

THE INSTITUTION OF ENGINEERS, SRI LANKA
PART 3 (C) - PROJECT

An integrated approach for enhanced disaster resistance

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Contents

- 1.0 An integrated approach for enhanced disaster resistance
- 2.0 The precautions against tsunami
- 3.0 The precautions against earthquake
- 4.0 The precautions against cyclones
- 5.0 The integrated approach
- 6.0 conclusions

1.0 An integrated approach for enhanced disaster resistance

The main types of disasters that can affect Sri Lanka consist of tsunami, cyclones and earthquakes. These can affect both common infrastructure and houses. It is shown in the individual studies that although damage to some infrastructure is inevitable, they stand a better chance for survival since they are engineered structures. The real problem exists with the houses. This is due to reluctance on the part of the owners to incur extra cost for events that will not occur very often such as cyclones and earthquakes.

Therefore, using separate studies, cost effective methodologies were developed for each type of disaster to provide enhanced resistance.

2.0 The precautions against tsunami

Tsunami can create waves of varying heights that can affect the coastal region. The key to prevent collapse of a building in an tsunami is the ability to resist lateral loads. This will be very useful in conditions of partial submergence. The following precautions were suggested for enhanced tsunami resistance.

1. Locating the foundation deep.
2. Use of tie beam at window sill level and above the lintels.
3. Providing columns at least at four corners.

2.1 Effects of these precautions on earthquakes

Single and two story houses have a tendency to amplify the acceleration due to earthquakes. Thus, keeping all the components of the buildings intact will be very important for survival. In this context, the deep foundation can assist in reducing the damage due to liquefaction. The provision of tie beams at window sill level and above the windows can prevent disintegration. They can also assist in redistributing the stresses.

2.2 Effects of these precautions on cyclones

Cyclones exert lateral loads on walls. Therefore, an enhanced lateral loads carrying capacity will certainly be an advantage. Thus, the presence of tie beams at window sill level and above windows can enhance the cyclone resistance.

Cyclone will exert uplifting forces on the roof. The best strategy is to anchor the roof structure to the walls where the weight of the wall is used to resist the uplifting. Thus, the continuous lintel can be used for such restrains.

3.0 The precautions against earthquakes

The ability of a house to remain as one unit is the key to resist earthquakes when the masonry units are of sufficient strength. For this, the tie beam at the plinth level is recommended. This can act in conjunction with the other two tie beams at window sill level and above windows.

It is also important to prevent the instability of gable walls. In this context, the raising the internal partition wall sufficiently will be important.

3.1 Effects of these precautions on tsunami

The tie beam at plinth level will be very useful during tsunami induced scouring to prevent the disintegration of the foundation. It can also provide a firm base to the walls resisting the forces exerted by the waves.

3.2 Effects of these precautions on cyclones

Cyclones can also damage unsupported gabled walls. Thus, the provision of additional supports to gable walls will be of significant value for enhanced resistance.

4.0 The precautions against cyclones

Cyclone damage to the roof is resisted primarily by using the self weight of the structure. A well anchored roof can be of assistance to keep the structure intact during an earthquake. A well anchored roof can also enhance the lateral load carrying capacity of the wall.

5.0 The integrated approach

5.1 General

It shown that the ideal defense against natural disasters is an integrated approach. This is because of two reasons :

1. It is difficult to predict the nature of the next natural disaster. It may be an earthquake, cyclone or tsunami.
2. Some features adopted for one type of disaster can be useful for enhanced resistance of another.

Therefore, an integrated approach will be the most viable and cost effective solution.

5.2 The Guidelines

The following guidelines can be presented for a single story house:

1. Construct a foundation that is deep enough to prevent scouring specially with sandy soils.
2. Provide a tie beam at plinth level with two numbers of 10mm tor steel bars enhancing the connectivity and robustness of typical rubble foundation.
3. Provide tie beams at window sill level and above the windows.
4. Use stub columns starting from the lintel above windows to anchor the roof structure.
5. Ensure that there is sufficient height for cross wall so that the self weight will be sufficient to resist the uplifting forces induced by cyclones.
6. It is highly desirable to have additional supports to gable walls in the form of return walls for enhanced earthquake and cyclone resistance.

5.3 The Cost Implications

Wherever additional precautions are introduced for enhanced safety, these will be additional costs. It is shown that the additional cost can be about 6% - 8% for enhanced earthquake and cyclone resistance. It rise to about 24% - 27% when tsunami resistance also included.

A disaster resistant house has the ability to save lives. When the cost to the national economy is considered at 2.2 million for a fatality and 1.2 million for a grievous injury, it would be possible to justify the extra cost of providing the enhanced disaster resistance.

6.0 Conclusions

It is proposed to have an integrated approach to resist the adverse forces exerted by a multitude of disasters that has to possibility to strike Sri Lanka. Such an approach will be useful to improve the confident of the general public and also to minimize the loss of lives and serious injuries.