Performance of Sidr affected a Few Typical Non-engineered Buildings at the Ganges Delta

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Summary

A tropical cyclone of velocity more than the Basic Wind Speed recommended by the Indian Wind Code, slammed the Bangladesh coast around 100km east of the Sagar Islands, India in the evening of 15th November 2007, affecting the lives of millions of people. The vulnerability of the Ganges Delta to large storm surges, due to its minimal topography was demonstrated after the passage of the Cyclone Sidr. Such devastations give one a rare scope to study their impact, especially on the non-engineered building elements, which constitute shelter for major segment of the population. This paper reports some of the major and prominent findings of two reconnaissance based vulnerability and damage surveys undertaken at the Sagar Islands, India and the Khulna and Barisal Divisions of Bangladesh.

Keywords: Anchorage; bamboo; bolting; Cyclone Sidr; GI sheet; hinge formation; non-engineered; overturning; roof structure; wood.

1. Introduction

The Ganges Delta, the abode of 125-143 million people, is world‘s one of the most cyclone prone regions. Administratively two-thirds of this region lies within Bangladesh and the rest in India. The vulnerability of this region to large storm surges due to its minimal topography was demonstrated time and again in the past. It is a matter of deep concern that the major casualty of such natural disasters has particularly been the people from the lowest socio-economic strata of the society who can hardly manage to have an engineered shelter. With this context the Cyclone Sidr, which hit the Bangladesh coast in the evening of 15.11.2007, was considered as a rare scope for studying the impact of cyclones, especially on the non-engineered building elements, which constitute shelter for major segment of the population. The fact that the reported velocity of the Cyclone Sidr is more than the Basic Wind Speed recommended by the Indian Wind Code inspired the authors to take the challenge of utilising this opportunity for learning from nature. Accordingly technical visits were undertaken to the Sidr affected areas within Sagar Islands of India and Khulna and Barisāl Divisions of Bangladesh to identify the various forms of damages experienced especially by the non-engineered structures and thereby pointing out the inadequacy of the design and construction practices. Some of the major findings and observations are reported in the present paper pending a detailed study with a thorough analysis of damaged structures.

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2. Discussion

The non-engineered buildings of the Ganges delta are predominantly pitch-roofed single-storied rectangular structures. The survey observed bamboo and wood as the primary material used for the construction of roof structures in the Indian and the Bangladeshi portions of the Delta respectively; while the dominant roof cladding material being burnt clay-tiles and G.I. sheets of non-uniform quality respectively. However, people who cannot afford wood are found to use bamboo as a replacement material in roof-structure as well as in the building skeleton. Again, people who can partially afford are often found to use small brick piers to a limited extent. The walling consists of either unreinforced brick masonry, or various combinations of G.I. sheets, tin sheets, wooden planks, bamboo mat etc. It was inferred through discussion with the local craftsmen that high rainfall and low elevation of the area has forced them to adopt the faulty custom of not providing sufficient anchorage to wooden or bamboo columns.

The study of the damage profile suggests that one of the primary reasons behind the various types of failures of the surveyed non-engineered buildings is weakness at the junctions of different structural elements. Failures of roof cladding materials of different structures were surveyed to be the commonest area of damage due to cyclones. The causes are usually inappropriate fastening devices, inadequate thickness of the cladding materials and insufficient frequencies of fasteners in the known areas of greater wind suction. It was observed that many-a-time, the wooden beams and the wooden columns were anchored with each other through a single nail or at the most through a single bolt. At the time of withstanding the lateral thrust of the Sidr, these junctions have acted as hinges, which allowed rotation of the members around the junctions and resulted into consequent damages. Further, a close inspection of the local building-construction practice revealed the fact that wooden / bamboo columns are simply placed over tiles or blocks of masonry without any attachment or anchorage in lieu of foundation. In the absence of any proper foundation, many building structures suffered overturning and / or dragging on the plinth. Figure 1 is a representative illustration of total devastation portraying the various types of damage profiles discussed above.

Fig 1: Totally devastated Residential Building at the Nalchhity Municipality, Jhalakathi District, Bangladesh

Apart from the above stated damage profile, the investigators came across certain examples in both sides of the international border, where non-engineered buildings survived Sidr in areas, which were otherwise devastated. It was observed that these buildings were near square in plan with pyramidal four-sloped roof and little roof overhang, where roof angles were restricted within a range of 30° - 45°. The roof trusses were properly connected with each other and to the system of vertical load bearing members.

3. Concluding Remarks

The present paper reports preliminary observations regarding the impact of Cyclone Sidr on the non-engineered buildings of the Ganges Delta. Prima-facie observations reveal failure of roof structure as the major mode of damage. Other modes of damage include overturning of structures due to improper foundation and hinge formation at the junctions of members. However, these primary observations need to be supplemented by detailed analysis along with suggestive guidelines. A further damage analysis through many other observed case histories is under progress to achieve this end and is expected to be reported in near future.

4. Acknowledgement

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