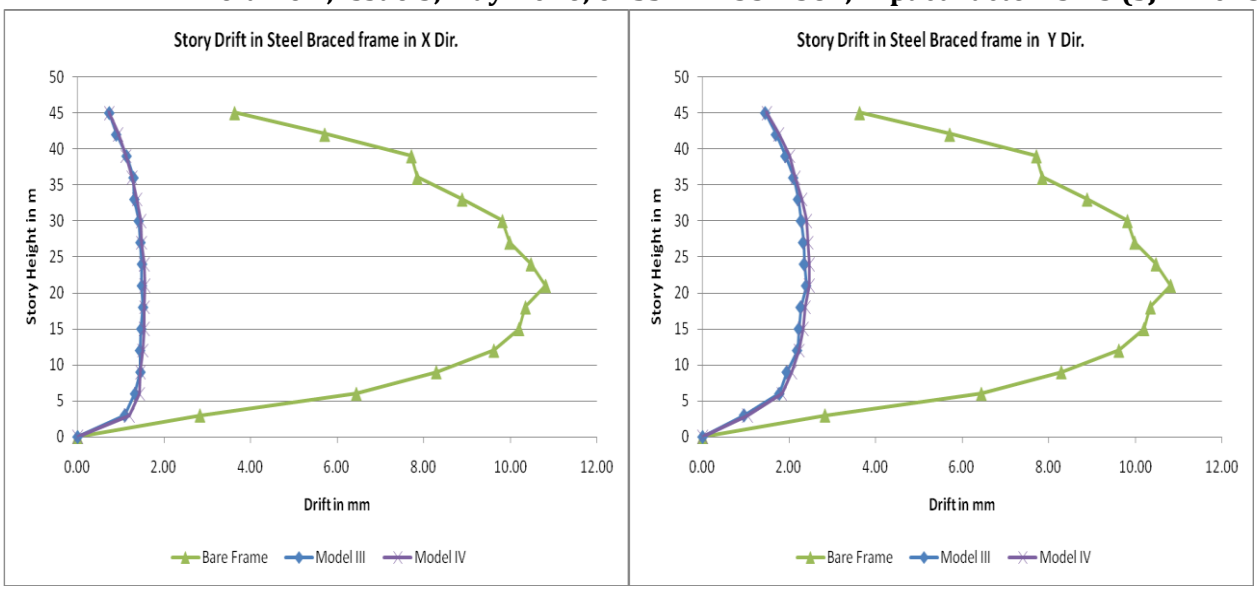


Figure 7 Story Drift in Steel Braced model

3.5. Quantity Comparison :

Quantity				
Model	**Concrete (cum)**	**Steel (kN)**	**Steel Tube (kN)**	**Total steel (KN)**
Bare Frame	806.9	1117.77	0	1117.77
Model I	931.4	886.364	0	886.364
Model II	931.2	929.928	0	929.928
Model III	819.9	730.836	864.88	1595.716
Model IV	820.5	732.738	864.88	1597.618

IV. CONCLUSIONS

After the comparing of the steel and RCC bracing for the RCC Frame with wind load, seismic load conclude that Base shear is varying with use of various materials for the same RCC frame using various RCC and Steel bracing.

By using periphery fully braced the reduction in Story Displacement and Story Drift in model I to bare frame is around 70%-80%, for braced frame model II to bare frame model 60%-70% . The quantity of material used describes the economical bracing to be used for the RCC frame.

The quantity to steel in bare to model I is 28% less, and bare to model II is 22%, whereas the quantity of steel is increased in model III and model IV 40% to bare model and about 65% in model I and model II.

It has been observed Model I to be most economical.

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