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A Case Study on Housing Estate Damages Due to 2011 Thailand Flood at Casa Ville Watcharapol

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Abstract

From July 2011 to early January 2012, Thailand was severely flooded. The flooding covered about 240,000 square kilometers in 65 provinces, including Bangkok, the capital of Thailand. "Casa Ville Watcharapol" village is a typical medium-size housing estate with 397 single houses. It is located on the area of 95 Rai, or 0.152 square kilometers, in Saimai District, Bangkok, which is considered to be on high ground. Unfortunately, it was flooded from October 25th to December 3rd, 2011 with flood heights at about 1 meter outside and 30 centimeters inside the houses.
Structural member strength and damage cost are two main topics for this study. The strength of the house main structures; i.e. beam and column on the ground floor, was examined by using Schmidt Hammer testing which is a non-destructive testing method. Concrete cracks, member distortions and settlements were surveyed by visual inspection. The damages on decoration materials such as paint, wall paper, tiles, ceiling, etc., electronic devices such as washer, dryer, water pump, tank, electricity plug and switch, water pipeline, etc., and furniture were inspected and recorded from the interview of the house owners.
The study was carried out from June through August 2012. The results are that the 2011 Thailand flood does not alter the strength of concrete in the houses since the obtained concrete compressive strength is about 170 kilogram per square centimeter (ksc) in average. According to the study, high possibility of damage happened to furniture (66.1%), kitchen ware (54.2%), trees (54.2%), electric water pump (47.4%), outside paints (39.0%), doors (37.3%), electronic devices (27.1%), soil settlement (23.7%), cloth (20.3%), and steel gate /fence (20.3%). An average damage cost per house is 135,704 Baht. Comparing to mean house price of 4,850,000 Baht, the damage-cost-to-house-price ratio is 2.80%. This number can be used to predict damage cost of a house in the next flood situation.

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Keywords: 2011 Thailand Flood, Housing Estate Damage, Casa Ville Watcharapol

1. Introduction

Beginning with the 2011 monsoon season, Thailand was severely flooded [1] from July 2011 to early January 2012, resulted in a total of 815 deaths (with 3 missing) and 13.6 million people affected. Sixty-five of Thailand's 77 provinces were declared flood disaster zones, including Bangkok, the capital of Thailand. At this time, over

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20,000 square kilometers (7,700 square miles) of farmland was also damaged. The flooded area covered Northern, Northeastern and Central Thailand along the Mekong and Chao Phraya river basins. From the study of Prajamwong and Suppataratarn [2], the lower Chao Phraya river basin experienced several floods in the past 30 years, which are in 1983, 1995, 1996, 2002, and 2006. However, 2011 Thailand flood can be considered as "the worst flooding yet in terms of the amount of water and people affected." The World Bank [3] has estimated 1,425 billion Baht in economic damages and losses due to the flooding which mainly came from seven major industrial estates.

"Casa Ville Watcharapol" village is a typical medium-size housing estate with 397 single houses, a club house, and three public parks. The price of the house varied from 3.5 to 7.5 million Baht with the average price of 4.85 million Baht. The village locates on the area of 95 Rai, or 0.152 square kilometers, in Saimai District, Bangkok, which is considered high ground since it is only 5 kilometers east of the Bangkok International Airport. It was not designed to prevent flood in the first place. Unfortunately, it was flooded from October 25th to December 3rd, 2011, with flood heights at about 1 meter outside and 30 centimeter inside the houses. The water covered all over the area except the club house which is elevated about 1 meter higher than the flood level. The flood photos are shown in Fig. 1 to 4.

Fig. 1. Water level in front of the village (Nov.24th, 2011)

Fig. 2. Water level in the village public area (Nov.24th, 2011)

Fig. 3. Water level outside a house (Nov.25th, 2011)

Fig. 4. Water level inside a house (Nov.26th, 2011)

The study for this paper was carried out from April through July 2012, which is about half a year after the flood. It is an appropriate time to see whether the house is still strong and stable or not when the water had moved out. If the result shows that the house is safe to live in, the resident can stay with peace of mine. On the other hand, if the house is not safe, the resident would contact an engineer for further inspection. The damage/repair costs were also collected. A damage-cost-to-house-price ratio will be calculated and used to predict the damage cost of a house in medium-size housing estate for the next flood prediction.

2. Objectives

The objectives of this study are as the followings.

- check the house strength by measuring the current compressive strength of beam and column at the first floor of the house
- check the house stability by inspecting the crack, alignment, and ground settlement
- survey the damaged items from the flood
- survey the damage/repair cost
- find out a damage-cost-to-house-price ratio of a house in a medium-size housing estate, which can be used to build a general village-damage-cost model in the future if more ratios from other villages are available.

3. Method of study

The study was divided into two parts which are house strength and damage/repair cost. In order to measure the compressive strength of the beam and column of the first floor for the first part of the study, the Schmidt Hammer [4] shown in Fig. 5 was used. It is an instrument for quick and approximate measurement of the resistance to pressure of manufactured concrete parts without destruction. The principles on which it works are based on the rebound impact of a hammer on a piston which rests against the surface of the concrete products—the greater resistance of the concrete, the greater the rebound impact. By reading this rebound on a scale and relating it to curves on graphs supplied with the instrument, the resistance to compression in kilogram per square centimeter (ksc) can be found. The hammer manual recommends that the test should be done at least 15 times for each concrete product for high accuracy.

Fig. 5. Sclerometro Meccanico Schmidt Hammer

A questionnaire was designed and used to collect all the obtained information, both from the Schmidt Hammer tests and from interviewing the house owners about the damage/repair cost. The questionnaire, not shown in this paper because of its length, was divided into four parts as follows:

- The first part is general information of the village and house; i.e. address, types of house, types of structural member, age of the building, period of time when water moved in and out, water height above the first floor.
- The second part collects the Schmidt Hammer test results. Statistically, the hammer was used to test 15 times for each first floor beam and column.
- The third part collects the damage/repair cost occurred outside the house. The collected items are soil settlement, perimeter wall and gate tilting, rust on steel gate/fence, water pipelines, power lines, cable lines, water tanks, water pumps, trees, outside paints, cars, motorcycles, bicycles, garage, Thai kitchen, pavilion, cleaning cost, and other items based on the house owners.
- The last part collects the damage/repair cost occurred inside the house. The collected items are concrete floor cracks, wooden floor damage, floor settlement, beam and column cracks, beam settlement, ladders, doors, windows, curtains, wallpapers, electrical plugs and switches, bulbs, ceilings, electronic devices such as television, radio, washer, dryer, etc., kitchen wares, sanitary wares, furniture, cloth, shoes, cleaning cost, and other items based on the house owners.

4. Studying Results and Analysis

It can be divided into three parts as follows:

4.1 House strength and stability

The survey was carried out in July 2012. All 397 houses in Casa Ville Watcharapol village were checked for the study. Since the characteristic of this village is living privately and quietly, 59 house owners allowed the researcher to conduct the survey. However, even though the Schmidt Hammer test did not destroy any beams or columns, 6 owners refused the test because they just had new paint on the house. For each house, 15 numbers of first floor beam strength reading were averaged and that numbers are shown in Fig 6. The first floor column strength readings of each house were also averaged and are plotted in Fig 7. Finally, these numbers were again averaged for the whole village. The average first floor beam and column compressive strengths are 173.87 and 171.98 ksc, respectively.

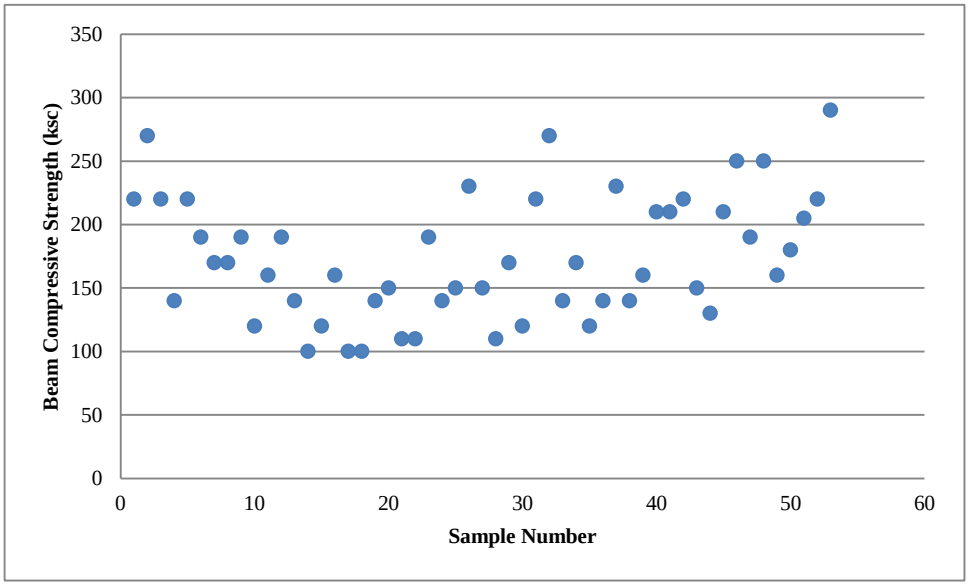

Fig. 6. First floor beam compressive strength reading from 53 samples

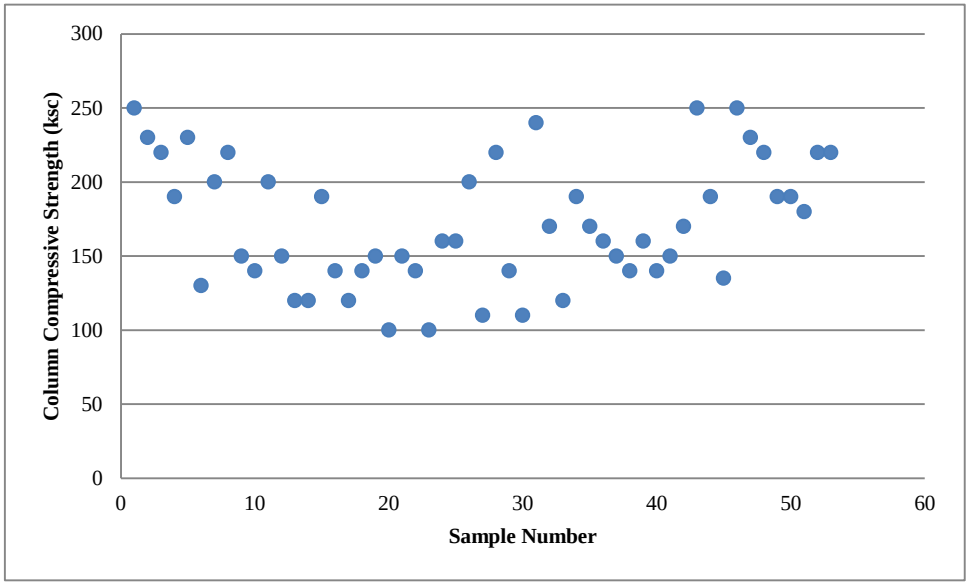

Fig. 7. First floor column compressive strength reading from 53 samples

In order to see whether the beam and column are still in good condition or not, the beam and column strengths measured before the flood is required. Unfortunately, that number is not available. Moreover, the design engineer's calculation sheet is not available, either. Therefore, the design concrete strength was needed to be estimated. According to Thailand B.E. 2522 Building Code Act, residential buildings in Thailand must be designed to withstand not-less-than 150 kilogram-per-square-meter live load in addition to its self-weight. With

the actual size of the beam that is about 25 centimeters x 40 centimeters and the column of about 25 centimeters x 25 centimeters, it can be calculated back to obtain the design concrete strength of 160 to 180 ksc which is in good agreement with the idea that 180 ksc design strength is commonly used in most design offices.

By comparing the testing beam/column strengths at around 170 ksc with the estimated original strength at 160-180 ksc, the first floor concrete beam and column still have high strength after the flood. Hence, it can be concluded that the structural members of the house in Casa Ville Watcharapol village, in general, are strong and safe. However, only a few houses had the strength less than 130 ksc which is considerably low. The researcher also found moisture left in the concrete in these houses as well. It is possible that there might be an underground water line passing underneath the house. In this case, the house owners were suggested to contact an engineer for a further detail inspection.

In terms of the house stability, the overall alignment of the house was visually inspected. From the survey, soil settlement can be found in some houses. Cracks can be observed in walls but not in beams and columns. At all of the inspected houses, beams and columns were in perfect horizontal and vertical directions, respectively. The explanation is that the house rests on the footings with piles driven to the dense soil level which is more than 20 meters under ground level. Consequently, the happening soil settlement around and under the house did not affect the house level at all. It can be concluded that the houses in this village are stable.

4.2 Damage/repair costs

The damage/repair costs were collected from the house owner interviews. The result costs are shown in Table 1. From the study, the total damage cost ranged from 120 Baht to 700,000 Baht with the mean of 135,704 Baht for a house while the total repair cost was 99,795 Baht for a house. Probably, the house owners skipped repairing some damaged items because they were afraid that the next flood may be coming.

Table 1. Damage and repair cost statistic

Cost	Mean (Baht)	Minimum (Baht)	Maximum (Baht)
Outside the house damage cost	51,861	1,500	350,000
Inside the house damage cost	83,306	120	362,500
Total damage cost	135,704	120	700,000
Outside the house repair cost	39,894	300	350,000
Inside the house repair cost	73,668	120	350,000
Total repair cost	99,795	120	700,000

Top ten list of most occurrence damaged items are shown in Table 2. Most of them were unmovable or hard-to-move things. From the table, comparing to 59 sample houses, furniture damage was found the most at 66.1%. Because of the high possibility, these top ten damages should be warned when the next flood comes.

Table 2. Top-ten lists of most occurrence damaged items

Damaged item	Number of occurrence	Ratio to sample number (%)
Furniture	39	66.1
Kitchen ware	32	54.2
Trees	32	54.2
Electric water pump	28	47.4
Outside paints	23	39.0
Doors	22	37.3
Electronic devices	16	27.1
Soil settlement	14	23.7
Cloth	12	20.3
Rust on steel gate and fence	12	20.3

Top ten lists of highest damage costs are shown in Table 3. Furniture was, again, on the top of the list because of its big size, heavy weight, and high price. Kitchen ware, outside paints, and soil settlement also came from the previous table. These top ten damaged items should be avoided during the flood because they are expensive.

Table 3. Top-ten lists of highest damage costs

Damaged item	Damage cost (Baht)
Furniture	49,379
Thai kitchen	38,143
Kitchen ware	33,384
Floor settlement	30,000
Pavilions	28,500
Perimeter walls	27,000
Outside paints	23,826
Garage	18,333
House walls	17,500
Soil settlement	15,800

4.3 Damage cost modelling

Since the house price reflected the house owner financial status which is the major parameter connected to the buying price of damaged items and also the repair cost, the price of a new house at Casa Ville Watcharapol varied from 3.5 to 8 million Baht. Considering the weight of the number of houses with lower and higher prices, the mean price is 4.85 million Baht. Since the mean damage cost was 135,704 Baht, the damage-cost-to-price ratio is 2.80%. This number can be used to predict damage cost of a house in the next flood situation. However, more ratios from more villages will make the damage- cost model more accurate.

5. Conclusions

Casa Ville Watcharapol village had a flood situation from October 25th to December 3rd, 2011. A study on house strength and damage was done half a year after the village had dried out. The study results can be concluded as follows:

1. By using the Schmidt Hammer test at the first floor beam and column, the house is in good condition as those before the flood with structural member strength at around 170 ksc.
2. All the houses are stable since they rest on footings with driven piles; no deviation or crack was observed on structural members.
3. By comparing the mean damage cost of 135,704 Baht with mean house price of 4,850,000 Baht, the damage-cost-to-house-price ratio is 2.80%. This number can be used to predict damage cost of a house in the next flood situation.
4. According to the study, high possibility of damage happened to furniture (66.1%), kitchen ware (54.2%), trees (54.2%), electric water pump (47.4%), outside paints (39.0%), doors (37.3%), electronic devices (27.1%), soil settlement (23.7%), cloth (20.3%), and steel gate /fence (20.3%).
5. Top-ten highest damage cost items were furniture (49,379 Baht), Thai kitchen (38,143 Baht), kitchen ware (33,384 Baht), floor settlement (30,000 Baht), pavilions (28,500 Baht), perimeter walls (27,000 Baht), outside paints (23,826 Baht), garage (18,333 Baht), house wall (17,500 Baht), and soil settlement (15,800 Baht).

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