WIND HAZARD IN PENINSULAR MALAYSIA: LEVEL OF AWARENESS

MUHAMMAD SYAMIM BIN EMBONG

Thesis submitted in fulfillment of the requirements
for the award of degree of
Bachelor of Civil Engineering

Faculty of Civil Engineering and Earth Resources
University Malaysia Pahang

JUNE 2013

ABSTRACT

Wind hazard risks in Malaysia due to windstorm are increase rapidly. From the record it shows that number of buildings structure damage and failure mostly due to thunderstorm. Awareness among Malaysian needs to conduct to ensure the level of knowledge regarding wind hazard. Survey was conducted to indicate the level of awareness and knowledge. Result shown that public awareness are low and not well notified about wind hazard. While for constructor and engineers, there are notified the wind hazard. However the implementations in design are not given prioritized. For that, it can conclude that level of awareness among Malaysian mostly still low

ABSTRAK

Risiko bahaya angin di Malaysia berikutan ribut yang meningkat dengan pesat. Daripada rekod, ia menunjukkan bahawa jumlah bangunan kerosakan struktur dan kegagalan kebanyakannya disebabkan oleh ribut petir. Kesedaran di kalangan rakyat Malaysia, perlu dijalankan untuk memastikan tahap pengetahuan mengenai bahaya angin. Kajian telah dijalankan untuk menunjukkan tahap kesedaran dan pengetahuan tentang bahaya angin. Keputusan menunjukkan bahawa kesedaran awam adalah rendah dan tidak baik dimaklumkan mengenai bahaya angin. Manakala bagi pembina dan jurutera, ada diberitahu mengenai bahaya angin. Walau bagaimanapun, pelaksanaan dalam reka bentuk yang tidak memberikan keutamaan. Untuk itu, ia boleh membuat kesimpulan bahawa tahap kesedaran di kalangan rakyat Malaysia kebanyakannya masih rendah.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Malaysia often has catastrophic consequences of flooding and storm events that cause damage to property, loss of life and population displacement Incidents such as Tropical Storm "Greg" who hit the West Coast Sabah on December 26, 1996 in which more than 200 people dead and 4,925 homes destroyed and big floods cover the entire state of Johor, Melaka, Negeri Sembilan, Pahang, Kelantan, Terengganu, Sabah and Sarawak in December 2006 has resulted in a loss of very large for the country

Disasters can be defined as an occurrence of a sudden, are complex and result in loss of life, destruction of property and the environment and affect the activities of the local community. Management requires efficient and effective coordination to mobilize resources, equipment, frequency and extensive use of manpower from various quarters. It also involves a complex action and requires a long period to resolve

Awareness of the risks of natural disasters due to climate change is critical to the economic development of an area in which we are now threatened with disaster in unexpected areas and not in the proper place or time. Therefore, risk management expertise is being tested to provide a first step to identify and assist public and private organizations as well as to the effects of disasters can be reduced to the lowest level regardless of loss of property or economic.

Through exposure, the public can play a role as well understand early action they have to do before disaster assistance arrived at the scene. Without the cooperation of the public is difficult for disaster relief machinery to do the work of rescue in the event of an incident.

Important public role because they are the people who were at the scene while waiting for help to arrive, they know what to do. Although the state's rare serious natural disasters but early preparation should be done so that they can play a role to help. In addition, the government media and the private sector also play a very important role in disseminating awareness programs and information in real time to the community in the event of a disaster.

1.2 PROBLEM STATEMENT

On August 13, 2010 left a scar and deep impression on people of Malaysia especially people around Melaka because on that day there was an incident happened in the wind hazard at Bazar Ramadhan Jasin. It has killed three lives and 18 others were injured due crushed by tent. From the incident has given a lesson to all the importance of establishing an early warning system in Malaysia. However, would not be effective early warning if people do not know what to do when receiving an early warning. From this, we can know the importance of public awareness of the dangers that wait upon when the wind hazard occurs. The effect of incident, the level of awareness among the people increases especially on wind hazard that have a great deal of influence on the design of structural engineering.

Figure 1.1: The damage due to wind disaster

Source: Berita Harian Online 2010

Since there are many damage occur for engineered and non-engineered building during the wind disaster and mostly are located at remote area. The engineers built the structure without having enough information and knowledge especially considering wind load on their design.

1.3 OBJECTIVES OF STUDY

The objective of this study is:

i. To study level of awareness regarding wind hazard in Malaysia.
ii. To identify and evaluate consideration on wind loading for Malaysian construction practice.

1.4 SCOPE OF STUDY

The Scope of study are this follows:

i. Level of awareness due to wind hazard due to wind hazard.
ii. Consideration on wind loading Malaysian construction practice.

CHAPTER 2

LITERATURE REVIEW

2.1 Wind Engineering

Wind engineering analyses effects of wind in the natural and the built environment and studies the possible damage, inconvenience or benefits which may result from wind. In the field of structural engineering it includes strong winds, which may cause discomfort, as well as extreme winds, such as in a tornado, hurricane or heavy storm, which may cause widespread destruction

Wind disasters pose a variety of problems in Malaysia particularly in residential area and commercial building, causing concerns for building owners and an engineer. Winds disaster easily can destroy buildings especially the roof. Debris such as signs, roofing material, and small items left outside become flying missiles in hurricanes. Extensive damage to trees, towers, water and underground utility lines (from uprooted trees), and fallen poles cause considerable disruption.

The awareness among the respective people is also increase but however the numbers people involve wind engineering activities in Malaysia still fewer. Currently there are no by law association regarding Wind Engineering Society in Malaysia. Most of possibility risk of wind hazard base on recent wind-induced damage to buildings and structures in Malaysia is due to thunderstorm. There are very little emphasizes of design building structure such as roof and cladding to minimize wind induced damage to buildings. Several study had made by previous researchers in Malaysia. From the study made there are several factors are founded to contribute damage to building component. It can be conclude most of the failures cause by lack of the consideration due to wind effect during design stage as has been proven. Since there are many damage occur for non engineered build during the thunderstorm. Most of non engineered buildings are located at remote area. The houses are builds by local expertise which doesn't have any technical knowledge. Therefore the initiatives to create the awareness among local expertise at remote area are taken. There is an issue where most of them cannot appreciate the previous technical brochures given since the content cannot be understood by them. This challenge has been taken by preparing the brochure that easily can be understood (Majid et. al. 2010)

In naturally, "wind is term used for air in motion and is usually applied to the natural horizontal motion of the atmosphere has been studied" (B. S Taranath, 2005). Although one cannot see the wind, it is a common observation that its flow is quite complex and turbulent in nature. Malaysia is located near the equator. In general, the wind climate is dominated by the two monsoon seasons and the inter-monsoon thunderstorms. The northeastern monsoon blows from December to March, usually accompanied by heavy rains. Around June to September, there blows the southwestern monsoon which is slightly tranquil. Thunderstorms frequently occur during the inter-monsoon periods. Although thunderstorms are localized phenomena, they often produce significant strong and gusty surface winds. (Majid et. al. 2012).

According to Bienkiewicz "A research on wind hazards can reduce economic losses resulting from future strong-wind events. Whereas several success stories can be cited, there is a pressing need to continue such research in the future, at an accelerated rate". Wind disasters come in many forms, including storm surge, heavy rainfall, flooding, high winds, and tornadoes. The National Weather Service is responsible for protecting life and property through issuance of timely watches and warnings, but it is essential that your family be ready before a storm approaches. High-rise buildings are also vulnerable to wind disasters, particularly at the higher levels since wind speed tends to increase with height.

Recent research suggests you should stay below the tenth floor, but still above any floors at risk for flooding. It is not uncommon for high-rise buildings to suffer a great deal of damage due to windows being blown out. Consequently, the areas around these buildings can be very dangerous. Reducing wind hazards risk is a long term commitment that builds on past experience and advances in our understanding of wind, wind induced loading and response of structures, impact of wind generated debris, and effects of other natural phenomena associated with strong winds as has been carried out by (Holmes et. al. 2009)

Tools for assessing the impact of wind hazard events should be developed and improved. A greater effort must be made to study and learn from the aftermath of wind events and investigations of wind-impacted structures should be enhanced by including a broader spectrum of structures, including critical infrastructure. More comprehensive data on wind and windstorm should be collected and data exchange on damage and loss should be encouraged. New methods to predict the risk or loss and damage due to windstorm should be developed with appropriate simulation and modeling tools. Improved understanding of the effects of wind-borne debris on structures as well as the additional risk to structures from wind-driven rain, ice and hail are other important issues.

Information regarding risk and preparedness should be broadly distributed in a community. This should is because, effective decision making for warning and evacuation, increased understanding of household and community adoption of preparedness measures, improved understanding of the role of improvisation and resilience in emergency preparedness and response, increased understanding of community physical, economic and social recovery from wind related disasters.

As with any other kind of disaster, community resilience is further determined by how quickly essential services are restored after a wind event. Damage resistant infrastructure must be designed and new technical methods must be developed for rapid repair of damaged infrastructure and restoration of services. Without restoration of essential services, like electricity and gas for cooking, potable water for drinking or telephone lines for communication, extreme community disruption will occur has been studied (P. Gaus, et. al. 2001)

2.2 WIND SPEED

At great heights above the surface of the earth, where frictional effects are negligible, air movements are driven by pressure gradients in the atmosphere, which in turn are the thermodynamic consequences of variable solar heating of the earth. This upper level wind speed is known as *the gradient wind velocity*. Different terrains can be categorized according to their associated roughness length. In practice, it has been found useful to start with a reference wind speed based on statistical analysis of wind speed records obtained at meteorological stations throughout the country. The definition of the reference wind speed varies from one country to another. Basic design wind speeds for different directions and different return periods can be derived using a rigorous analysis incorporating probability distributions for wind speed and direction

2.3 DESIGN WIND LOAD

The characteristics of wind pressures on a structure are a function of the characteristics of the approaching wind, the geometry of the structure under consideration, and the geometry and proximity of the structures upwind. The pressures are not steady, but highly fluctuating, partly as a result of the gustiness of the wind, but also because of local vortex shedding at the edges of the structures themselves.

The fluctuating pressures can result in fatigue damage to structures, and in dynamic excitation, if the structure happens to be dynamically wind sensitive. The pressures are also not uniformly distributed over the surface of the structure, but vary with position. The complexities of wind loading should be kept in mind when applying a design document. Because of the many uncertainties involved, the maximum wind loads experienced by a structure during its lifetime, may vary widely from those assumed in design. Thus, failure or non-failure of a structure in a wind storm can not necessarily be taken as an indication of the non-conservativeness, or conservativeness, of the Wind Loading Standard. The Standards do not apply to buildings or structures that are of unusual shape or location. Wind loading governs the design of some types of structures such as tall buildings and slender towers. It often becomes attractive to make use of experimental wind tunnel data in place of the coefficients given in the Wind Loading Code for these structures.

2.4 TYPES OF DESIGN WIND LOAD

Typically for wind sensitive structures there are three basic wind effects:

i. Environmental wind studies to investigate the wind effects on the surrounding environment caused by erection of the structure (e.g. tall building). This study is particularly important to study the impact of wind on pedestrians, motor vehicles and architectural features such as fountains, etc, which utilize public domain within the vicinity of the proposed structure.

ii. Wind loads for façade to assess design wind pressures across the surface area of the structure for designing the cladding system. Due to the significant cost of ordinary façade system based on very high total cost of building, the engineer cannot afford the luxury of a conservative in assessing the design wind load.. With due consideration to the complexity of building shapes and dynamic characteristics of the wind and building structures, even the most advanced wind codes generally cannot accurately assess design loads. Wind tunnel testing to assess design loads for cladding is now normal industry practice, with the aim of minimizing initial capital costs, and more significantly avoiding expensive maintenance costs associated with malfunctions due to leakage and/or structural failure.

iii. Wind loads for structure – to determine the design wind load for designing the lateral load resisting structural system of a structure to satisfy various design criteria.

2.5 DESIGN CRITERIA

In terms of designing a structure for lateral wind loads the following basic design criteria need to be satisfied.

i. Stability against overturning, uplift and/or sliding of the structure as a whole. Strength of the structural components of the building is required to be sufficient to withstand imposed loading without failure during the life of the structure.
ii. Serviceability for example for buildings, where inter storey and overall deflections are expected to remain within acceptable limits. Control of deflection and drift is imperative for tall buildings with the view to limiting damage and cracking of non structural members such as the facade, internal partitions and ceiling

2.6 CODE PROVISIONS FOR WIND LOADS

Wind loading codes and standard have achieved wide acceptance among practicing structural engineer whereas the wind code is the guide in calculating wind loading although great accuracy cannot be obtained from them. In recent years, wind loads specified in codes and standards have been refined significantly. This is because our knowledge of how wind affects buildings and structures has expanded due to new technology and advanced research that have ensued in greater accuracy in predicting wind loads. We now have an opportunity to design buildings economically without compromising safety. Most international codes and standards utilize the "gust loading factor" (GLF) approach for assessing the dynamic along-wind loads and their effects on tall structures. The concept of the GLF for civil engineering applications was first introduced by Davenport (1967), following the statistical treatment of buffeting in aeronautical sciences (Liepmann 1952). Several modifications based on the first GLF model by Davenport followed, which include Vellozzi and Cohen (1968), Vickery (1970), Simiu and Scanlan (1996), and Solari (1993a, b). Variations of these models have been adopted by major international codes and standards.

Advanced wind loading codes and standards invariably contain the following features:

i. A specification of a basic or reference wind speed for various locations, or zones, within jurisdiction. Almost always a reference height of 10 m in open country terrain is chosen.
ii. Modification factors for the effects of height and terrain type, and sometimes for: change of terrain, wind direction, topography, and shelter.
iii. Shape factors (pressure or force coefficients) for structures of various shapes.
iv. Some account of possible resonant dynamic effects of wind on flexible structures.

Wind loading codes come in many shapes and forms, sometimes being stand-alone documents, sometimes part of larger loading codes and sometimes part of structural design codes. Below are few example of major international standard wind code that has been widely used:

i. European, BS EN 1991-1-4:2005. Eurocode 1: Actions on structures. Part 1-4: General actions- Wind Actions
ii. American Standard ASCE 7-02. Minimum Design Loads for Buildings and Other Structures
iii. Japanese, AIJ Recommendations for Loads on Buildings
iv. Australian/New Zealand Standard AS/NZS1170.2
v. British Standard. Loading for Buildings. Part 2. Code of practice for wind loads BS6399: Part 2
vi. The Chinese national loading code GB50009
vii. Hong Kong Wind Code
viii. The Canadian national building code NBCC

Beside the major international standard there are few countries adopted the codes and derive it into their own local code such as the Indian code IS:875 (Part 3) derived from British, Australian, New Zealand and American standard and the Malaysian code MS 1553:2002 Code of practice on Wind loading for building structures are based on AS/NZS

1170.2:2002. Most buildings are designed using wind loading codes rather than wind tunnel testing. Code-based predictions of wind loading may be used throughout the design of a building, or may just be used as an intermediate step before wind tunnel testing is conducted.

2.7 AGAINST WIND DAMAGE

A well-connected house is one that is soundly designed and constructed using the continuous load path method of construction. This requires that a home is built using a system of connectors at all the joints from the roof to the foundation thereby redistributing the external pressures of wind from the frame of the house to the foundation. This flier highlights connectors that, when used properly, will help resist wind's overturning forces.

During a thunderstorm, hurricane or tornado the force of wind on a house works in three ways:

i. It exerts horizontal pressure on the structure which can cause the structure to "tilt" – this is called shear or racking. The structure can move off of the foundation – this is called sliding.
ii. It exerts a lateral force. If the structure is unable to slide, it causes the structure to rotate off of its foundation. This is called overturning
iii. As it flows over the roof the wind create a strong lifting effect, much like that of air flowing over an airplane wing. This is called uplift.

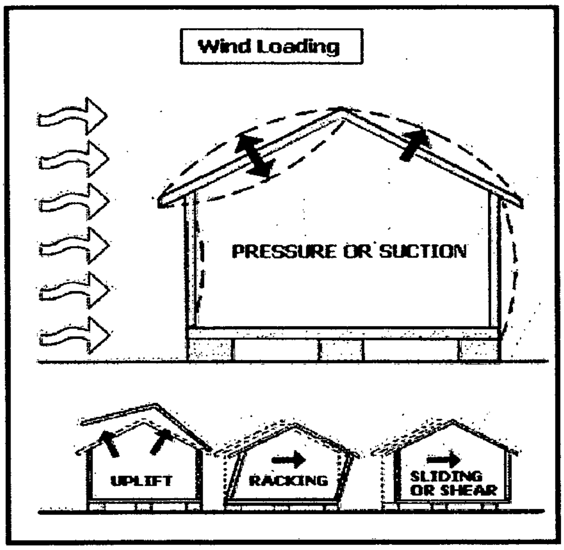

Figure 2.1: Components need to be considered when design wind load.

Wind loads Buildings and their components are to be designed to withstand the code-specified wind loads. Calculating wind loads is important in design of the wind force-resisting system, including structural members, components, and cladding, against shear, sliding, overturning, and uplift actions

J.D. Holmes1 stated when wind hits a building, pressure is exerted against the building as the air pushes against the sides and moves up and around the building. Wind uplift is a force that occurs when the pressure below a roof is greater than above it. This can happen from many different ways but is usually because pressure above the roof system decreases by high air flow (wind) or pressure increases inside a building from air pressure buildup. When wind uplift is greater than the system was designed for, the roof could potentially lift off the building.

Wind can severely damage a home via uplift, racking, sliding, and overturning. Uplift occurs when the wind flows over the home's roof, creating a lifting effect. It can separate the home from the foundation, the second story from the first story, and the roof from the home. Racking and sliding occur when the wind exerts pressure on the home's side, causing it to tilt out of square or move off of its foundation. Overturning occurs when strong wind that is unable to rack or slide a home ultimately rotates the home off of the foundation. Wind also can cause damage indirectly via windborne debris that becomes destructive and deadly missiles.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter describes the research plans are made that include information to be collected, sampling methods, data analysis methods used and respondents were involved. This chapter also covers methods of collecting data from samples taken. Surveyed parties are public, contractors and consultants and those involved in the construction sector.

3.2 DATA COLLECTION

Information obtained from this survey revolves around the awareness of the public about what to do if a wind disaster occurs. Information obtained for statistical level of public awareness of the wind hazards. This information is also to identify and evaluate the consideration on wind loading Malaysia construction practice. In this study, the questionnaire will be distributed to the public, contactors and engineers to get their feedback on the wind disaster.

3.3 QUESTIONNAIRE

Through the questionnaire method, it covers several levels where it is important in the process of gathering the information required in this study. The processes involved in this method are:

i. Questionnaires preparation
ii. Distribution of questionnaires
iii. Acceptance questionnaires

3.3.1 Questionnaires preparation

This stage is the most important stage in order to obtain the best possible information for the research. This preparation is important to ensure that the questions presented in the form meets the requirements to obtain sufficient data and information.

Questionnaires produced contain five printed pages including the front page as agreed by the supervisor from the discussion. The questionnaires were made to the questions they deem appropriate for the target aimed. Various questions have been composed, designed and organized to get feedback and data for further study. Production of this questionnaire is based on the objectives and scope of the set on beginning of the study.

i. Part A

   Part A requires the respondent to fill information about the respondent's own self. This information is such as gender and age. All questions require respondents fill out the information in the space provided and mark (/) in the space.

ii. Part B

   Part B has a most of fifteen questions related to what actions should be taken if the wind disaster occurs. In this part, questions 1 to 10 only has two options, Yes or No. While questions 11-15 have 3 options, all questions require respondents choose only one answer. Questions 1-10 to understand the background of the respondents related to their understanding of the questionnaire. While questions 11-15 seeking views on the state when the wind disaster occurs.

iii. Part C

Part C, for this par need to be answered by the construction field or relevant only. This part has five most of questions related to wind loading.

3.3.2 Distribution of questionnaires

After completed questionnaires printed, the form of the distribution process will do. In this stage, questionnaires sent to respondents. Questionnaires were sent to the respondents was 55 sample. Questionnaires will be distributed to the public, contractors and engineers.

3.3.3 Acceptance questionnaires

Acceptance the questionnaire was conducted after the distribution. Usually, acceptance of questionnaires sent is less than the amount sent. In the case of this study, the acceptance form is impressive and it reached the desired amount.