ANALYSIS OF MULTISTORY STRUCTURE ON INCLINED PLANE

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ABSTRACT: Earthquakes are very disastrous and cause a great harm to living life, material life and buildings. Hence proper dynamic analysis for building having earthquake threat is needed. This will ensure proper designs resulting in an earthquake proof structure. Different dynamic investigation techniques are accessible for tremor examination of multi-storey structures which are response spectrum method (RSM), seismic coefficient method (SCM), time history strategy and Codal provision technique (CPT). The analysis of a G+4 storey RCC building on varying slope angles i.e., 00, 150, 200, 250, 300 and 400 is studied and compared with the same on the flat ground. The structural analysis software STAAD Pro v8i is used to study the effect of inclined ground on building performance. The analysis is carried out to evaluate the effect of inclined ground on structural forces. Soil structure interaction must be suitably considered from design point of view. Overall displacement of the structure with respect to different inclined ground configurations is also analysed.

Keywords: Structural Behaviour, Horizontal Force, Bending Moment, Axial force, Slope Ground

I. INTRODUCTION

Now days, rapid construction is taking place in hilly areas due to scarcity of plain ground. As a result the hilly areas have marked effect on the buildings in terms of style, material and method of construction leading to popularity of structures in hilly regions. Due to inclined profile, the various levels of such structures step back towards the hill slope and may also have setback also at the same time. These structures become highly uneven and asymmetric, due to variation in mass and stiffness distributions on different vertical axis at each floor. Such construction in earthquake prone areas makes them to attract greater shear forces and torsion compared to normal construction.

A scarcity of plain ground in hilly area compels the construction activity on inclined ground. Slope construction of buildings constructed in masonry with mud mortar/cement mortar without conforming to seismic codal provisions and wind analysis have proved unsafe and, resulted in loss of life and property when subjected to earthquake ground motions and neglecting the winds which flows at upper part of the hills. Hilly areas are more prone in seismic activity and wind activity for e.g. Northern region of India.

II. OBJECTIVE OF THIS STUDY

Safety and serviceability is the prime requirement for buildings on inclined ground. To meet these requirements, the structure should have adequate lateral strength, lateral stiffness, and sufficient ductility. The main objective of present work is to investigate the structural behaviour of building frame resting on inclined ground subjected to seismic loading. The objectives of this study are as follows:

- Analysis of inclined ground, its displacement which shows the behaviour as of regular building.
  -Step Back Configuration
  -Step Back and Set Back
  Configuration -Set Back Configuration
- Evaluating the displacements value as the slopes increases.
- Three dimensional space frame analysis is carried out for four different configurations of buildings ranging from G+ 4 storey resting on inclined ground under the action of seismic load by using STAAD software.
- Dynamic response of these buildings, in terms of base shear, fundamental time period and displacement will be presented, and comparison will be done by considering configuration as well as with other configurations.
- A suitable configuration of building to be used in hilly area is suggested.

METHOD OF ANALYSIS

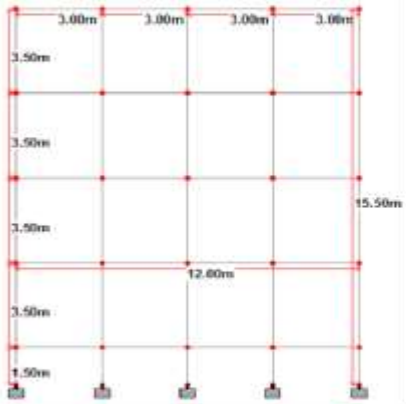
- The analysis of multi-storey buildings for the gravity loads or vertical loads and horizontal loads can be done by analysis tool STAAD pro.
- For the static and dynamic analysis of multi-storey buildings have moment resisting frame By STAAD Pro. software Method.
- Equivalent static lateral force method – For Static analysis only discussed as per IS 1893(part-1):2002 for regular buildings only.
- Analysis of the soil bearing capacity of different hilly areas.
- Analysis of Displacement of Column in various slopes configurations.
- Comparisons of the structure of different configurations on the basis of angle of inclined with the help of STAAD-Pro.
- Graphical comparison will be done in accordance to the proposed structure and their different configurations.

III. METHODOLOGY

This thesis deals with relative study of behaviour of inclined ground building framesconsidering different inclination (00, 100, 150, 200, 250 and 300) under earthquake forces. The comparison ofinclined ground and plane ground building under seismic forces is done. Here G+ 4storey is taken and same live load is applied in three the buildings for its behaviour andcomparison. The framed buildings are subjected to vibrations because of earthquake and thereforeseismic analysis is essential for these building frames. The rigid system is determined byapplying in five building frames in seismic intensities: V with the help of STAAD Pro.

IV. STRUCTURAL MODELS

Structural models for different inclined ground are shown in plan, elevation and 3Dstructural model of plane and inclined ground structures in Fig.



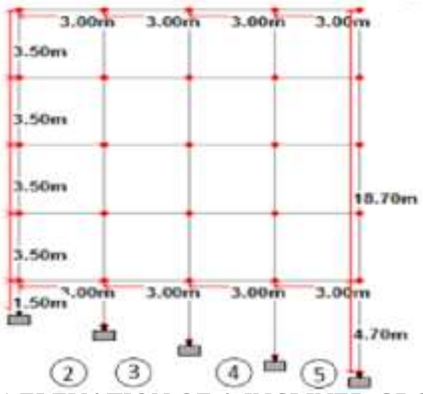
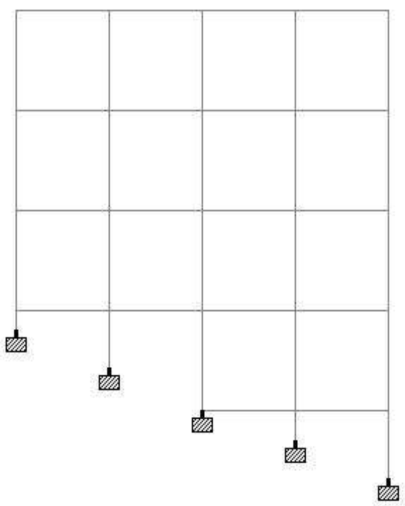


Fig 1 ELEVATION OF A INCLINED GROUND (0^0) Fig 2 ELEVATION OF A INCLINED GROUND (15^0)



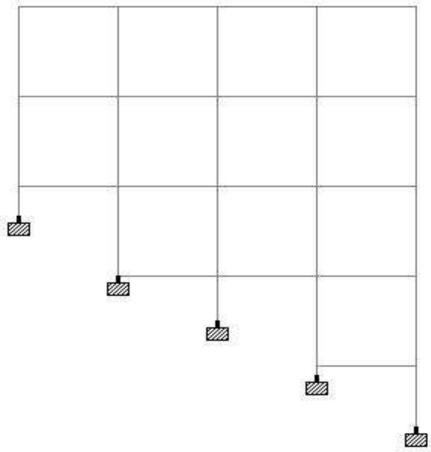


Fig 3 ELEVATION OF A INCLINED GROUND (20^0)
Fig 4 ELEVATION OF A INCLINED GROUND (30^0)

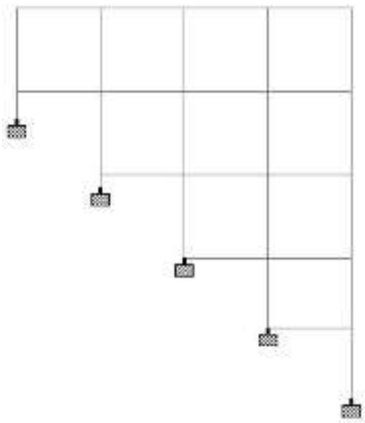


Fig 5 ELEVATION OF A INCLINED GROUND (40^0)

ANALYSIS RESULT
ANALYSIS RESULTS IN TERMS OF BENDING MOMENT MAXIMUM IN DIFFERENT CASES:

COLOUMN	BENDING MOMENT (KN-M)
1	146.4
2	163.7
3	177.8
4	158.3
5	155.5

Table-1 Bending Moment for 0^0

COLOUMN	BENDING MOMENT (KN-M)
1	128.1
2	152.7
3	177.7
4	192.8
5	247.8

Table-2 Bending Moment for 15^0

COLOUMN	BENDING MOMENT (KN-M)
1	125.3
2	149.6
3	172.9
4	189.65
5	201.22

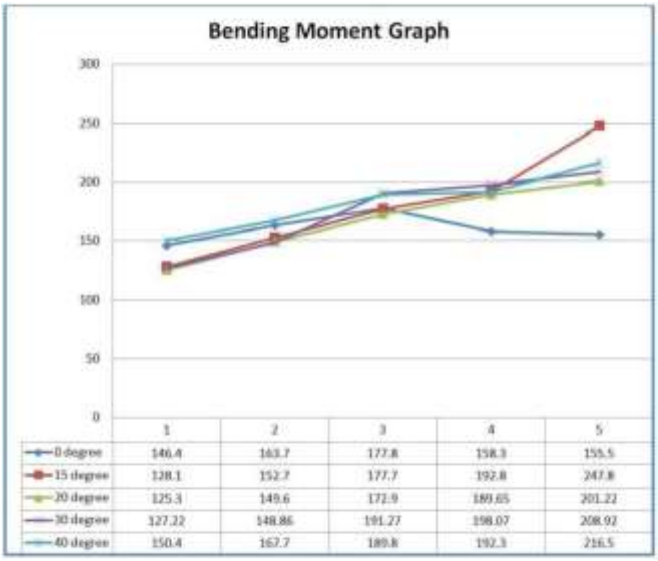
Table-3 Bending Moment for 20^0

COLOUMN	BENDING MOMENT (KN-M)
1	127.22
2	148.86
3	191.27
4	198.07
5	208.92

Table-4 Bending Moment for 30^0

COLOUMN	BENDING MOMENT (KN-M)
1	150.4
2	167.7
3	189.8
4	192.3
5	216.5

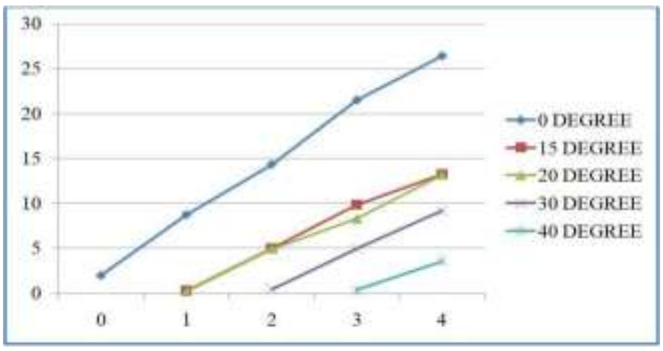
Table-5 Bending Moment for 40^0



ANALYSIS RESULTS IN TERMS OF MAXIMUM DEFLECTION IN DIFFERENT CASES:

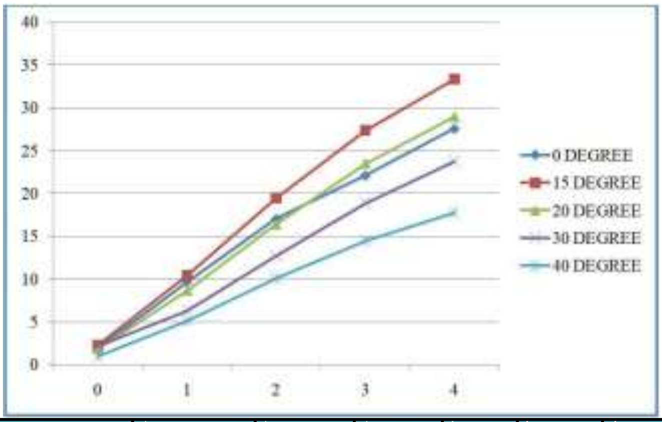
COLUMN NO.	FLOOR NO.	0	15	20	30	40
1	0	1.992	-	-	-	-
1	1	8.756	0.307	0.207	-	-
1	2	14.34	5.02	4.956	0.461	-
1	3	21.5	9.81	8.3	4.966	0.35
1	4	26.4	13.23	13.19	9.158	3.555

Table-6 MAXIMUM DEFLECTION FOR COLOUMN 1



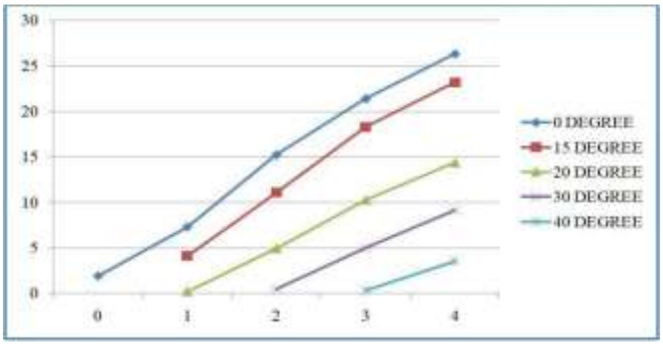
COLUMN NO.	FLOOR NO.	0	15	20	30	40
2	0	1.959	2.3	1.88	2.21	1
2	1	9.70	10.44	8.68	6.34	5.162
2	2	17.05	19.42	16.40	12.74	10.12
2	3	22.12	27.39	23.51	18.91	14.48
2	4	27.6	33.34	28.96	23.76	17.76

Table-7 MAXIMUM DEFLECTION FOR COLOUMN 2



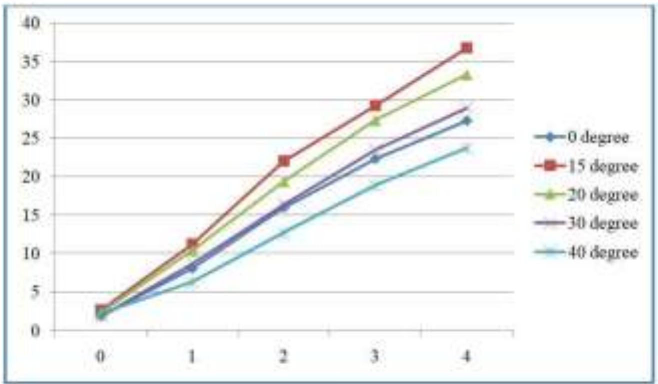
COLUMN NO.	FLOOR NO.	0	15	20	30	40
3	0	1.912	-	-	-	-
3	1	7.311	4.14	0.21	-	-
3	2	15.231	11.12	4.96	0.461	-
3	3	21.408	18.31	10.3	4.996	0.35
3	4	26.33	23.23	14.4	9.158	3.56

Table-8 MAXIMUM DEFLECTION FOR COLOUMN 3



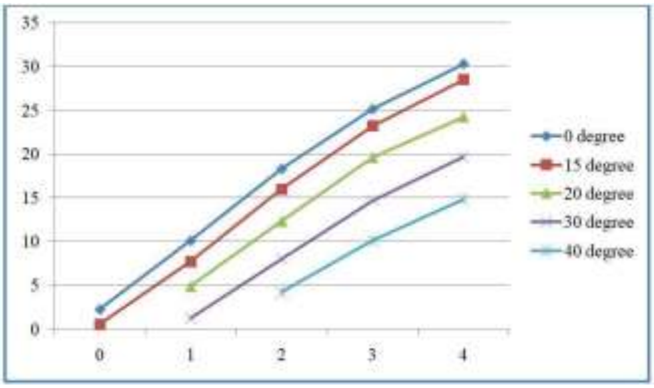
COLUMN NO.	FLOOR NO.	0	15	20	30	40
4	0	1.88	2.673	2.3	1.88	2.216
4	1	8.08	11.22	10.44	8.68	6.34
4	2	16.06	22.1	19.42	16.4	12.75
4	3	22.346	29.3	27.4	23.5	18.92
4	4	27.33	36.8	33.34	29	23.77

Table-9 MAXIMUM DEFLECTION FOR COLOUMN 4



COLUMN NO.	FLOOR NO.	0	15	20	30	40
5	0	2.289	0.553	-	-	-
5	1	10.14	7.72	4.915	1.299	-
5	2	18.33	16.02	12.35	8.042	4.25
5	3	25.16	23.23	19.61	14.7	10.13
5	4	30.32	28.52	24.24	19.7	14.87

Table-10 MAXIMUM DEFLECTION FOR COLOUMN 5



ANALYSIS OF SHEAR FORCE IN DIFFERENT CASES:

COLOUMN	SHEAR FORCE (KN)
1	64.7
2	59.3
3	71.5
4	76.6
5	82.2

Table-11SHEAR FORCE FOR 0 DEGREE

COLOUMN	SHEAR FORCE (KN)
1	52.1
2	44.8
3	47.3
4	49.6
5	50.1

Table-12SHEAR FORCE FOR 15 DEGREE

COLOUMN	SHEAR FORCE (KN)
1	46.3
2	32.3
3	29.3
4	29.8
5	29.6

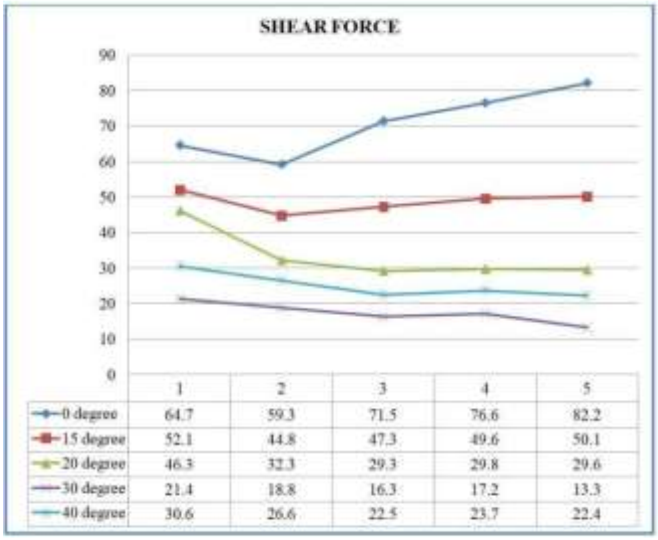
Table-13SHEAR FORCE FOR 20 DEGREE

COLOUMN	SHEAR FORCE (KN)
1	21.4
2	18.8
3	16.3
4	17.2
5	13.3

Table-14SHEAR FORCE FOR 30 DEGREE

COLOUMN	SHEAR FORCE (KN)
1	30.6
2	26.6
3	22.5
4	23.7
5	22.4

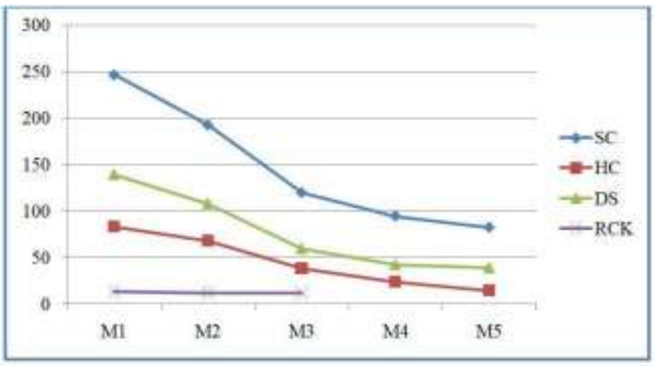
Table-15SHEAR FORCE FOR 40 DEGREE



STOREY DISPLACEMENT WITH RESPECT TO DIFFERENT TYPE OF SOIL:

MODEL NUMBER	TYPE OF SOIL			
	SC	HC	DS	RCK
M1	247.10	83.48	139.61	13.66
M2	193.04	68.28	108.47	12.06
M3	120.17	38.54	59.90	12.22
M4	94.87	23.69	42.34	10.32
M5	82.66	14.42	39.06	9.76

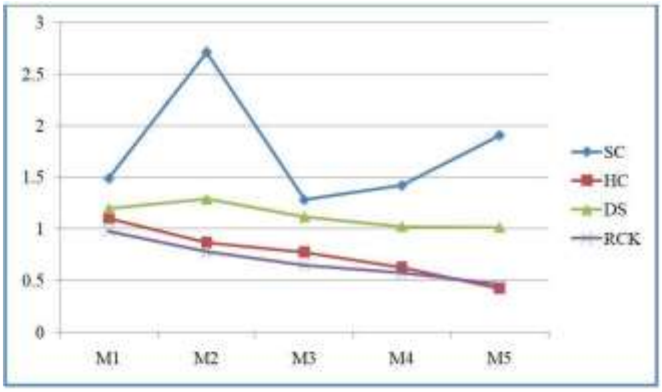
Table-14 STORY DISPLACEMENT FOR DIFFERENT TYPES OF SOIL



TIME PERIOD FOR DIFFERENT MODELS UNDER DIFFERENT SOIL CONDITIONS:

MODEL NUMBER	TYPE OF SOIL			
	SC	HC	DS	RCK
M1	1.493	1.105	1.201	0.982
M2	2.714	0.869	1.292	0.78
M3	1.285	0.777	1.120	0.653
M4	1.425	0.632	1.024	0.578
M5	1.910	0.426	1.017	0.467

Table-14 TIME PERIOD FOR DIFFERENT MODELS



V. CONCLUSION

Analysis of building frame for seismic forces is a common problem formulation now aday's due to availability of several software tools and programs. Reinforced concrete (RC) structural frames are common form of constructions resting on plane and inclined ground (hilly areas) in India. There buildings are subjected to various types of forces during theirlifetime, such forces due to dead and live loads and dynamic forces due to the wind and earthquake.

Results from seismic analyses performed on three RC buildings with three different ground slopes (0^0, 10^0, 15^0, 20^0, 25^0 and 30^0) have been carried out by using static method. The top storey displacement and the footing reaction, axial force, shear and moment action induced in columns and beams have been studied to investigate the influence of inclined ground onstructural performance of building frame.

The static analysis has been done on computer with the help of STAAD Pro. Software using the seismic parameters as per the IS: 1893- 2002 for the zone (IV) and the post processing result were obtained.

- Various codes are studied for analysis of seimic forces but every code as per time need to be reviesed and none of the code can be used for different area.
- In Step back buildings and Step back-Set back buildings, it is observed that extreme left column at ground level, which are short, are the worst affected. Special attention should be given to these columns in design and detailing.
- Although, the Setback buildings on plain ground attract less action forces as compared to Step back Set back buildings, overall economic cost involved in levelling the inclined ground and other related issues needs to be studied in detail.
- Bending moment in regular structure will be constant but in irregular structure where length of column changes according to slope then bending moment will vary respectively

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