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COMPARATIVE ANALYSIS OF CONVENTIONAL SLAB AND FLAT SLAB SYSTEM OF COMMERCIAL BUILDING ON DIFFERENT ZONES AND HEIGHTS BY USING ETABS

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Abstract - *The main objective of this project is to analyse & study the comparative seismic performance of conventional & flat slab system of commercial building in all zones with different heights using Etabs. Flat slab buildings are widely used now days for the better performance, low cost and easier work. So based on these advantages of flat slab, this project is compared between grid slab & flat slab with drop panels & consists of double basement, G+5, and G+ 10 with terrace floors. The report includes detailed analysis of a multi storey Commercial building using software ETABs. All the structures were subjected to various kinds of loads such as dead load, live load, earthquake load & wind load individually or as a group. ETABS includes all the major analysis engines such as static, dynamic, linear & non-linear etc., and is used to analyse and design the buildings. This study is mainly based on Response spectrum method to know the seismic performance of the structures. Analysis were done by dynamic method as per IS: 1893-2016, and all the RCC members were designed as per IS: 456-2000. Load Calculations were calculated as per IS: 875 Codes. The results provide best information on base shear, storey drifts, displacements, stiffness and storey shears and show its performance on different conditions such as different zones and heights.*

***Key Words*: Conventional Slab, Flat Slab, Response Spectrum Analysis, Seismic parameters, ETABS.**

1. INTRODUCTION

Coming into this project it provides information on comparative study & analysis of Conventional slab & Flat slab with drop panels of Commercial building with different heights (G+10, G+15) by Response spectrum method under different conditions like Seismic zones, different heights. Coming to brief introduction about Conventional slabs & Flat slabs. Generally Conventional slab system consist of beams connected at regular intervals in perpendicular directions they are also called Beam-Slab mechanism, because in this load transfer will follow Yield line theory i.e., load transfer from slabs to beams to columns to foundation. Flat slab is a RC slab directly supported by columns without beams. In this, load transfer will follow Finite element method in which the load transfers from part by part or node to node. Load mechanism carries from slab to column to foundation by FEM. Generally used for commercial buildings, institutions, hospitals wherever no need have beam, where heavier loads like car parking, libraries & where requirement of more space is needed. This project is based on Flat slab with drop panel & Conventional slab systems of commercial building in all zones with different heights. Main Differences of Flat Slab & Conventional Slab in Modeling are no beams used in flat slab & beams used in conventional slab, but here instead of beams strip beams are used as slab element due to large span. In conventional slab system we use membrane as slab & because of in this load transfers by yield line theory, whereas in Flat slab we use shell thin as slab because of in this load transfers through finite element method i.e., node to node. This project is checked for Zone II & compared for different zones and different heights, how it behaves whether it passes all checks, if not what behavior it takes place and to study the comparative results like Base shear, Torsion irregularities, Modal mass ratios, Storey shears, drifts & stiffness of different type of buildings when subjected to seismic loads under different conditions such as seismic zones by Response spectrum method. Based on these comparative results we are going to study the performance of flat Slab & Conventional slab mechanism how it works under different seismic zones & at different heights. Further, this project is studied for different material grades & different soil conditions & cost conditions how it behaves under seismic forces and what are the remedies are carried out.

2. LITERATURE REVIEW

Dr. Kaushal Parikh et al (2017)
Revised the study of performance of multi-storey building having conventional slab and flat slab structure under earthquake forces. Author studied the model under different load conditions, zones and soil conditions. And also studied that lateral displacement and time period increases as number of floor increases, which is useful in this project.

Dr. Manjunath N Hegde (2016)
Analyzed the comparative study of performance of conventional RC slab & Flat slab with drop panels of 20 stories. He also analysed the Flat slab structure with shear wall at different locations taking 2 zones (III,V) by response spectrum method using Etabs with comparing the results of all models w.r.to time period, lateral displacements, etc., to study the performance of the building.

Guru Prasad T N (2015)
Analyzed and studied the performance of Conventional slab & Flat slab structure of different buildings under earthquake forces by different method of analysis like time history,

Response spectrum method, Equivalent static forces & relative results were recorded to study about seismic behaviour of building. And he also stated that natural time period increases as the height of building increases, he observed that the time period is more in conventional slab than flat slab & flat slab with shear walls due to stiffness participation factor which is less in bare frames.

Sahana T.S (2014)

Studied the use of flat slabs in multi-storey commercial building situated in high seismic zones. Author carried this work with 6 number of conventional & Flat slab buildings of G+3, G+8, G+12 under different load conditions of seismic zone IV using Etabs. The main importance of this paper to study the effect of height of the building under seismic zones. It provides good information on different parameters like lateral displacement, storey drifts, storey shears & time period.

Swapnil B. Cholekar (2013)

Author carried the work on dynamic response of Flat slab with & without drop and conventional RC framed structures for different heights by using response spectrum method in Etabs under seismic zone III. After evaluating results he found differences in seismic parameters & axial force.

Kandekar S.B (2012)

Comparative study of seismic performance of multi-storeyed Flat slab & Conventional RC slab under different conditions using response spectrum method. The main objective of this paper to study the performance of buildings under different heights under seismic zones due to structures with large degree of indeterminacy is greater when compared with less indeterminacy because they have more members which are monolithically connected to each other which results in large redistribution of forces when yielding takes place, so there might be change in results when height is changed.

Naveen Kumar B M (2015)

Comparative study on the seismic performance of Flat slab & Conventional RC slabs in high seismic zones. The main importance of this paper is to study the effect of height of the building under seismic forces which provides seismic details like seismic drifts, lateral displacements, time period & base shear.

Makode et al (2014)

Studied the performance of Flat slab & Grid slab system under seismic zones using response spectrum method. In this author carried the work with 12-storeyed building with Flat slab & Grid slab. Results of Base shear, storey drifts & axial force are potted for the study of seismic behaviour. Author founded that base shear of flat slab is less than grid slab in both directions.

Bothara & Varghese (2012)

Studied the seismic performance of Flat slab & Conventional slab system which consists of beams at intervals in perpendicular directions. Author performed the dynamic analysis of a 9-storey building of flat & conventional slab using response spectrum method & results in terms of storey drifts, shear force etc. Author identified that grid slabs shows low drift values than flat slabs at higher levels.

3. METHODOLOGY

Here, method adopted is Response Spectrum Method (RSM). In this method earthquake forces are subjected to models ww.r.to all other loads & analyzed to know the seismic performance of all models. Generally, RSM is a dynamic method which measures the natural mode to indicate seismic response of an elastic structure.

Coming to methodology, both conventional slab and flat slabs are modeled using grid slab method only, but in flat slab drop panels are modeled as slab only by calculating drop thickness as l/d ratio as per IS456;2000. After defining & assigning all materials, loads are applied and analyzed for seismic results by changing each zone like II, III, IV, V, from those results compared between all models and shown in graph.

3.1. BUILDING DESCRIPTION

Table 3.1.1: Geometry & Preliminary data

Building Type	Commercial Building
Type of structure	Moment Resisting Frame
Type of Construction	Conventional slab & Flat slab
No. of Wings	Wing A & B
No. of stories	With double basement, G+5 & G+10
Stilt level height	4.2m
Storey height	4.2m
Type of wall	Glass with double glazed thickness of 25mm
Building Shape	Simple Rectangular L shape
Live load on floor	4 KN/m³
Live load on terrace	2 KN/m³
Floor finish on floor	1.65 KN/m³
Sunken load on floor(toilets)	3.5 KN/m³
Wall load on outer beams (Glass)	0.297 KN/m³
Wall load on inner beams (brick)	Differs as per beam depth
Live load on floor in basement outer portion	16 KN/m³
Zones	II,III,IV,V
Soil type	Medium
Importance factor	1.0
Response reduction factor	5.0

Table 3.1.2: Material Properties

Concrete Grade for Columns &Shear walls , M40	40 N/mm^2
Concrete Grade for Beams, Slabs, Retaining walls , M30	30 N/mm^2
All Steel grades , Fe500	500 N/mm^2
Density of Concrete	25 KN/m^3
Density of Glass	28 KN/m^3

3.2 Types of Models & their Structural Systems:

Table shows about different models w.r.to their structural systems performed using Etabs by response spectrum method for earthquake and wind load analysis.

Table 3.2: Models & their Structural Systems

S.No.	Models	Structural Systems
1.	M1	Conventional slab of Wing A 5Floors in X & Y, under all zones
2.	M2	Conventional slab of Wing B 5Floors in X & Y, under all zones
3.	M3	Flat slab of Wing A 5Floors in X & Y, under all zones
4.	M4	Flat slab of Wing B 5Floors in X & Y, under all zones
5.	M5	Conventional slab of Wing A 10Floors in X & Y, under all zones
6.	M6	Conventional slab of Wing B 10Floors in X & Y, under all zones
7.	M7	Flat slab of Wing A 10Floors in X & Y, under all zones
8.	M8	Flat slab of Wing B 10Floors in X & Y, under all zones

3.3 Time Period values:

We calculate time period values differently for conventional slab & Flat Slabs. Coming to Conventional slab we calculate using regular formula without infill's it is same in all direction, whereas in Flat slab we use RC structural wall formula for time period it gives different values in each direction because it depends on base dimension.

Table 3.3: Time Period values for different models in x & y direction

Structural Systems	Direction	5 Floors		10 Floors	
		WingA	WingB	WingA	WingB
Conventional Slab System M1,M2,M5 ,M6	X -dir	1.143s	1.143s	1.592s	1.592s
	Y -dir	1.143s	1.143s	1.592s	1.592s
Flat Slab System M3,M4,M7 , M8	X -dir	0.533s	0.516s	0.935s	0.904s
	Y -dir	0.966s	0.993s	1.510s	1.540s

Figures shows plan view of wing A & B of Conventional slab & Flat slab systems. Fig 3.1 shows combined plan of wing a & B is shown, but in between the wings 200mm expansion joint is provided so we model them as separate towers in Etabs for accurate results and shown in figs 3.2,3.4,3.6,3.8.

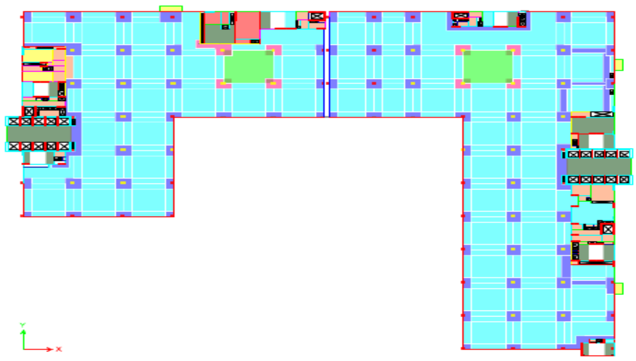

Fig 3.1: Typical Floor plan of wing A & B

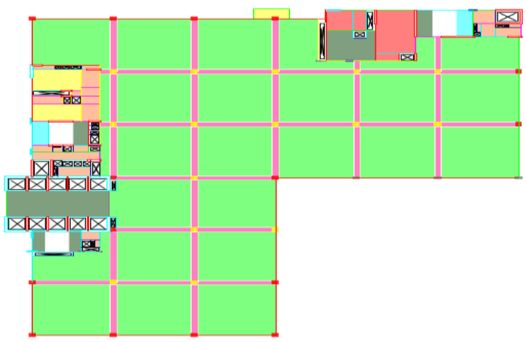

Fig 3.2: Typical plan of M1 & M5

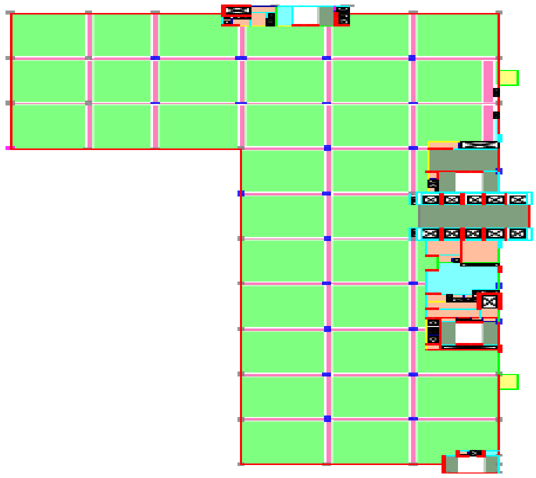

Fig 3.4: Typical plan of M2 & M6

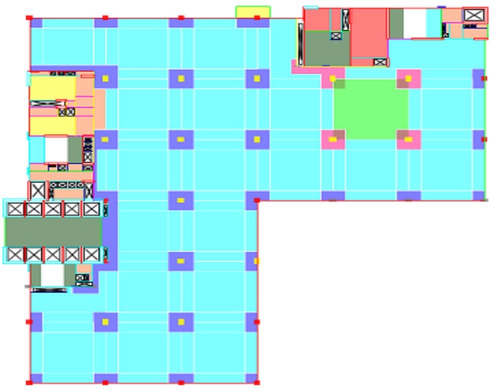

Fig 3.6: Typical plan of M3 & M7

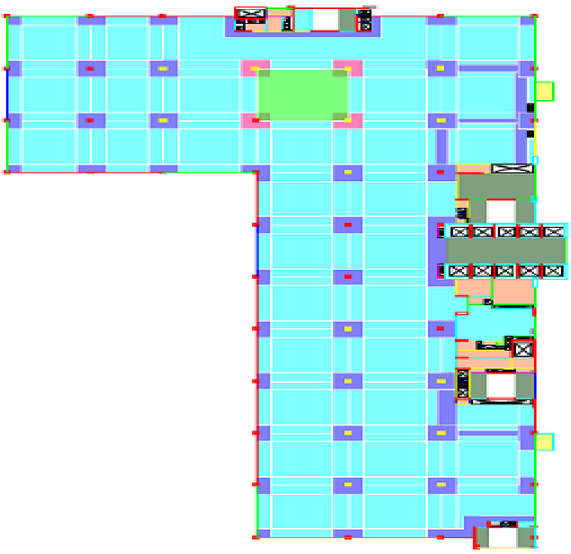

Fig 3.8: Typical plan of M4 & M8

4. COMPARISON OF MAXIMUM RESUTS WITH DISCUSSION

4.1 Maximum Storey Displacement

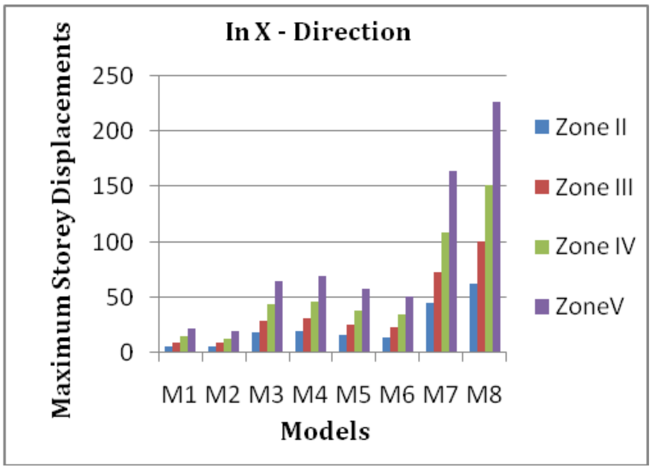

Chart 1: Maximum Storey Displacements in X-Direction

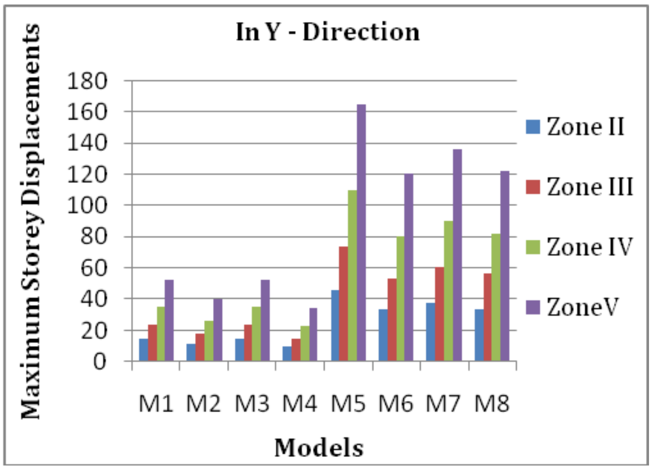

Chart 2: Maximum Storey Displacements in Y-Direction

From Above figures 3.1 & 3.2, we can see that in Zone II all the maximum values of Displacement are under limit as per codes whereas in other zones slightly increasing & reaches to maximum in higher Zones III, IV, and V. So in that case we have to change column sizes & shear wall sizes to minimize Displacements.

4.2 Maximum Storey Drifts

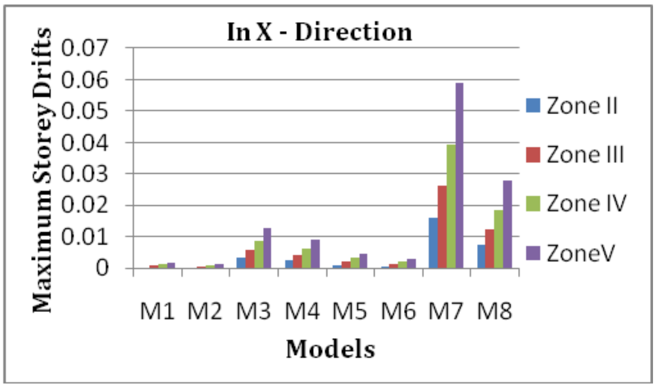

Chart 3: Maximum Storey Drifts in X-Direction

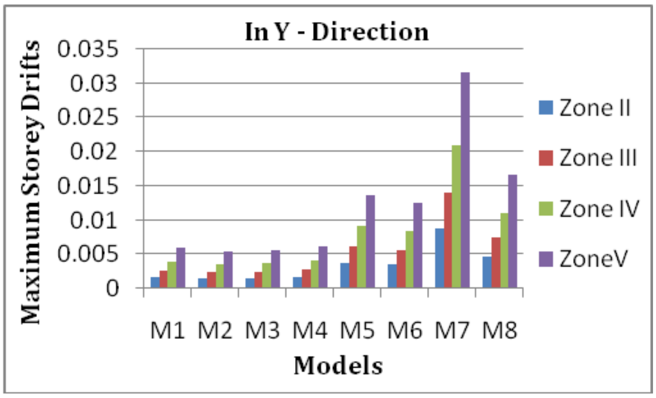

Chart 4: Maximum Storey Drifts in Y-Direction

From Above figures 3.3 & 3.4, we can see that in Zone II, III, IV all the maximum values of Drift are under limit as per codes i.e., H/250(0.0168) whereas in Zone V slightly increasing & crosses limits. So in that case we have to change column sizes & shear wall sizes to minimize Drifts.

4.3 Maximum Storey Shears

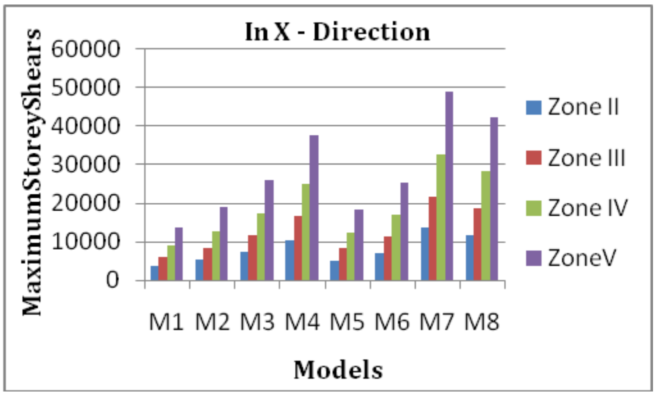

Chart 5: Maximum Storey Shears in X-Direction

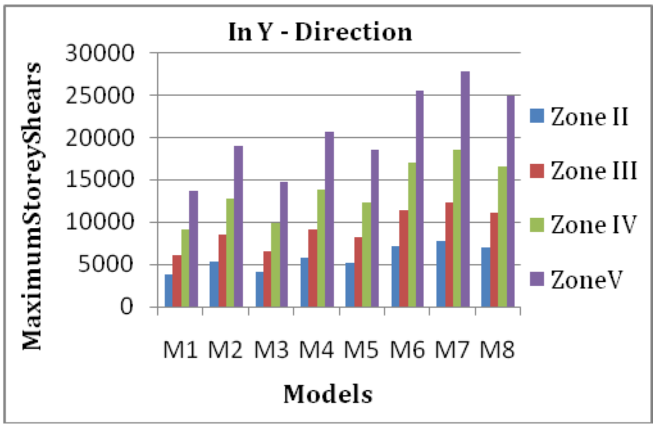

Chart 6: Maximum Storey Shears in Y-Direction

From Above figures 3.5 & 3.6, we can see that in Zone II, III, IV all the maximum values of Shear are minimum, whereas in Zone V having maximum values. So in that case we have to change column sizes & shear wall sizes to minimize Shear values.

4.4 Maximum Storey Stiffness

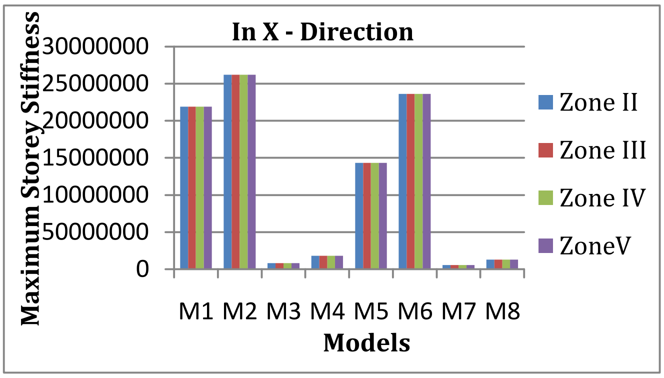

Chart 7: Maximum Storey Stiffness in X-Direction

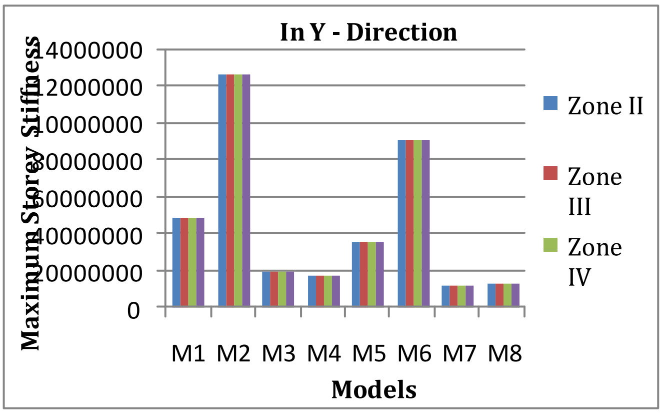

Chart 8: Maximum Storey Stiffness in Y-Direction

From Above figures 3.7 & 3.8, we can see that in all Zones storey stiffness values are same due to same columns & their positions, whereas in different models it will change according to size.

5. CONCLUSIONS

Main Objective of this project is to show the comparative analysis results between Conventional & Flat slab structure in all zones & with different heights how it behaves. The main thing in this project is checking building in zone II as per location of building and comparing with other zones & heights to check the behaviour how it works in different zones:

1. A maximum Storey Displacement value of conventional slab of G+5 is lesser than the flat slab & also it shows lesser values when compared with higher heights G+10. It means Flat slab having more values in both directions than conventional slab in X-direction, whereas in Y- direction displacement values are vice-versa.
2. A maximum Storey Drift value of conventional slab of G+5 is lesser than the flat slab & also it shows greater values when compared with higher heights G+10. It means conventional slab having less drifts than flat slab in both X & Y directions of both heights G+5, G+10.
3. In all models maximum Storey Shear values of conventional slab of G+5 is 34% lesser than the flat slab & also it shows 13% lesser values when compared with higher heights G+10 in X- direction, whereas in Y - direction it is 3% lesser in G+5 & 13% lesser in G+10. From this we can see that values are more in Flat slab & increases with higher heights of Flat slab.
4. In models M1, M2, M5, M6 maximum Storey Stiffness values of conventional slab of G+5 is greater than the flat slab & also it shows lesser values when compared with higher heights G+10. From this we can see that values are more in lower heights & decreases with increasing heights in X- direction, whereas in Y- direction it is vice-versa.

So, from above conclusions we say that all models are passing and giving good results in zone II, whereas in other zones it is increasing slightly so for that we need to check with changing column sizes & wall positions to get good and accurate results.

6. FUTURE SCOPE

Further, this project is studied for different conditions such as:

- Different soil conditions like Low & High, where this project is done in Medium soil condition.
- Different Analysis methods like time history or push over analysis etc.,
- Cost Comparison of conventional & flat slab building.
- Different Grades of Concrete
- Different Heights
- Different load Combinations like Wind load, Temperature etc.

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