Abstract

Project Title: A Cost Analysis for Safe Low-Rise Building Structures in Chiang Mai, Thailand

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Degree: Master of International Business Administration

Completion Date: March 2013

Number of Pages: 66

Chiang Mai is one of the three most at risk provinces of Thailand for seismic activity. Findings indicate that the most at-risk buildings in Chiang Mai are low-rise concrete post-and-beam buildings, which account for over 84% of buildings within Chiang Mai city limits. With the anticipated 6.0 magnitude earthquake, a local expert estimates 47% of Chiang Mai city buildings will have extensive damage or collapse. The purpose of this research is to quantify the cost of improving local building construction to a safe standard, enabling local engineering firms to adequately market themselves, thus bridging the gap between sound business principles and safe construction practices.

There were three objectives for this research: 1.) Determine the most threatening factors of Chiang Mai buildings. 2.) Design a building to the International Building Code for seismic, wind, flood, and vertical forces 3.) Compare the costs of the sample current local building structure to the cost of the sample IBC building structure. This has been accomplished by evaluating a sample local building to compare local construction practices to the international building code design standard, then calculating the difference in cost between the two models.

The cost analysis was conducted using the tabular method. Comparing the cost of the control model to the IBC model by level, an increase of 2,186 THB (2.7%) was required at the roof level, an increase of 10,330 THB (18.2%) was required at the floor level and a decrease of 6,102 THB (10.4%) was allowed at the foundation level.

Comparing the cost of the control model to the IBC model by material, an increase of 5,517 THB (7.1%) was required for concrete material, a decrease of 1,037 THB (1.8%) was

allowed for steel rebar reinforcement and an increase of 1,934 THB (3.3%) was required for steel roof framing.

The total cost of the control model structural materials was 195,240 THB and the total cost of the IBC model structural materials was 201,654 THB, an increase of structural material of 6,414 THB, or 3.3%.

The structural engineering design was estimated at 1,256 THB for the control model and 10,107 THB for the IBC model. This was a substantial cost increase of 8,851 THB which was greater than the cost increase of all structural materials for the IBC model.

The building structure accounts for approximately 35% of all building material costs, with other building material costs including utilities, finishes, doors, windows and masonry block walls. Therefore, the total increase in the overall building cost was estimated at 1.1%.

It was concluded that Chiang Mai buildings are at high risk. The primary dangers include: modified concrete mixtures that do not reach required strength, structures not designed for lateral loading such as earthquakes, corruption within construction industry which compromises the quality of local structures, lack of adequate reinforcement of masonry walls and concrete connections observed by significant cracking and lack of adequate steel rebar reinforcement at critical structural regions. Materials were found to be used inefficiently. While there was a significant increase of structural materials required at the floor level, there was a decrease in structural materials allowed at the foundation level. Therefore, if a structural engineer is utilized, materials can be used much more efficiently, greatly allowing local engineering firms to market the necessity of their services to the end consumer.

Through this quantitative analysis the following policy recommendations can be conferred: 1.) Require full structural engineering analysis of all non-bamboo structures regardless of height due to the high inherent risk level of all non-bamboo structures. 2.) Adopt a nationwide building code with local education programs and incentives. 3.) Allow qualified foreign engineers limited practice in engineering in Thailand, in order to bring the latest engineering technology into the local engineering industry. 4.) Implement a government funded program of site-inspectors for all non-bamboo structures. 5.) Educate the public on the benefits and limited cost of building safe structural buildings.