FAILURE OF ROOF STRUCTURE DUE TO WIND LOAD

LEE SID HWA

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Universiti Teknologi Malaysia

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ABSTRACT

There are reported roof failure due to uplifting of the roof structures or roof sheeting during rainstorm has been causing damages to the buildings. Generally, failure occurred at the two points, either at the roof truss's sheeting or at the truss to roof beam connections. There are 2 types of structure are to be analyzed; the different of these two building will be the buildings dimension, meaning that one is a single storey houses and other is a 20 storey apartment. The roof structure's data is extracted from the reported cases for simulation purposes. For a more conservative result, the wind speed is taken as 40 m/s. Due to different aspect for this 2 type of structure, the wind-uplifting force will be determined. The calculated resulting forces transferred at different connection points were compared with the experimental result obtained from laboratory testing. The result of this, is that the connection of both houses and apartment is safe under the wind speed of 40m/s. However, this happen when the proper used of selected material plus all the material is in well condition. To improve the study of this project, the larger scale testing like wind tunnel can provide the more accurate result due to the integrity of the roof structure.

ABSTRAK

Seperti yang dicatat dalam bahan bacaan seperti suratkhabar, kes-kes kepingan atap yang dicabut oleh angin kuat dalam hujan lebat menyababkan kegagalan struktur bumbung. Sebenarnya menurut kajian yang telah dilakukan, biasanya kegagalan struktur bumbung berlaku di 2 tempat, iaitu di tempat sambungan pada komponen-komponen kayu dan paku atau kepingan zink yang dipaku pada gulung gulung. Oleh itu, 2 jenis struktur akan dikaji untuk menyelidik bahawa faktor-faktor ketinggian, saiz, dan lokasi akan menjadi sebab kegagalan struktur bumbung. Perhubungan antara bangunan apartment yang setinggi 20 tingkat dan rumah biasa setinggi satu tingkat. Untuk mendapatkan bacaan yang lebih selamat, halaju angin adalah 40 m/s. Selepas pengiraan untuk kapasiti pada setiap sambungan, kapasiti yand dikaji akan selamat dalam halaju angin 40 m/s. Tetapi keputusan ini adalah benar jikalau semua komponen dalam struktur adalah baik. Pada akhirnya, kajian ini mencadangkan penggunaan Wind Tunnel untuk mendapatkan keputusan yang lebih memuaskan.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The roof is often the most expressive part of a house, symbolic of shelter and functionally important for its capacity to protect the house from the element. However, sometimes we tend to ignore the roof structure and put the concentration on the structural member like beam and column. However, there is some real life report, wind has cause of damage to buildings.

As printed on the newspaper or magazine, there is some cases that related to the failure of roof structure due to the wind blow especially at rainstorm. Due to this tragedy, there is something that can do to reduced or minimize through some study or research to the wind load effect on the roof structure.

Wind damage in rainwater tends to occur progressively, usually starting with damage to one of the components forming the building envelope (typically the roof, cladding or unprotected windows), and which, if it progresses far enough, can lead to failure of the complete structure. Even in cases where complete structural failure does not occur failure of the building envelope often allows wind-driven rain to

penetrate the building leading to damage to the contents as well as loss of function. The loss of roof sheeting is often attributed to the loss of roof sheeting is often attributed to either inadequate nailing.

For roof pitches in the range commonly used for residential structures, wind forces oriented normal to the ridge of the roof will cause wind uplifting forces. Sometimes, there are weakness could extend the damage from wind; these weaknesses involve the attachment of roofing to the roof sheathing. The sheathing attachment to the roof framing, rake overhang details, and attachment of internal partitions to the external walls contributes significantly to the extensive damage and to system failures.

For country that located at near the equator like Malaysia, the temperature is high all year round (except at altitude). In many tropical regions people identify two seasons: wet and dry. Unlike the foreign country, phenomenon like hurricane, snow fall doesn't happen on this area, but when the raining monsoon occurs: a large amount of rainwater will fall, makes the withdrawal of water is crucial to avoid leaking or water spill out. This is why pitched roof is so common compared to flat roof throughout the country. Timber made roof truss has such advantages:

- Lowest overall cost.
- Fast to install.
- Requires ordinary tools and
- Doesn't require skilled labour to install.
- Virtually any roof and ceiling is possible.
- Engineered product.
- No job site waste.

1.2 Problem Statement

Throughout these years, there are some cases that related to the failure of roof structure due to the wind blow especially at rainstorm. Due to this tragedy, there is considered vital if there is a way that can do to reduced or minimize through some study or research to the wind load effect on the roof structure.

For example, there are some real life cases like in the US, wind is the most common, and the most costly cause of damage to buildings. Over a 7 year period from 1986 to 1993 extreme wind damage cost $41 billion in insured catastrophe losses as compared to $6.8 billion for all other natural hazards combined. Reasons given for these losses include: increased development in high risk areas, a lack of awareness of or failure to follow recommended construction practices and the introduction of new and unproven materials. Economic losses include repairing or replacing damaged homes and their contents, while the loss of personal possessions and relocation during reconstruction are common outcomes of residential damage.

Figure 1.1: Some of the common example of roof failure

Uplifting of the roof structures or roof sheeting during rainstorm has been causing damages to the buildings. Generally, failure occurred at the two points, either at the roof frame's sheeting or at the frame to roof beam connections. There are 2 types of structure are to be analyzed; the different of these two building will be the buildings dimension and geographical locations.

Wind damage in rainwater tends to occur progressively, usually starting with damage to one of the components forming the building envelope (typically the roof, cladding or unprotected windows), and which, if it progresses far enough, can lead to failure of the complete structure. Even in cases where complete structural failure does not occur failure of the building envelope often allows wind-driven rain to penetrate the building leading to damage to the contents as well as loss of function.

1.3 Objective of Research

Residential houses located in the countryside region (kampung houses) that were relatively unsheltered from the full force of the storm incurred the decent damage. The damage to these houses presented a unique opportunity to investigate the type and extent of damage to this type of structure.

The objectives of this study are:

a) To investigate the roof structure elements and their tying down system that frequently failed due to wind forces.

b) To determine the minimum wind speed required which causes the uplifting of the roof of various construction and age.

c) To review the safety of the presently practiced construction of roof structure.

1.4 Scope of Research

The scope of this research is to determine the ways to succeed the objectives. One of these was the calculation of connection capacity. For those countryside housing estates, it had presumed that all connection using nails rather than the metal connection plate that used recently due to the age of the existing houses. And so, the weakness in strength is the main focus of the research.

For the worst case environment performance, the experimental circumstances practiced for extreme possibility, means the testing data based on the highest wind speed that occurred before.

Moreover, this research will also determine the effect of the failure pattern of the roof connection that due to strong wind blow condition. The connection part that involved was connection between zinc roof sheeting and purlin; purlin and rafter; and also the rafter and beam.

The result decided through the testing by laboratory equipment or through certain calculation. And through that, the roof structures ultimate storm resistance can be calculated. Data obtained through experiments will be analyzed and suggestions will be given as necessary.

1.5 Significance of the Research

At the end of the research, the wind speed limit, ultimate resistance and effect under severe weather will be provided, as an understanding and awareness to

the involved parties. With this, whenever the resident know about the current wind speed, they will know the consequence of roof structure failure. To avoid the tragedy again, repairing and strengthening of roof structure maybe needed.