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Analysis and Design of Reinforced Concrete Structures Building Model (G+5)

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Abstract: A novel high step-up dc/dc converter is presented for renewable energy applications. It consists of a coupled inductor and two voltage multiplier cells, in order to obtain high step-up voltage gain. Two capacitors are charged during the switch-off period, using the energy stored in the coupled inductor which increases the voltage transfer gain. The energy stored in the leakage inductance is recycled with the use of a passive clamp circuit. The voltage stress on the main power switch is also reduced. The voltage conversion ratio, the effect of the leakage inductance and the parasitic parameters on the voltage gain is discussed. The voltage stress and current stress on the power devices are illustrated and the comparisons between the proposed converter and other converters are given. Finally, a prototype circuit rated 200-W output power is implemented in the laboratory, and the experimental results show the satisfactory agreement with the theoretical analysis.

Keywords: Active Coupled-Inductor Network (ACLN), High Step-Up Voltage Gain DC–DC Converter,Low Voltage Stress.

I. INTRODUCTION

A. Motivation

Day to day variations in the designing of the structures we were motivated to deal with this project. As civil engineering is much concerned with different designs to meet the necessity of human life we took this project.

B. Problem Definition

As the land is con sized to meet the demands of all the growing population the adoption of multi storied had grown up to meet their demands. As it is cost effective

C. Objectives of Project

Carrying out a complete design of the main structural elements of a multi – storied building including slabs, beams, columns and footing .Getting real life experience with the engineering practices. Structure should be so arranged that it can transmit dead, wind and imposed loads in a direct manner to the foundations. The general arrangement should ensure a robust and stable structure that will not collapse progressively under the effects of misuse or accidental damage to any one element.

D. Limitations of Project

- Depending on the site area the number of floors is limited.
- Designing is completely based on IRC codes.
- Once the structure is designed completely minor changes are accepted in site with cost consideration.
- If once the structure is designed for one purpose it cannot be used for other purpose if the load acting on it is increased than the designed.

1. Steel Reinforcement

Steel bars are essentially used in the tension zone of flexural members of concrete to resist the tensile stresses as concrete is weak in tension and in compression members to increase the load carrying capacity. Steel is used as reinforcement to take up the tensile stresses in RCC construction the following reasons,

- Its tensile strength is high
- It can develop good bond with concrete
- Its coefficient of expansion is nearly same as for concrete

2. Functions of Reinforcement in RCC

The reinforcement in RCC serves the following different types of functions,

- To resist the bending tension in flexural members like slabs, beams and walls of water tanks etc.
- To increase the load carrying capacity of compression members like columns
- To resist diagonal tension due to shear.
- To resist the effects of secondary stresses like temperature etc.
- To reduce the shrinkage of concrete.
- To resist spiral cracking due to torsion..
- To prevent the development of wide cracks in concrete due to tensile strain.

3. Types of Reinforcement

Reinforcing steel consists of bars usually circular in cross section. The following four types of steel reinforcement are generally used in reinforced concrete construction.

- Mild steel and medium tensile steel bars conforming to IS 432 (part I)
- High yield strength deformed steel bars (HYSD bars) conforming to IS 1566

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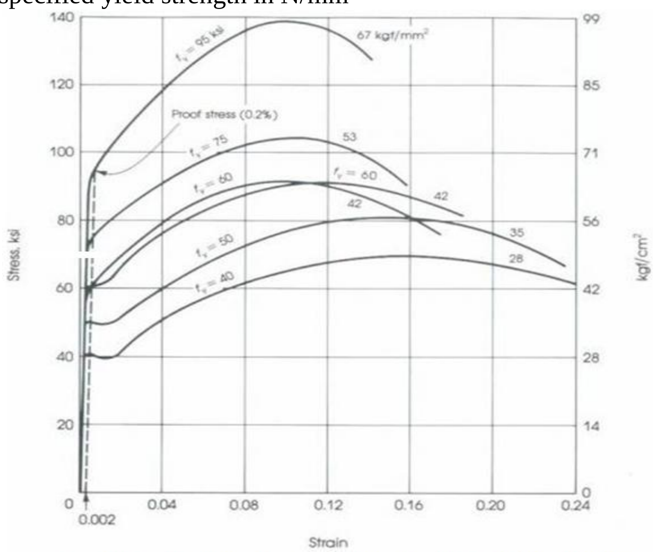
- Steel wire fabric conforming to IS 1566
- Structural steel conforming to Grade A of IS 2062

All reinforcement shall be free from loose mill scale, loose rust, oil, mud, and any other substances which reduces bond between steel and concrete. The grades of steel normally used for reinforcement are Fe 250, Fe 415, Fe 500. Fe refers to ferrous metal and the number following it refers to specified yield strength in N/mm^2



typical stress-strain curves for some reinforcing steel bars of different grades.

Fig.1.

4. High Yield Strength Deformed Bars (fe 415 and fe 500)

As the name indicates, these HYSD bars have high yield strength but the yield point is not well defined. The yield stress or characteristic stress is given by 0.2% proof stress. These bars possess ribs, lugs or deformations on their surface due to which the bond strength is improved.

TABLE I
Properties of HYSD Bars (IS 1786-1985)

Property	Fe 415	Fe 500
0.2% proof stress, min N/mm^2	415	500
Elongation %, min	14.5	12.0
Ultimate stress, min N/mm^2	15% more than actual 0.2% proof stress	10% more than actual 0.2% proof stress

E. Characteristic Load

The maximum working load that the structure has to with stand and for which it has to be designed is called characteristic load. The characteristic loads are calculated based on statistical analysis. As per code, the characteristic load is defined as that value of load which has 95% probability of not being exceeded during the life of the structure.

II. LITERATURE SURVEY

A. Overview

1. Site Selection Level at the Site

The level at the site must be higher than that of its surrounding so as to provide good drainage.

2. Climate Condition

The intensity of the rainfall and sub soil water level should be low as to avoid dampness in the building.

3. Sub-Soil Condition

A hard strata should be available at a reasonable depth so as to construct the foundation of the building safely and economically.

4. Availabilities of Modern Amenities

The site must be within municipal limits so that modern amenities like water supply, electricity, drainage, road etc. can be made available inner future if there is no provision at present.

5. Availabilities of other Facilities

The site should provide as easy access from the nearest road and after sufficient light and air, these should be good and cheap transport facilities available near the site, it is always better if public services like fire brigade, police station etc.

B. Surroundings

The situation and surrounding of the site must as to suit the purpose for which the building it to be constructed.

C. Building

Any structure constructed of what so ever material and used for residential, business education or other purposes is called building.

1. Types of the Building

- Based on occupancy
- Based on type of construction

D. Parts of a Building

A building can be divided into two parts

- Sub structure
- Super structure

1. Sub Structure

The part of a building constructed beneath the ground level is known as sub structure.

2. Super Structure

The part of the building constructed above ground level is known as super structure. it is second part of a building. All the activities of the building construction take place after the making of sub-structure. Flooring, wall roofing are the example of super structure of a building.

E. Material Used in Construction

Following are the materials used for the construction of a building.

- Bricks.
- Sand.
- Cement. .
- Stone.
- Coarse aggregate.
- Fine aggregate.
- Timber.
- Metal.
- Floor tiles.
- Roof tiles.
- Reinforcement.
- Plastic materials.
- Doors & windows.
- Asphalt bitumen.
- Coloring material.
- White cement.
- Paints & varnishes.
- Brick ballast.
- Sanitary materials.
- Water.
- Finishing tiles. etc.

1. Proposed System

- ETABS is the most preferred software.
- Done through software analysis.
- Can be done at very less time.
- Most accurate method.

2. Conclusion

In manual designing we can directly see the loads acting and their distribution on the system whereas in software analysis results are obtained directly.

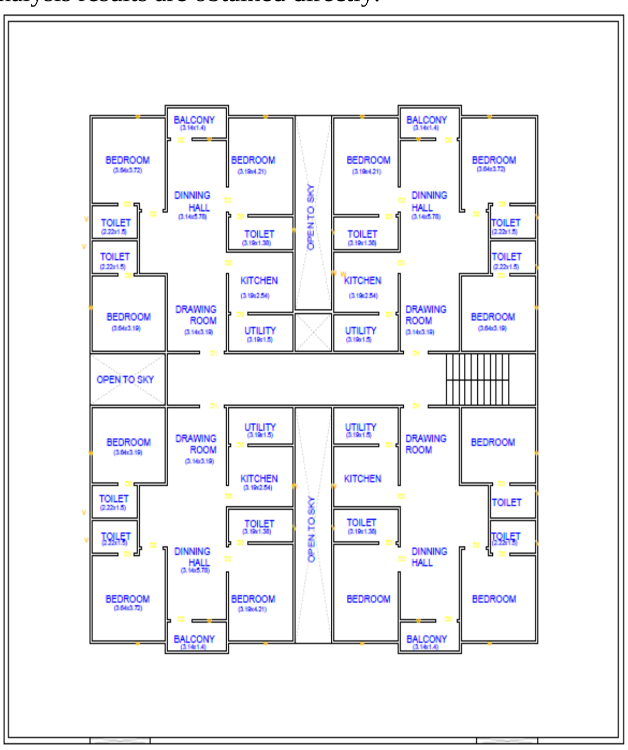


Fig.2. Typical Plan View of G+5 Building.

III. ANALYSIS

A. Loads

The reinforced concrete structures are designed to resist the following types of loads.

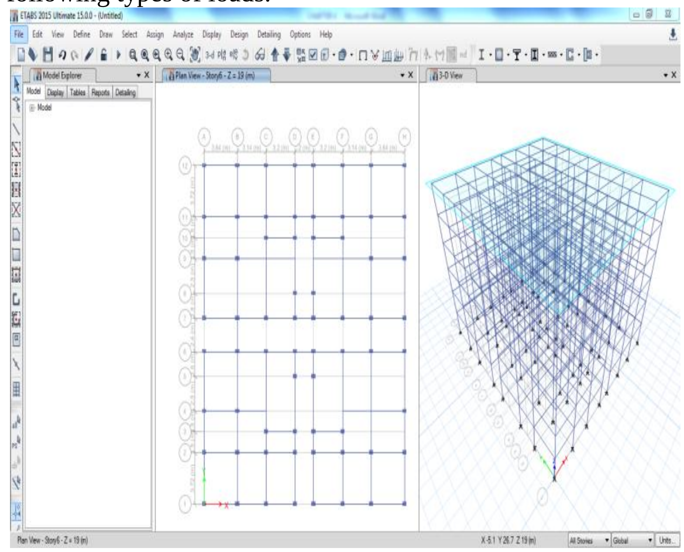


Fig.3. Plan View G+5 Building

B. Dead Load

Dead loads are permanent or stationary loads which are transferred to the structure throughout their life span. Dead loads mainly cause due to self-weight of structural members, permanent partitions, fixed equipment's and fittings. These loads shall be calculated by estimating the quantity of each material and them multiplying it with the unit weight. The unit weights of various materials used in building construction are given in the code IS 875 (part -1) -1987. The unit weight of commonly used building materials are given below:

TABLE II. Unit Weight of Common Building Materials

S.No.	Material	Unit weight KN/m^3
1	Plain concrete	24
2	Reinforced concrete	25
3	Brick masonry, cement plaster	20
4	Stone masonry	24
5	Wood	8
6	Steel	78.5
7	Floor finish	0.6-1.2

C. Live Loads (or) Imposed Loads

These are the loads that changes with time. Live loads or imposed loads include loads due to the people occupying the floor, weight of movable partitions, weight of furniture and materials. The live loads to be taken in design of buildings have been given in IS: 875 (part-2) -1987. Some of the common live loads used in the design of buildings are given below:

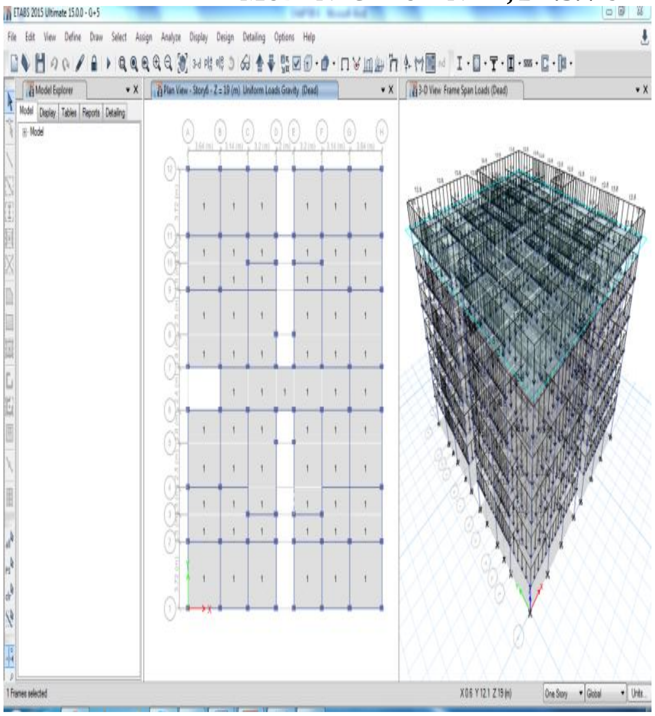


Fig.4. Plan Showing the Dead Load & Live load

D. Methods of Design of Reinforced Concrete

The aim of design is to decide the size of the member and amount of reinforcement required, so that the structure will perform satisfactorily during its life period with minimum cost. The following three methods have been developed for the design of reinforced concrete structures.

- Working stress method
- Ultimate load method
- Limit state method

1. Working Stress Method

Working stress method is based on elastic theory assuming reinforced concrete as elastic material. The stress-strain curve of concrete is assumed as linear from zero at neutral axis to a maximum value at the extreme fiber. This method adopts permissible stresses which are obtained by dividing ultimate stress by a factor known as factor of safety. For concrete a factor of safety of 3 is used and for steel it is 1.78. This factor of safety accounts for any uncertainties in estimation of working loads and variation in material properties. In working stress method, the structural members are designed for working loads such that the stresses developed are within the allowable stresses. Hence, the failure criterion is the stress. This method is simple and reasonably reliable The drawbacks of this method are

- Stress strain curve for concrete is assumed as linear, which is not true.
- Factor of safety doesn't predict the true margin of safety.
- The failure criteria assumed is stress but strain criteria is the reliable.
- The effect of creep and shrinkage of concrete is ignored.
- This method gives uneconomical sections.

This method has been deleted in IS 456-2000, but the concept of this method is retained for checking the serviceability states and cracking.

E. Design Values and Partial Safety Factors

1. Materials

The design strength of materials is obtained by dividing the characteristic strength by a factor known as partial safety factor. The partial safety factor takes in to account variation of material strength, local weakness etc.

The design strength of the materials, $f_d$is given by

$$\text{Design strength} = \frac{characteristic\ \ strength}{partial\ \ safety\ \ factor}$$

$$F_d = \frac{f}{rm} \qquad (1)$$

Where f=characteristic strength of the material

r_m= partial safety factor appropriate to the material and limit state being considered. The value of partial safety factors materials as recommended by IS 456-2000 are given below:

Table 3.3: Partial safety factor for material strengths, r_m as per IS 456-2000

TABLE III

Material	Limit state of collapse	Limit state of serviceability
Steel	1.15	1.0
Concrete	1.5	1.0

F. Specification

1. Detailed Specification

The detailed specification is a detailed description and expresses the requirements. The detailed specification of an item of work specifies the quality and quantities of materials the proportion of mortar. Workmanship. The method of preparation of work and excavation and the method of measurement the detailed specification of different items of work are prepared separately and describe what the works should be and how they shall be executed. Detailed specifications are written to express the requirement clearly in a convince from avoiding repetition and ambiguity the detailed specification are arranged as per order as the work is carried out the detailed specification of prepared properly are very helpful for the execution of work. The detailed specification form an important part of contract document. Every engineering Department prepared, the detailed specifications on various items of work and get them printed in order book from under the name. Detailed specification when the work or a structure or project is taken up instead of waiting detailed specification every time the printed detailed specifications are referred. The detailed specifications of various item of work are as follows

2. Reinforcement Cement Concrete *Steel*

Steel reinforcing bars shall be of mild steel or deformed steel of standard specifications and shall be free from corrosion, loose rust scales, oil, grease, paint etc. The steel bar shall be round, and capable of being bent accurately and placed in position as per design and drawing and bound together tight with steel wire at their point of intersection.

bars shall be bent cold by applying gradual and even motion of 40 mm(11/2") diameter and above may be bent by heating to dull red and allowed to cool slowly without immersing in water or quenching. Joints in the bar should be avoided as far as possible, when joints have to be made an overlap of 40 times diameters of the bar shall give with proper hooks at ends and joints should be staggered.

Fig.5. Screen 3.1: Steel Reinforcing Bars on Site

Fig.6. Screen 3.2: Centering and Formwork on Site During Execution

3. Proportion of Cement Concrete

Cement concrete shall be 1:2:4 proportion by volume for slabs, beams and lintels and 1:1½:3 proportion for columns under otherwise specified.

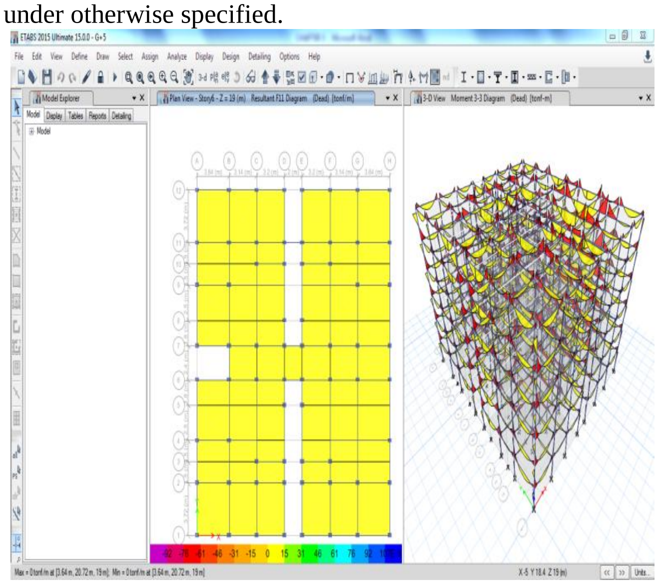


Fig.7. Plan Showing the Shear Force & Bending Moment

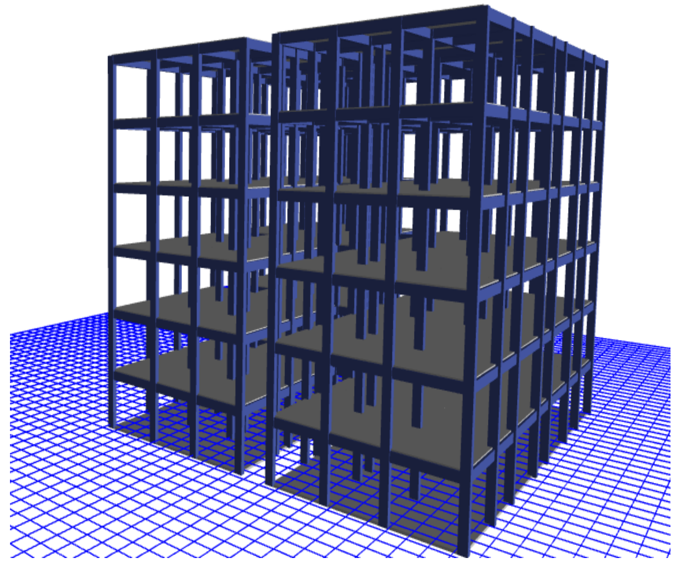


Fig.8. 3D Rendering View of Structure.

IV. DESIGN OF SLABS

Slabs are plane members whose thickness is small as compared to its length and breadth. Slabs are most frequently used as roof coverings and floors in various shapes such as square, rectangle, circular, triangular etc in buildings. Slabs supports mainly transverse loads and transfers them to the supports by bending action in one or more directions. Beams or walls are the common supports for the slabs.

A. Classification of Slabs

Slabs are classified based on many aspects;

1. Based on Shape

- Square, rectangular, polygonal, triangular etc.

2. Based on Type of Support

- Slab supported on beams, slab supported on walls, slab supported on columns.

3. Based on Support or Boundary Conditions

- Simply supported, cantilever, overhanging, fixed or continuous slab.

4. Based on Use

- Roof slab, floor slab, water tank slab, foundation slab.

5. Basis of Cross Section or Sectional Configuration

- Ribbed slab/grid slab, solid slab, filler slab, and folded slab.

Fig.9. Screen 4.2: One Way Slab

Fig.10. Screen 4.6: Cover Provision On Site

TABLE IV. Modal Direction Factors

Case	Mode	Period sec	UX	UY	UZ	RZ
Modal	1	0.775	0	0.999	0	0.001
Modal	2	0.66	0.258	0.001	0	0.741
Modal	3	0.64	0.742	0	0	0.258
Modal	4	0.255	0	0.999	0	0.001
Modal	5	0.214	0.131	0.001	0	0.869
Modal	6	0.207	0.869	0	0	0.131
Modal	7	0.15	0	0.999	0	0.001
Modal	8	0.123	0.033	0.001	0	0.966
Modal	9	0.118	0.967	0	0	0.033
Modal	10	0.108	0	0.999	0	0.001
Modal	11	0.087	0	0.999	0	0.001
Modal	12	0.086	0.009	0.001	0	0.99

V. SUMMARY AND CONCLUSIONS

A. Summary

Ground+5 buildings are considered as vertically irregular buildings as per IS 1893: 2002 that requires dynamic analysis considering strength and stiffness of the infill walls. IS 1893: 2002 also permits Equivalent Static Analysis (ESA) of OGS buildings ignoring strength and stiffness of the infill walls, provided a multiplication factor of 2.5 is applied on the design forces (bending moments and shear forces) in the ground storey columns and beams. The objective of the present study is to review the rationality of this approach. An existing RC framed building (G+3) with open ground storey located in Seismic Zone-V is analyzed for two different cases: (a) considering infill strength and stiffness and (b) without considering infill strength and stiffness (bare frame). Infill weights (and associated masses) were modelled in both the cases through applying static dead load. Non-integral infill walls subjected to lateral load behave like diagonal struts. Thus an infill wall can be modelled as an equivalent ‘compression only’ strut in the building model. Rigid joints connect the beams and columns, but pin joints connect the equivalent struts to the beam-to-column junctions. Infill stiffness was modelled using a diagonal strut approach as per Smith and Carter (1969). Linear static and dynamic analyses of the two building models are carried out to compare the force demand in the open ground storey frames. The code specified multiplication factor is compared with the ratio of their force demands. Two different support conditions are considered for the analysis to check the effect of the support conditions on the relative frame force demand. The support conditions considered are: pinned-end and fixed-end conditions. Nonlinear static (pushover) analysis is carried out for all the building models considered. First pushover analysis is done for the gravity loads incrementally under load control. The lateral pushover analysis is followed after the gravity pushover, under displacement control.

VI. CONCLUSION

Followings are the salient conclusions obtained from the present study:

- IS code gives a value of 2.5 to be multiplied to the ground storey beam and column forces when a building has to be designed as open ground storey building or stilt building. The ratio of IR values for columns and DCR values of beams for both the support conditions and building models were found out using ESA and RSA and both the analyses supports that a factor of 2.5 is too high to be multiplied to the beam and column forces of the ground storey. This is particularly true for low-rise OGS buildings.
- Problem of OGS buildings cannot be identified properly through elastic analysis as the stiffness of OGS building and Bare-frame building are almost same.
- Nonlinear analysis reveals that OGS building fails through a ground storey mechanism at a comparatively low base shear and displacement. And the mode of failure is found to be brittle.
- Both elastic and inelastic analyses show that the beams forces at the ground storey reduce drastically for the presence of infill stiffness in the adjacent storey. And design force amplification factor need not be applied to ground storey beams.
- The linear (static/dynamic) analyses show that Column forces at the ground storey increases for the presence of infill wall in the upper storeys. But design force amplification factor found to be much lesser than 2.5.
- From the literature available it was found that the support condition for the buildings was not given much importance. Linear and nonlinear analyses show that support condition influences the response considerably and can be an important parameter to decide the force amplification factor.

VII. SCOPE FOR FUTURE WORK

- The proposed results need to be validated by further case studies. Building models considered in this study are of low height and therefore influence of period-shift is negligible. For high-rise buildings shift-in-period can be an additional parameter what is not accounted in the present study.
- Another field of wide research could be the design of the infill walls considering the door and the window

openings which has not been considered in this research work.

- It is found in the present study that the multiplication factor of 2.5 as given in IS 1893:2002 is not justified through elastic force demand. However this factor may be required to achieve a ductile mode of failure and to avoid localized storey mechanism. This can be studied elaborately.

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