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Comparisons of the Different Bracing System with Lateral and Transverse Loading on 2D Steel Frame

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***Abstract* – This paper is for identifying the effective bracing system for different kind of loading system like lateral loading and transverse loading of the 2D steel frame. In this paper basic types of bracing are analysed with an example models and compared.**

Keywords – Bracing, Chevron, X-Cross, Inverted Chevron, Diagonal, 2D Frame, Lateral and Transverse loading

I. INTRODUCTION

Most of the times engineers are miss match the bracing type for the steel structure. This is caused due to the miss understand the behaviour of the bracing system and its type, which is used in the steel structure, some bracing are done to resist the lateral loads and some are done to resist the transverse load. Identifying the real need of bracing and providing the required bracing type for a steel structure will make the structure as efficient one. This comparative study will help engineers to choose the correct type of bracing type which will required for different loading type, like lateral and transverse.

II. BRACING

Bracing the frame in a steel structure is very important; it will resist the heavy lateral load like wind and earthquake forces. Primarily bracing is done to resist the lateral loads but also sometimes when there is heavy transverse load in steel beam; bracing is also done to resist the transverse load so that bay's length can be increased, other words column to column distance can be increased. The foremost purpose of bracing in the steel structure is to increase the ductility of the steel structure, so that the structure can stretch without breaking suddenly.

III. TYPES OF BRACING

There are many types of bracing are done for steel structures, but the mostly used types of bracings are mentioned as follows:

- Single Diagonal Bracing
- X – Cross Bracing
- Chevron Bracing
- Inverted Chevron Or "V" Bracing
- A – Chevron Bracing
- Braced Chevron Bracing
- Braced Single Bracing
- Knee Bracing
- "K" Bracing

In these type of bracing the most commonly used bracing type are first four only, so in this paper first four types are used for the comparison.

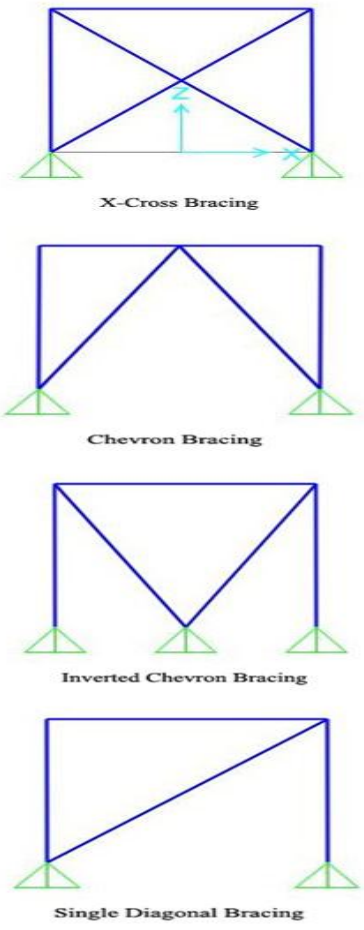

Fig.1. Types of Basic Bracing

IV. DESIGN DATA

These are the data taken account for the analysis of the 2D frame.

A. Frame Details:

- Frame Span – 3 M
- Frame Height – 3 M
- Support Condition – Pinned

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B. Material Property:

- Members Used – ISJB 150 (For Column, Beam, Bracing)
- Material Used – Steel
- Minimum Yield Stress – 250000 Kn/M^2
- Minimum Tensile Stress – 410000 Kn/M^2
- Effective Yield Stress – 275000 Kn/M^2
- Effective Tensile Stress – 451000 Kn/M^2
- Modulus of Elasticity, E -2.100E+08 Kn/M^2
- Poisson Ratio – 0.3
- Co-efficient of Thermal Expansion, A – 1.170E-05 1/C

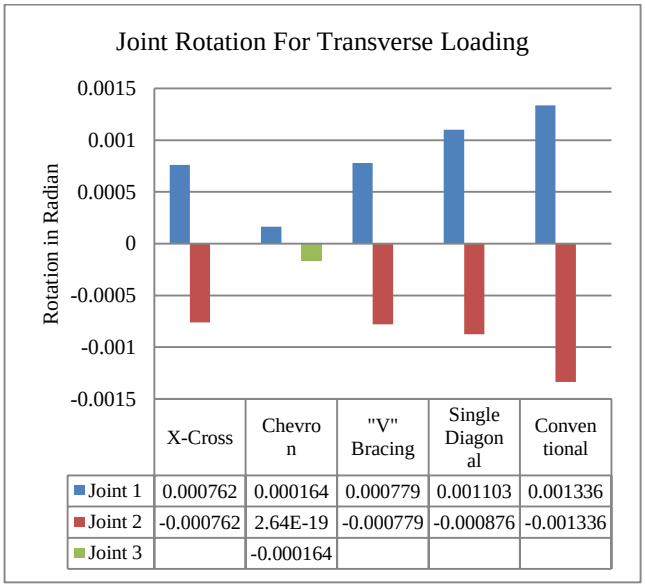
V. LOAD DETAILS:

Frames are loaded transversely and laterally as separately, with Dead load of 2KN/M of Uniformly Distributed load (UDL). Self-Weight is not considered for analysis, only dead load is considered.

All bracing are symmetrical in model, expect the single diagonal bracing. So Lateral loading is done, in single diagonal bracing, on both sides separately, so that effect way of bracing can be identified in single diagonal bracing.

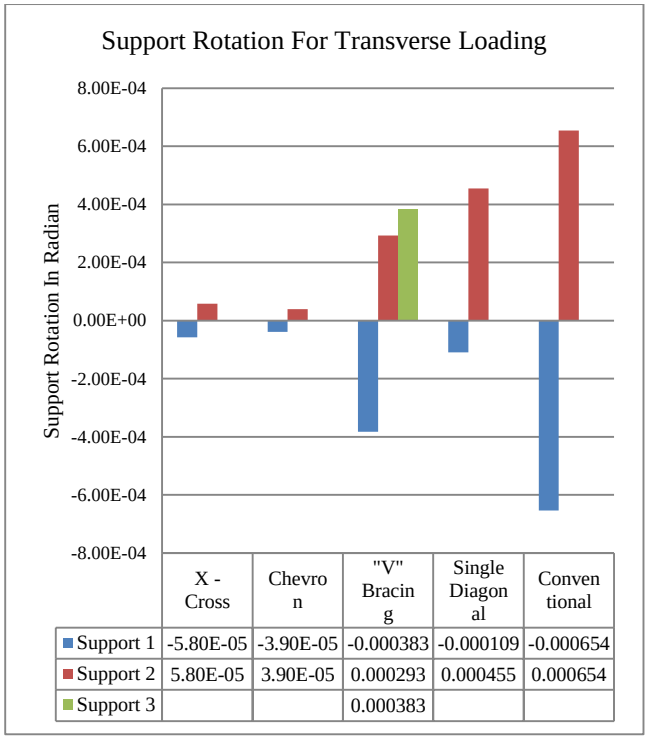
VI. COMPARISION

Comparisons have been done for various outputs for both Lateral and Transverse Loading of the frame. Compared output are Support reaction on X and Z axis of the frame, Joint Displacement on X and Z axis, Joint rotation, Support rotation, Shear force and Bending Moment of the frame which is loaded.



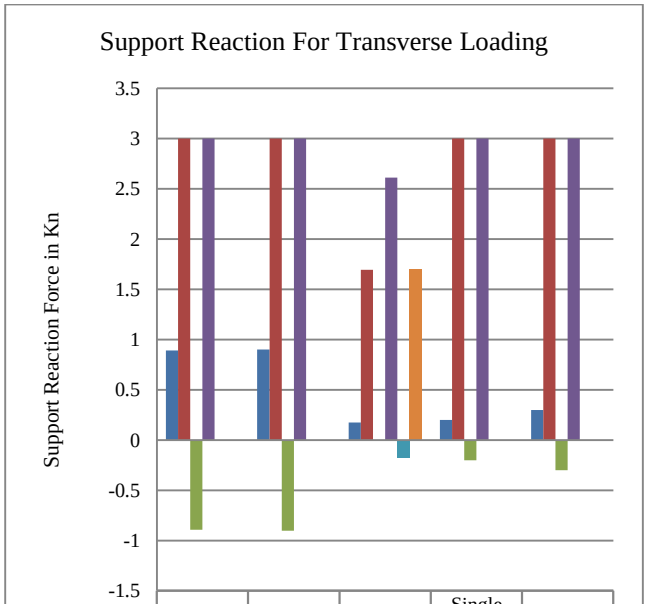
	X-Cross	Chevron	"V" Bracing	Single Diagonal	Conventional
Joint 1	0.000762	0.000164	0.000779	0.001103	0.001336
Joint 2	-0.000762	2.64E-19	-0.000779	-0.000876	-0.001336
Joint 3		-0.000164			

Table – 1 – *Joint Rotation Comparison for Transverse Loading*



	X - Cross	Chevron	"V" Bracing	Single Diagonal	Conventional
Support 1	-5.80E-05	-3.90E-05	-0.000383	-0.000109	-0.000654
Support 2	5.80E-05	3.90E-05	0.000293	0.000455	0.000654
Support 3			0.000383		

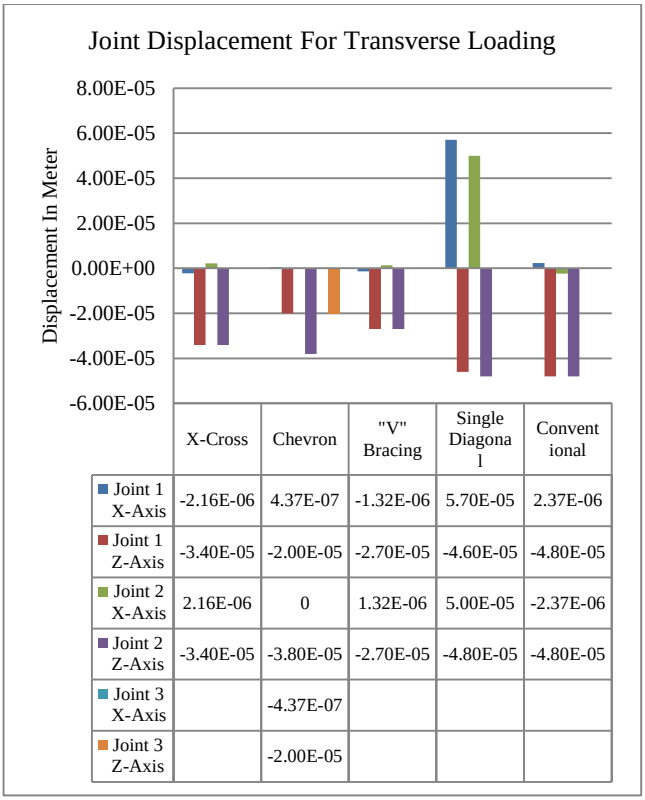
Table – 2 – Support Rotation Comparison for Transverse Loading



	X-Cross	Chevron	"V" Bracing	Single Diagonal	Conventional
Support 1 X-Axis	0.893	0.901	0.175	0.2	0.299
Support 1 Z-Axis	3	3	1.694	3	3
Support 2 X-Axis	-0.893	-0.901	-5.00E-16	-0.2	-0.299
Support 2 Z-Axis	3	3	2.613	3	3
Support 3 X-Axis			-0.175		
Support 3 Z-Axis			1.694		

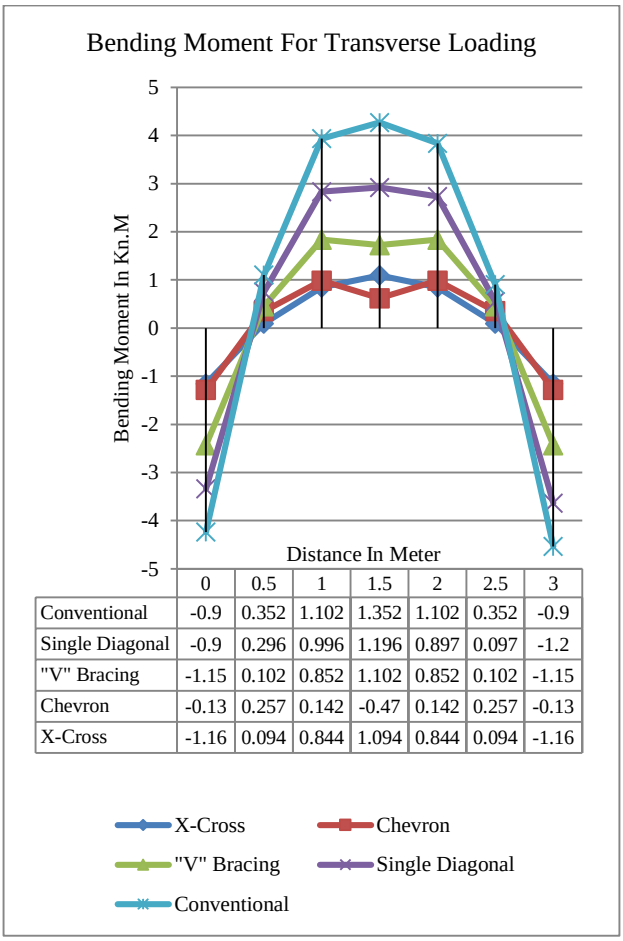
Table – 3 – Support Reaction Comparison for Transverse Loading

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 04, April-2016



	X-Cross	Chevron	"V" Bracing	Single Diagonal	Conventional
Joint 1 X-Axis	-2.16E-06	4.37E-07	-1.32E-06	5.70E-05	2.37E-06
Joint 1 Z-Axis	-3.40E-05	-2.00E-05	-2.70E-05	-4.60E-05	-4.80E-05
Joint 2 X-Axis	2.16E-06	0	1.32E-06	5.00E-05	-2.37E-06
Joint 2 Z-Axis	-3.40E-05	-3.80E-05	-2.70E-05	-4.80E-05	-4.80E-05
Joint 3 X-Axis		-4.37E-07			
Joint 3 Z-Axis		-2.00E-05			

Table – 4 – Joint Displacement Comparison for Transverse Loading



	0	0.5	1	1.5	2	2.5	3
Conventional	-0.9	0.352	1.102	1.352	1.102	0.352	-0.9
Single Diagonal	-0.9	0.296	0.996	1.196	0.897	0.097	-1.2
"V" Bracing	-1.15	0.102	0.852	1.102	0.852	0.102	-1.15
Chevron	-0.13	0.257	0.142	-0.47	0.142	0.257	-0.13
X-Cross	-1.16	0.094	0.844	1.094	0.844	0.094	-1.16

Table – 5 – Bending Moment Comparison for Transverse Loading On Loaded Beam Member

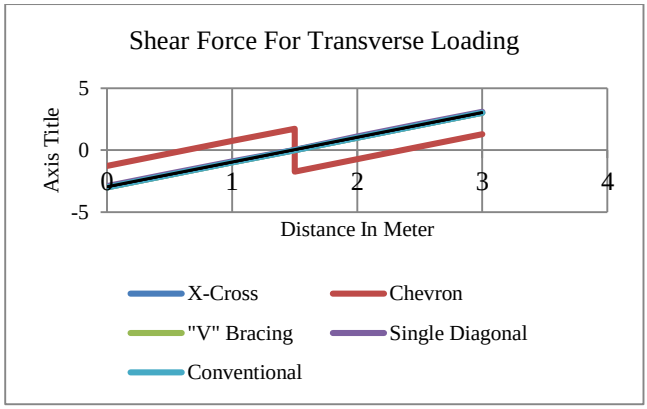
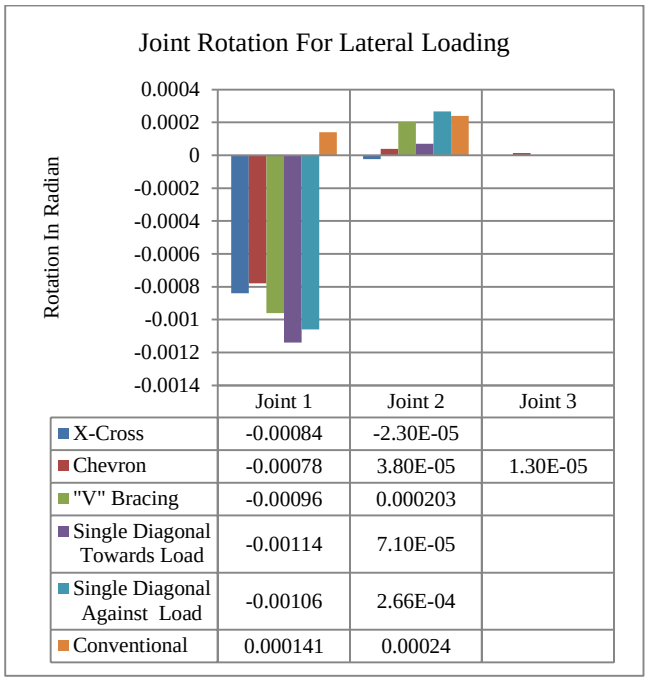
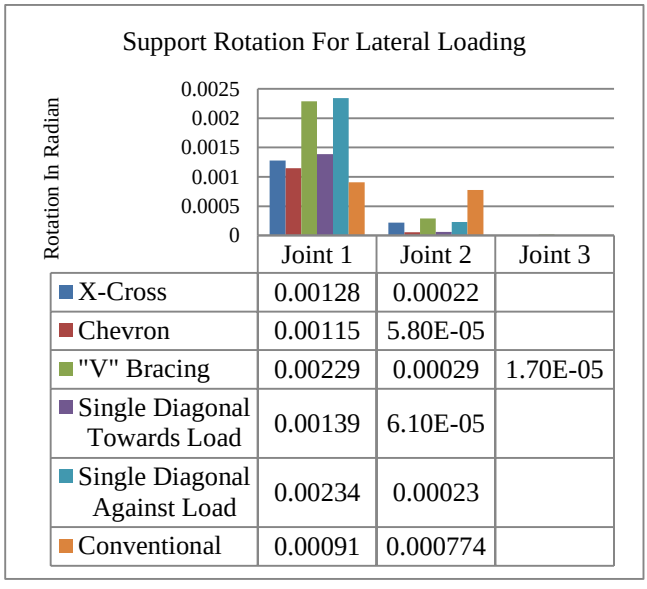


Table – 6 – Shear Force Comparison for Transverse Loading On Beam Member



	Joint 1	Joint 2	Joint 3
X-Cross	-0.00084	-2.30E-05	
Chevron	-0.00078	3.80E-05	1.30E-05
"V" Bracing	-0.00096	0.000203	
Single Diagonal Towards Load	-0.00114	7.10E-05	
Single Diagonal Against Load	-0.00106	2.66E-04	
Conventional	0.000141	0.00024	

Table – 7 - Joint Rotation Comparison for Lateral Loading



	Joint 1	Joint 2	Joint 3
X-Cross	0.00128	0.00022	
Chevron	0.00115	5.80E-05	
"V" Bracing	0.00229	0.00029	1.70E-05
Single Diagonal Towards Load	0.00139	6.10E-05	
Single Diagonal Against Load	0.00234	0.00023	
Conventional	0.00091	0.000774	

Table – 8 – Support Rotation Comparison for Lateral Loading

International Journal of Engineering Research & Technology (IJERT)
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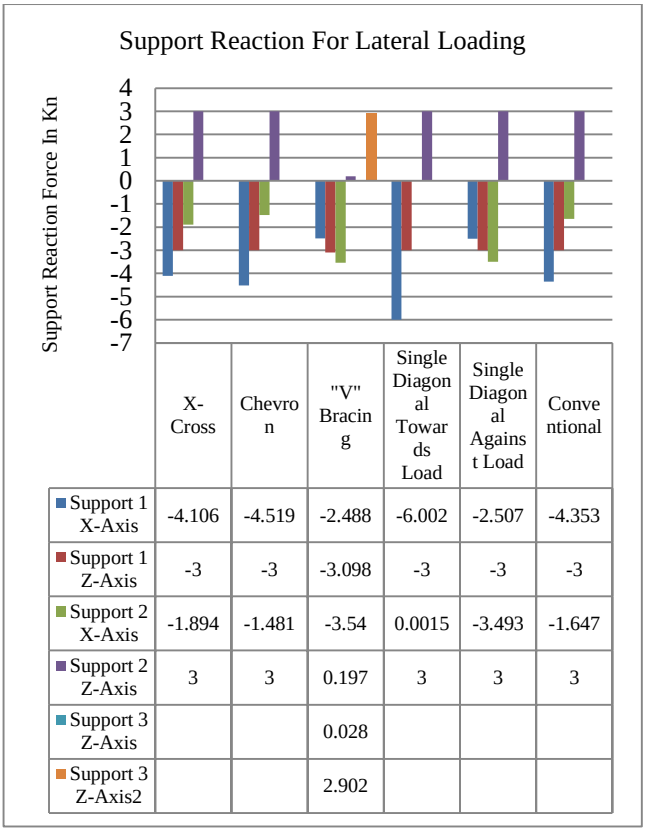
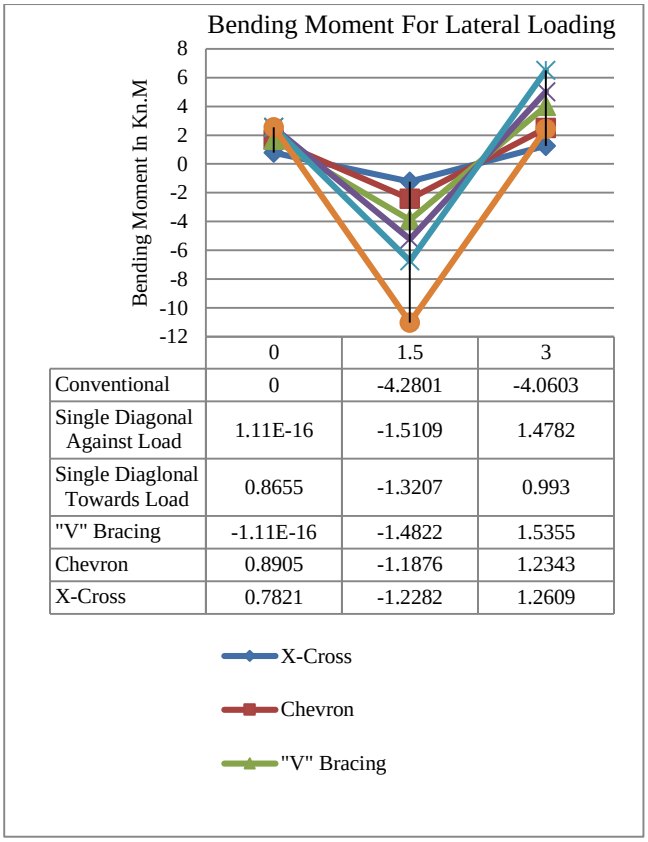
Vol. 5 Issue 04, April-2016



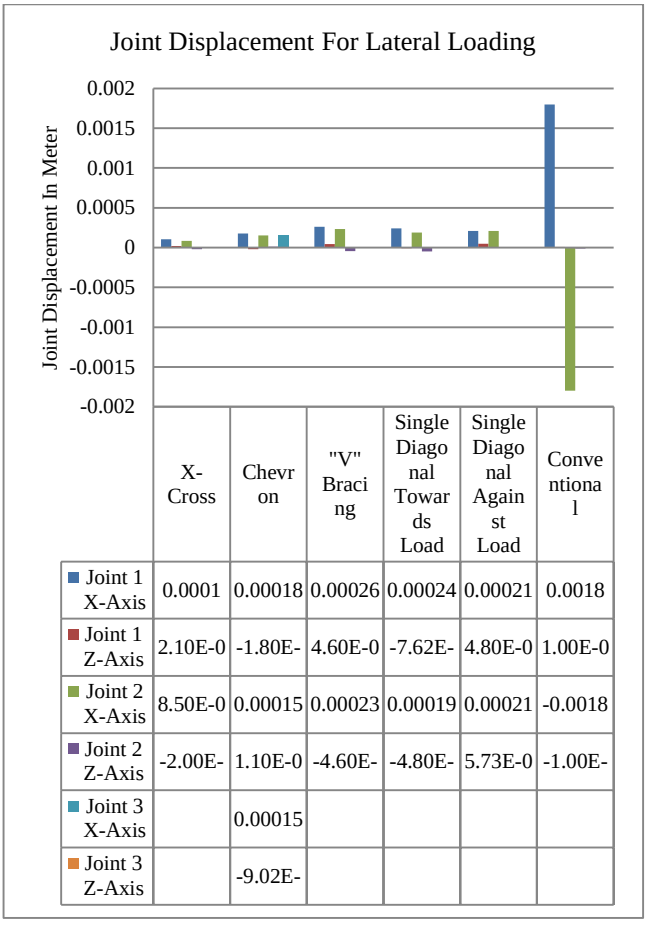
	X-Cross	Chevron	"V" Bracing	Single Diagonal Towards Load	Single Diagonal Against Load	Conventional
Support 1 X-Axis	-4.106	-4.519	-2.488	-6.002	-2.507	-4.353
Support 1 Z-Axis	-3	-3	-3.098	-3	-3	-3
Support 2 X-Axis	-1.894	-1.481	-3.54	0.0015	-3.493	-1.647
Support 2 Z-Axis	3	3	0.197	3	3	3
Support 3 Z-Axis			0.028			
Support 3 Z-Axis2			2.902			

Table – 9 – Support Reaction Comparison for Lateral Loading



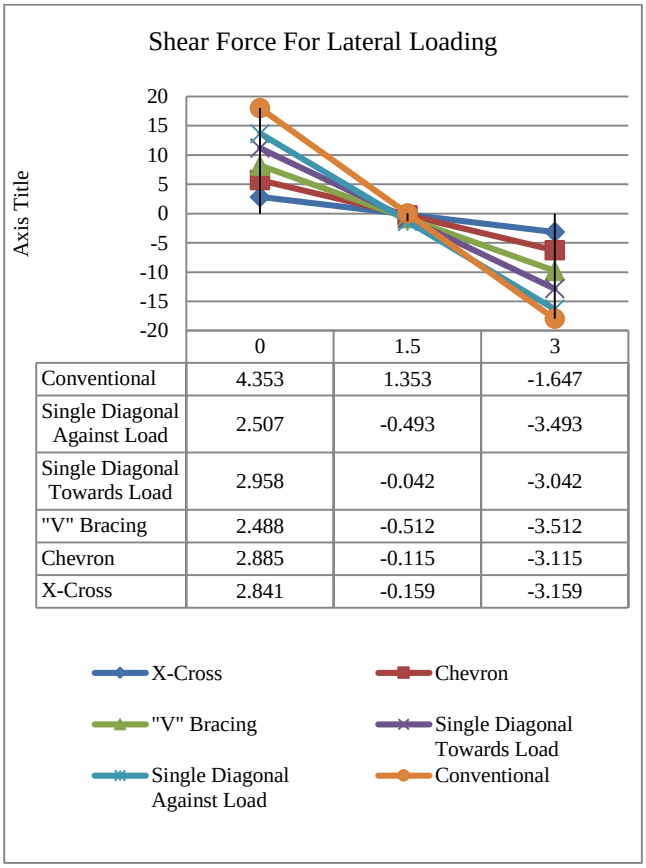
	0	1.5	3
Conventional	0	-4.2801	-4.0603
Single Diagonal Against Load	1.11E-16	-1.5109	1.4782
Single Diaglonal Towards Load	0.8655	-1.3207	0.993
"V" Bracing	-1.11E-16	-1.4822	1.5355
Chevron	0.8905	-1.1876	1.2343
X-Cross	0.7821	-1.2282	1.2609

Type -11 – Bending Moment Comparison for Lateral Loading On Loaded Column Member



	X-Cross	Chevron	"V" Bracing	Single Diagonal Towards Load	Single Diagonal Against Load	Conventional
Joint 1 X-Axis	0.0001	0.00018	0.00026	0.00024	0.00021	0.0018
Joint 1 Z-Axis	2.10E-0	-1.80E-	4.60E-0	-7.62E-	4.80E-0	1.00E-0
Joint 2 X-Axis	8.50E-0	0.00015	0.00023	0.00019	0.00021	-0.0018
Joint 2 Z-Axis	-2.00E-	1.10E-0	-4.60E-	-4.80E-	5.73E-0	-1.00E-
Joint 3 X-Axis		0.00015				
Joint 3 Z-Axis		-9.02E-				

Table – 10 – Joint Displacement Comparison for Lateral Loading



	0	1.5	3
Conventional	4.353	1.353	-1.647
Single Diagonal Against Load	2.507	-0.493	-3.493
Single Diagonal Towards Load	2.958	-0.042	-3.042
"V" Bracing	2.488	-0.512	-3.512
Chevron	2.885	-0.115	-3.115
X-Cross	2.841	-0.159	-3.159

Type – 12 - Shear Force Comparison For lateral Loading On Loaded Column member

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 04, April-2016

VII. RESULT

It's very clear from the comparison, which for Transverse Loading Chevron Bracing is effective and for Lateral Loading X – Cross Bracing is effective.

VIII. CONCLUSION

Now this comparative study will help engineers to choose the correct type of bracing type which will required for different loading type like lateral and transverse.

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