Risk Analysis and Protection Strategy of Coastal Urban Construction Project under Extreme Typhoon Climate -- A Case Study of Xiamen City

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Abstract: Typhoon is a tropical cyclone with a sustained wind speed ranging from 12 to 13. It is a kind of weather with serious damage. It is of great significance to study the characteristics and causes of disasters caused by super typhoon for disaster prevention and mitigation. Xiamen is located in the southeast coastal area of China, with dense population and developed economy, which is affected by typhoon all the year round. In 2016, the super typhoon "moranti" caused serious damage to the social economy and people's safety in Xiamen. Based on the theory of natural disasters, this paper studies the causes of "moranti" disasters, mainly analyzes the situation, precipitation, wind power, social conditions, architectural design, social prevention and education from the perspective of the risk of the disaster factors and the vulnerability of the disaster bearing body, and finds that there are still many problems in building typhoon prevention in Xiamen. In order to reduce the loss of buildings in Xiamen area under the extreme typhoon environment as much as possible, the corresponding and feasible protective measures and improvement schemes are put forward.

1. Introduction
Based on the theory of natural disaster system, the risk assessment model of typhoon disaster is composed of risk of disaster-inducing factors, vulnerability of disaster bearing body and sensitivity of disaster pregnant environment. The risk of disaster-inducing factors indicates the intensity, range and frequency of typhoon rainstorm, gale and storm surge. The vulnerability of disaster bearing body refers to the probability of loss of the object affected by the disaster causing factor when the disaster occurs. The environmental sensitivity of disaster pregnant environment indicates the characteristics of environmental change in typhoon affected areas. Because this paper mainly studies the risk assessment in fixed time and space, the environmental sensitivity of disaster pregnant can be ignored temporarily[1].

According to Niu Haiyan's assessment of the risk of typhoons in coastal areas of China, the index of disaster factors and exposure in Fujian area are high, so it is easy to be seriously affected by typhoons [2].

According to Chen Xiang's study on the vulnerability of typhoon disaster in Fujian Province, the eastern coastal area of Fujian Province is a vulnerable area of extremely strong typhoon disaster, including Xiamen. There are two reasons for the strong vulnerability of this area: one is that this area is close to the source of typhoon, which is the area with the strongest typhoon disaster causing factors; the other is that this area is located in the east coast, with convenient transportation, which is the most developed and densely populated area in Fujian Province. Due to the prominent contradiction between
people and land, human beings move to high-risk areas and coastal cities and industrial and mining enterprises develop rapidly, which increases the vulnerability of typhoon disaster.[3]

2. Risk analysis of disaster factors in construction projects

2.1. Risk of disaster causing factors
The harm of typhoon precipitation is mainly concentrated precipitation, and the harm of typhoon gale is mainly reflected in the great destructive power of strong wind.

2.1.1 Situation analysis
Typhoon "moranti" No.14 in 2016 was generated on the Western Pacific Ocean east of the Philippines at 14:00 on September 10. It was strengthened to be a typhoon at 02:00 on December 12, and it was strengthened to be a super typhoon at 11:00 on December 12. The maximum wind force near the center was above 17 (65m. S-1). It weakened to a strong typhoon at 21:00 on September 14 and 3:05 on 15. When landing in Xiang'an District, Xiamen City, Fujian Province, the maximum wind force near the landing center is 15 degrees (48m. S-1), and the minimum air pressure at the center is 945hpa, which is the strongest typhoon landing in the south coast of Fujian Province since 1949. At 17:00 on September 15, it weakened to tropical depression, and at 02:00 on September 17, the Central Meteorological Station stopped numbering it. Typhoon moranti has four characteristics: strong intensity, the maximum wind near its center once reached 70 m.s-1 when it was strongest, which is the strongest typhoon in 2016; small scale, strong typhoon level when it landed (42-50 m.s-1, 14-15), and the radius of wind circle of level 10 is only 50km; the route is relatively stable. Since its formation, the route moves northwest by west, and moves Northwest after passing through the Bashi Strait without landing on Taiwan Island, so the intensity is not weakened much; there is potential multiple typhoon effect, and there are low-value systems on both sides of it, especially on the East side, where there are many low-pressure disturbances.

2.1.2 Precipitation analysis
"Moranti" landing coincides with the Mid Autumn Festival, which is time that wind, rain, tide "three meet". "Moranti" has a close structure and concentrated energy. When landing, the typhoon spiral rain belt is also concentrated on turning anticlockwise to land. During the 16 hours from 18:00 on the 14th to 10:00 on the 15th, the average rainfall of the whole city is 104mm, and the maximum rainfall is 295mm. Before and after landing, there is a general rainstorm in Xiamen, with an hourly rainfall of 50-80mm, in which the northeast and south of Xiamen Island are out. Now there are two extreme centers. There are two characteristics of precipitation, one is the short time of precipitation, the other is the large amount of precipitation, which means that the cumulative precipitation time effect will be very short.[4]

2.1.3 Wind analysis
The "moranti" center has strong intensity, but its scale is small. The wind circle of Grade 10 is 50km at the time of landing, so the energy is very concentrated, which has a great impact on the landing point. It is the maximum wind value measured by the meteorological automatic stations in Xiamen before and after the landing of "moranti". The wind has greatly exceeded the thresholds for general building materials and temporary facilities.

2.2. Vulnerability of disaster bearing body

2.2.1. Social profile
Xiamen is a coastal area with flat terrain and no high mountains. It covers an area of 1699.39 km², with a permanent population of 4.11 million and a regional GDP of 479.1 billion yuan. It is a densely populated, large-scale and developed area with a high vulnerability.
2.2.2. Architectural design
After Typhoon "moranti" in 2016, based on the fact that light steel structure and curtain wall are greatly affected by typhoon, Xiamen Construction Bureau organized experts to investigate the damage of light steel structure buildings, structures and curtain wall[5]. It is found that the load design code has insufficient consideration for anti wind design. The additional load of flying objects in typhoon should be considered, and the design value of wind load for low floors should be increased; the influence of narrow pipe effect between high and high floors, and between high and multi floors should be considered in curtain wall design.

2.2.3. Social precaution and education
First of all, the legal plan system needs to be improved, and there is no plan to prevent super typhoon. Typhoon prevention in coastal areas involves a wide range of interests, and the lack of necessary system guarantees makes the actual work more difficult. To this end, in April 2011, the national defense chief issued the opinions on Further Strengthening the prevention of Typhoon Disaster[6], but it is only a normative document, with low actual legal effect and level, and limited effect of actual work. At the local level, Fujian Province put typhoon prevention and flood control together. In 2014, Fujian Province prepared the emergency plan for flood and typhoon prevention[7], which focuses on flood control and pays less attention to typhoon prevention. It can be seen that the lack of laws and regulations for typhoon disasters has led to frequent management confusion and low efficiency in actual work.

Secondly, the system of social disaster prevention and reduction is not perfect. Lack of professional management personnel and weak organization. The grass-roots departments failed to effectively organize personnel to prepare materials and equipment, and relevant measures were not implemented in place.

Finally, the comprehensive disaster reduction capacity of the society is insufficient. First of all, the social propaganda ability is not in place. The meteorological department of "moranti" typhoon has predicted that the landing site will be in Xiamen, but the relevant TV, radio, Internet, newspapers and other media have not released this information to a high degree; at the same time, various media have not effectively informed about how to effectively avoid risks; there is a lack of necessary leaflets, brochures and other materials to enhance the public awareness of disaster prevention. Secondly, social disaster prevention measures are not in place. Before the disaster, the billboards and outdoor structures in the municipal and county areas were not effectively fixed or demolished; the tower cranes at the construction site were not lowered in time; the branches of the street trees were not trimmed in time.

3. Protection measures

3.1. Protection measures against wind damage
The building height in Xiamen area has exceeded 300 meters, and the number of high-rise buildings is increasing day by day. Special structures such as high-rise structure, long-span structure and membrane structure have become a common phenomenon. The design and construction of these buildings, especially the impact of typhoon, should be considered. Considering the damage of buildings in the past in the wind disaster, we should pay attention to the following aspects:

(1) For the general high-rise buildings, the wind load and its influence should be considered as one of the main design and analysis contents; for the high-rise buildings with very complex structure, it is suggested to determine the wind load by wind tunnel test and considering the largest strong wind record in history[8].

(2) Stress analysis and reinforcement design of auxiliary facilities of high-rise buildings should be emphasized[9], such as top antenna, billboard, solar water heater, air conditioning cooling tower, etc.

(3) The quality control of curtain wall structure design and construction should be strengthened. Curtain wall design should consider the effect of narrow pipe between high-rise and high-rise, high-rise and multi-storey. In addition, the pull-out resistance of anchor bolt and the fixing measures of stone and glass are mainly considered to prevent falling.
(4) We should strengthen the fixation, inspection and acceptance of temporary facilities such as tower cranes, scaffolds, derricks, etc. in the construction project to prevent these temporary facilities from collapsing under the strong wind.

(5) It is an effective method to reinforce and check the damage of temporary buildings and vulnerable parts before the arrival of typhoon, which can also reduce the risk of casualties\textsuperscript{[9]}.

(6) Outdoor billboards and signs, street lights and other structures, which are the most vulnerable objects of wind disaster, should be given enough attention \textsuperscript{[10]}. In the design, production, installation, testing and other links, unified standards and specifications should be formed nationwide, and relevant departments should supervise them. Coastal cities should carry out wind resistant design for these indispensable structures, so as to reduce losses.

3.2. Protection measures against disasters caused by precipitation

The following points should be paid attention to in the protection of precipitation Engineering:

(1) In view of the potential geological hazard points, daily monitoring should be strengthened to avoid building houses with landslides as much as possible. Before the typhoon, we should take emergency measures and set up warning signs.

(2) Routine maintenance shall be carried out for the highway slope, and drainage ditch and intercepting ditch shall be cleaned in time to ensure smooth drainage of the slope and slow down the increase of sliding force caused by rainwater infiltration into the soil.

(3) Ensure that the river channel is unblocked, and prohibit sand mining near the engineering facilities such as embankment, pier, artificial dam, etc., so as to prevent the instability of the river channel caused by sand mining and reduce the resistance of the engineering structure \textsuperscript{[11]}.

(4) For urban waterlogging, it is necessary to strengthen the daily maintenance of municipal drainage pipe network to ensure the smooth flow. Before the typhoon, it is necessary to strengthen the inspection and cleaning of drainage outlets in low-lying areas.

(5) We should strengthen the inspection of dangerous houses and temporary facilities to prevent the collapse of the foundation due to the weakening of the bearing capacity caused by the flood immersion, and take measures such as personnel transfer when necessary.

4. Conclusion

To sum up, Moranti's great loss is the result of many factors. Moranti's destructive power is far beyond the scope of ordinary typhoon, and there are some problems in the construction itself. Natural factors can be monitored, but the current capacity of human transformation is very small. Focus on engineering, we need to start from the whole life cycle of project construction, concentrate on precaution, make arrangements for the society, construction units, the masses, etc., actively investigate hidden dangers and risks, get well prepared in typhoon protection, to minimize the losses caused by typhoon disasters.

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