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Analysis of Steel Gable Frame for Various Loadings

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ABSTRACT

We know gable frame structure is most common in all countries for the industrial building. Whenever large clear span is required for special industrial and commercial purpose the gable frame structure is the first preference in the industrial building and also economical. In this work single bay gable frame of the 15m span and 3m rise with column height 8m is used. First, this frame is analyze by applying UDL load on slanting sides of the gable frame then the same frame is analysis by applying the nodal load, and point load on slanting side of the gable frame. Manually analysis has been done using Stiffness Matrix Method of Deflection, Reaction, Banding Moments and Shear Forces The same frames also create in STAAD Pro, and output such as Deflection, Reaction, Banding Moments and Shear Forces have been calculated and a comparison between Manual Calculation and STAAD Pro. Software Calculations has been made.

1. INTRODUCTION

The structure can be defined as the assemblage of two or more than two structural element by rigid or pinned connections. The primary function of the structure is to carry the load and safely transmit it from one point to another. Before bring the structure into serviceability analysis of structure is very important to know the force induce in the structure due the influence of loads. The primary objective analysis is to determine the internal forces and corresponding displacements of all the structural elements as well as those of the entire structural system. The safety and proper functioning of the structure can be ensured only through a thorough structural analysis.

In this paper the gable frame is analyzed by the use of stiffness matrix method and also with STAAD PRO. The member force like axial force, shear force, and bending moment are calculated and the support reaction are also calculated manually by stiffness matrix method and also with STAAD PRO. And the comparison between result of manually and STAAD PRO calculation will be done The Excel sheet which is based on manually calculation it will easy to operate for most common portal frames

2.Stiffness matrix method

Between 1934 and 1938 A. R. Collar and W. J. Duncan published the first papers with the representation and terminology for matrix systems that are used today. Stiffness of the element can be define as the force required for the unit displacement of tShe member

Procedure of stiffness matrix method

Divide the structure into finite elements and arbitrarily identify each element and its nodes. Elements usually extend between points of support, points of concentrated loads, corners or joints, or to points where internal loadings or displacements are to be determined.

Establish the x, y, z, global coordinate system, usually for convenience with the origin located at a nodal point on one of the elements and the axes located such that all the nodes have positive coordinates.

At each nodal point of the frame, specify numerically the three x, y, z coding components. In all cases use the lowest code numbers to identify all the unconstrained degrees of freedom, followed by the remaining or highest code numbers to identify the constrained degrees of freedom.

From the problem, establish the known displacements D and known external loads Q When establishing Q be sure to include any reversed fixed-end loadings if an element supports an intermediate load.

Local stiffness matrix is formed for all the members individually [K’]

Local transformation matrix is formed for all the members separately [T]

Member Global matrix made by the relation of [K]=[T]’[K][T]

Displacement of joint find by relation [D]=[K]’[Q]

Member end force find by the relation of [F]=[K][D]+[Q]

Where [K’] local member stiffness matrix

[K] is global stiffness matrix

[Q] is force is matrix

[D] is displacement matrix

[F] is member force matrix

3.**DESCRIPTION OF THE PROBLEM**

Example 1: Analyse the, one bay Gable frame with Udl 30 KN/m on all inclined elements, shown in Fig.4 by stiffness matrix method. Assume E=200 Gpa; I=6.48×10^{-4} m^4 and A=0.0132 m^2. The flexural rigidity EI and axial rigidity EA are the same for all beams.

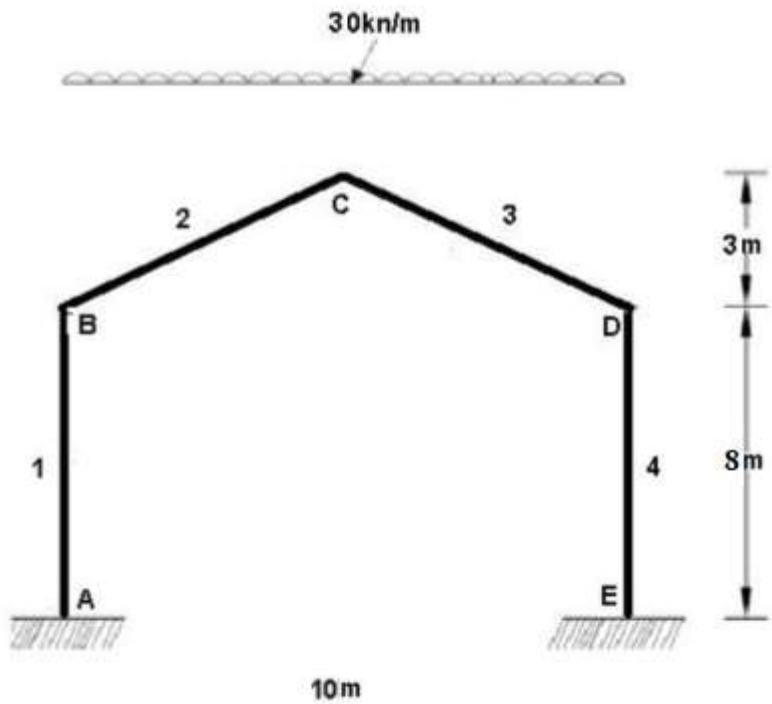

Fig 3

The gable frame is divided into 4 elment as shown into fig and the each node has 3 degree of freedom

Fixed end moment TABLE 1

Members	Fixed end moment (FEM)KNm
M_{FAB}	0
M_{FBA}	0
M_{FBC}	-28.33KNm
M_{FCB}	28.33KNm
M_{FCD}	-28.33KNm
M_{FDC}	28.33KNM
M_{FDE}	0
M_{FED}	0

JOINT DISPLCEMENTS

TABLE 2

Joint No.	**Dx (mm)**	**Dy (mm)**	**qz (rad.)**
1	0.0000	0.0000	0.0000
2	-0.4636	-0.1628	-0.0007
3	1.3905	-3.3458	0.0002
4	3.2161	-0.1904	0.0001
5	0.0000	0.0000	0.0000

SUPPORT REACTIONS

TABLE 2

Joint No.	Rx (kN)	Ry (kN)	Mz (kN-m)
1	10.46	53.77	-29.77
5	-10.46	62.86	40.93

MEMBER END FORCES

TABLE 3

Member No.	Joint No.	Axial (kN)	Shear (kN)	Moment (kN-m)
1	1	53.77	-10.46	-29.77
	2	-53.77	10.46	-53.90
2	2	21.63	15.72	25.57
	3	-21.63	-15.72	66.11
3	3	26.31	-23.53	-66.11
	4	-26.31	23.53	-71.07
4	5	62.86	10.46	40.93
	4	-62.86	-10.46	42.74

COMPARISON WITH STAAD

TABLE 4

JOINT DISPLACEMNET									
	Manual calculation value			STAAD PRO value			Differences		
Member No.	Dx(mm)	Dy(mm)	Qz(rad.)	Dx(mm)	Dy(mm)	Qz(rad)	Dx (mm)	Dy (mm)	Qz (rad)
1	0.000	0.0000	0.0000	0.000	0.0000	0.0000	0	0	0
2	-0.4636	-0.1628	-0.0007	-0.478	-0.1688	-0.0007	0.014	.0006	0
3	1.3905	-3.3458	0.0002	1.3957	-3.3558	0.00023	.0005	.01	0
4	3.2161	-0.1904	0.0001	3.2361	-0.1924	0.00011	0.02	.002	.00001
5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0	0	0

TABLE 5

Manual calculation				STAAD PRO			DIFFERENCE		
Joint No.	**Rx (kN)**	**Ry (kN)**	**Mz (kN-m)**	**Rx (kN)**	**Ry (kN)**	**Mz (kN-m)**	**Rx (kN)**	**Ry (kN)**	**Mz (kN-m)**
1	10.46	53.77	-29.77	10.98	54.00	-30.1	0.42	0.23	0.33
5	-10.46	62.86	40.93	-10.98	62.90	40.9	.46	.04	0.03

0

MEMBER END FORCES										
MANUAL CALCULATION					STAAD PRO VALUE			DIFFERENCE		
Member No.	**Joint No.**	**Axial (kN)**	**Shear (kN)**	**Moment (kN-m)**	**Axial (kN)**	**Shear (kN)**	**Moment (kN-m)**	**Axial (kN)**	**Shear (kN)**	**Moment (kN-m)**
1	1	53.77	-10.46	-29.77	54.00	-10.98	-30.1	0.23	.53	0.33
	2	-53.77	10.46	-53.90	-53.77	10.98	-53.94	0.23	.53	0.04
2	2	21.63	15.72	25.57	21.68	15.70	25.59	0.05	.02	.02
	3	-21.63	-15.72	66.11	-21.68	-15.70	66.20	0.05	.2	.02
3	3	26.31	-23.53	-66.11	26.34	-23.59	-66.20	.03	0.09	0.15
	4	-26.31	23.53	-71.07	-26.32	23.5	-71.27	.01	0.03	0.20
4	5	62.86	10.46	40.93	62.85	10.46	40.98			0.05
	4	-62.86	-10.46	42.74	-62.85	-10.46	42.74	.01	0	0

4 RESULTS AND DISCUSSIONS

The first part of the work is completing of manual analysis using Stiffness Matrix Method and Second part is analysis in STAAD Pro software mostly used for analysis and design, and third part is comparison the results of both analysis. The same frame which is chosen for the research in model in STAAD Pro with applied the loading which is calculated by manual means. The compare final results of vertical and horizontal elements of stiffness matrix method with STAAD Pro results then only maximum deference is 0.33 in results.

5 CONCLUSION

The manual analysis by stiffness matrix method and STAAD Pro analysis, the following conclusion can be listed follows:

1. Stiffness matrix method is easy and full with lots off number as a degree of freedom in matrix of 15×15 for for gable frame subjected to vertical loadings of point load and U.D.L.

2. The comparison of manual and software's results, the results are quite same.
3. STAAD Pro is a great software for analysis and design, the only high skilled parson can use but we are creating Excel Sheets on base of this manual calculation, it will helps to every medal class constructors for saving time and money as we know STAAD Pro software and its License is costly in market.
4. The Excel sheets can be recommended for analysis of standard and mostly used for construction portal frames Etc.

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