CHAPTER 2: ANCIENT CHINESE BUILDINGS

CHARACTERISTICS OF EARTHQUAKE DAMAGE TO ANCIENT BUILDINGS

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Ancient Chinese buildings such as palaces, temples, government offices, residential buildings, memorial gateways, dhamari columns, parks, tombs, etc., stand towering among various types of buildings over the world with their unique structural system, and national and architectural style. In the Tangshan seismic area including Tangshan District, Tianjin, Beijing and Chengde there are many ancient buildings of all types distributed extensively in the area due to past cultural development. These ancient buildings had generally suffered strong earthquakes in the past and simple records were left of the earthquake damage to some of these buildings. In the Tangshan earthquake most of these buildings suffered various degrees of damage or failure again. In order to investigate the earthquake resistance of ancient buildings systematically and collect required information, a seismic archaeological investigation group was organized by the State Cultural Relic Administration Bureau after the quake. The group rushed into the field and carried out a lot of investigations obtaining a great amount of valuable information. Characteristics of earthquake damage to the ancient buildings in the Beijing-Tianjin-Tangshan District and Chengde City in the Tangshan earthquake are outlined as follows according to the classification of buildings.

1. Ancient Framed Wood Buildings

(1) Single-story framed wood buildings

Ancient single-story framed wood buildings include mainly palaces and temples, the main structure of which is composed of wood columns, beams, bracket sets, gable-and-hip roofs or overhanging gable roofs. The earthquake resistance of this type of building is relatively good. In addition, the materials used in construction and workmanship of these buildings was also good therefore little damage to these buildings occurred during the earthquake. Damage to the wood frame of these buildings was not serious even in the epicentral areas of Tangshan, but the curtain walls and glazed ornaments on the roofs were mostly damaged in the intensity VI area.

In Beijing and Chengde, in the intensity VI area, wood frames of individual buildings were slightly damaged. For example, the connecting beams of the external eaves at Ren Shou Hall of the Summer Palace in Beijing and the architrave in the hall at the southeast corner of the Red Terrace at Fu Shou Temple in Chengde were both pulled out from the mortise slightly. Collapse, inclination and cracking of the curtain wall, and falling and damage to the ornaments on the roof were mostly found in the Forbidden City.

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In Tianjin, in the intensity VIII area, the above-mentioned damage was more serious. For example, the protruding girder of the Great Hall at the Tian Hou Temple was seriously pulled out, purlins on the back eaves of the porch were loosened and the curtain wall collapsed locally.

The Ancestral Temple of Liu's Family located in the epicentral area of Tangshan was a single-story framed wood building with gable walls at both ends and columns embedded in the gable. The curtain walls on all four sides collapsed in the earthquake and part of the tiles on the roof fell down, but the wood frames remained standing except that the wood beams on two sides of the column embedded in the gable were pulled out about 3 cm.

(2) Multi-story framed wood buildings

Multi-story framed wood buildings mainly consist of pavilions and wall-gate towers the main structure of which is composed of columns, longitudinal and transversal beams, bracket sets or protruding small eaves and gable-and-hip roofs or pyramidal roofs. These types of ancient buildings are characterized by lots of beams and columns and a good integrity. But they are relatively high and they vibrated strongly in the earthquake therefore, curtain walls of pavilions were often damaged earlier or more seriously in the earthquake. For example, the brick walls on the second floor of the De Sheng Gate and Zheng Yang Gate in Beijing collapsed extensively; the brick walls on both sides of the third floor of the Tian Zun Pavilion in Ninghe County collapsed completely but the walls of the Shan Hai Wall-Gate Tower, Guan Yin Pavilion of the Dule Temple in Ji County, Shenwu Gate of the Forbidden City, and Fo Xiang Pavilion of the Summer Palace in Beijing were damaged slightly and locally.

2. Ancient Masonry Buildings

All types of ancient masonry buildings were laid with lime mortar and the strength of masonry was low so earthquake damage to these buildings was far more serious than to the framed wood buildings.

(1) Arched brick hall without beams

Earthquake resistance of arched brick halls composed of brick walls and arches was poor. In the areas of intensity VI and VII several halls without beams, such as those in Huanghuadian in Wuqing County and those on Chezhu Hill in Fengren County, all collapsed seriously; at the Bell Tower in Beijing, built by bricks and stones, the tops of arches cracked and loosened, the corner of the end section of the stone protruding girder dropped down and the stone enclosing beam at the waist of the hall cracked at the corner.

(2) Brick pagodas

There were many brick pagodas in the areas of intensity VI to VIII, which were classified as lama pagodas and closely-spaced eave pagodas. Damage to these pagodas was basically similar. In the area of intensity VI damage occurred mostly to the tops of the pagodas; in the areas of intensity VII and VIII more severe damage appeared on the pagoda bodies including cracks, and foundations and brick eaves fell down at the pagoda at the Tian Gong Temple and Hua Pagoda on Chezhu Hill in Fengren County, the pagoda on Bangchui Hill in Qian'an County, Wenfeng
Pagoda in Luan County, the pagoda of Yanqing Temple in Luannan County and the pagoda of Yuanying Temple in Changli County, etc.

(3) Buildings with glazed brick veneers

These types of buildings were distributed mainly in Beijing and Chengde in the area of intensity VI. Due to inhomogeneity between the glazed veneer and matrix materials (such as wood trunk) and the low strength of the adhesive material, etc., glazed brick veneers on the walls of buildings mostly fell down or collapsed in the earthquake. For example, a lot of glazed veneers fell down at the Shan Yin Hall in Bei Hai Park, Beijing; veneers of eight pavilions at the Pule Temple, Chengde collapsed completely.

Moreover, enclosing walls and city walls built with stone and brick had no expansion joints generally. Some of them lacked maintenance and cracking had occurred prior to the earthquake. A lot of these walls collapsed in the earthquake such as those in the Forbidden City, Yong He Temple, Guang Ji Temple, Huang Temple and Summer Palace in Beijing, Summer Resort Park, Fu Shou Temple, Pu Tuo Temple and Pule Temple in Chengde, etc. The walls partly collapsed although the intensity of the areas where they were located was not high. City walls of Ju Yong Gate partly collapsed and those of Shanhaiguan Gate cracked during the earthquake.

(Translator: Lu Rongjian)
Figure 1. Location of the key ancient buildings investigated.
Earthquake Damage to Ancient Buildings in the Tangshan District

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Due to the development of civilization in the past, tens of ancient building of different styles from various periods have been left in the Tangshan District. Most of these ancient buildings were seriously damaged in the Tangshan earthquake. For some of these buildings bases cracked, main structures inclined, and roofs fell down and walls collapsed. Earthquake damage to eight ancient key buildings investigated after the quake is presented in this paper. The location of these key buildings can be found in Figure 1.

1. Ancestral Hall of Liu's Family in Tangshan

The Ancestral Hall of Liu's Family was located north of Xinhua Road and west of Wenhua Road. It was built in the second year of reign of Yongle in the Ming Dynasty and was rehabilitated in the reign of Guangxu in the Qing Dynasty. The Hall was a rising-beam type wood structure with simplified gable walls and a gray tile roof. Its width was about 10 m and five bays of wood frame were installed in the depth direction. There were porches both in front and at the back of the Hall. The main ridge was 4.5 m high and a column was embedded in the middle of the gable walls at both ends. The stone columns of both porches were 3 m high and the other columns of the Hall were wood columns 26 cm in diameter. The Hall was basically intact before the quake.

The Hall was located in the meizoseismal area (intensity XI). All buildings of different types in the neighborhood collapsed completely. Although the Hall was seriously damaged the wood frames stood and the tile roof and the ridge were also basically intact. The main damage to the Hall was: the connection of the beam and the central column embedded in the gable wall were loosened and the beam pulled out from the mortise by 2-3 cm and the enclosing walls fell down, the tile ornaments on the front and back eaves dropped down (Photos 1 and 2).

2. No-Beam Pavilion and Hua Pagoda on Chezhou Hill in Fengren County

The so-called no-beam pavilion and the Hua Pagoda were located on top of Chezhou Hill 15 km south of the town of Fengren County. Based on the “County Annals of Fengren,” the no-beam pavilion was also called the Shoufeng Temple built in the early period of Chongxi in the Liao Dynasty. In the first construction the pavilion was only one-story and two pagodas were built to the left and right of the pavilion respectively. In the sixth year of Chongxi the pavilion was rehabilitated and two stories were added to the original building. Up to Wanli's reign in the Ming Dynasty the pavilion had deteriorated badly and a large-scale rehabilitation was carried out. The existing pavilion is the one built in the Ming Dynasty. It is a three-story masonry structure with a gable-and-hip roof with gray tiles on it. The top of the 1st and 3rd story is a

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brick arched structure. There were wood beams in the 2nd story with an enclosing balcony installed with white stone balustrade.

The Hua Pagoda was located west of the pavilion and was also called Yueshi Pagoda built in the reign of Chongxi in the Liao Dynasty (there was historically another pagoda opposite the Hua Pagoda according to the County Annals). It was a masonry structure with a platform upon the foundation. A high base with decorated moldings was built on the platform and bracket sets and a flat base was installed in the high base for supporting the pagoda. It had been rehabilitated in the 6th year of Chongxi in the Liao Dynasty and again in the 26th year of Wanli in the Ming Dynasty.

In the Tangshan earthquake the no-beam pavilion was damaged very seriously. The east gable wall fell down completely to the east and the roof collapsed; a through crack appeared on the western gable from top to bottom. The 2nd and 3rd story in the south collapsed; a crack in the southeast direction existed on the foundation platform in front of the pavilion with a width of about 5 cm (Photo 3).

Damage to the Hua Pagoda was also serious. The mast of the pagoda collapsed, the upper portion of the pagoda fell down, the east eaves in the first story dropped to the ground and cracks appeared on the base (Photo 4).

3. Pagoda at the Tiangong Temple in Fengren

The pagoda was located at the Tiangong Temple west of the town of Fengren County. The temple building was demolished in earlier years. The pagoda was a thirteen-story solid brick pagoda with closely spaced eaves built on a huge and high foundation platform. There were four false doors (for decoration) in the lower story, one on each side, and bracket sets were used to support the eaves. Judged by its architectural style it is the remains of the ancient Liao Dynasty. Before the quake the pagoda was basically intact except that the mast was damaged.

Because the epicentral distance was so short and the pagoda was built on hilly land it was seriously damaged in the quake and nearly collapsed. The mast of the pagoda was completely broken into pieces and a large crack about 10 cm wide was found on the pagoda from top to bottom. The bricks in the lower story and base were all loose and broken.

4. Dhanari Column in Lulong County

The Dhanari Column was located in the town of Lulong County. It was built in the 11th year of Dading in the Jin Dynasty and was rehabilitated in the period of Wanli in the Ming Dynasty and also repaired in 1974. It was built on a stone foundation platform octagonal in shape and seven stories in height; the total height was 9 m. A stone balustrade was installed around the platform. The column was intact before the quake.

After the quake the top of the column fell down within the balustrade in a southeast direction. The column itself also inclined to the southeast and an obvious offset existed in the upper story (Photo 5).
5. Shanhaiguan Gate-Tower in Qinhuangdao

The town of Shanhaiguan was built in 1381 in the Ming Dynasty. There were four gates in it. The east gate is the famous tower called “the No. 1 gate-tower in the world”. Based on measurement, the existing city wall was 12 m high and 10 m wide from east to west and 20 m long from north to south. The tower was a 2-story building; the first story was 5.6 m high and the second 6.4 m. The area of the building was 198 m². The first story of the gate-tower was a brick and wood structure with a double-eaved gable and hip roof. Thickness of the wall on the first story was 1.3 m and that on the second story was 0.9 m. On the north, south and east walls there were 68 openings for shooting arrows.

Since the completion of construction the No. 1 gate-tower had been repaired several times in the reigns of Jiajing and Wanli of the Ming Dynasty and in the reign of Qianlong, Daoguang, and Guangxu of the Qing Dynasty. In 1952 a thorough repair had been carried out. Before the quake the gate-tower was intact.

After the quake the gate-tower was slightly damaged. Cracks only occurred on the hanging ridge on the northeast corner of the tower, east wall on the first story and its corner, north wall and its northwest corner. Cracks also appeared on part of the protruding city wall.

6. Pagoda at Yuanying Temple in Changli County

The pagoda was located within Yuanying Temple in the town of Changli County (the temple no longer exists). Based on the “County Annals of Changli,” the pagoda was built in the Liao Dynasty and had been repaired in the early years of Hongwu in the Ming Dynasty and in the early years of Xunzi in the Qing Dynasty. The pagoda was originally 32 m high but it is 30.5 m high at present. The mast on top of the pagoda fell down during an earthquake that occurred in the 14th year of Guangxu in the Qing Dynasty. The pagoda was a 13-story solid masonry structure octagonal in shape with closely spaced eaves. The base was decorated with Buddhas upon which was a platform supported by bracket sets. Further upward was another platform decorated with lotus petals supporting the pagoda body. On the wall of the first story there were engraved brick doors and windows, Buddha’s, etc., and columns at the corners.

Earthquake damage to the pagoda was serious. The whole pagoda inclined to the east; the base collapsed in the east, west and northeast respectively; a crack 2-3 cm wide on the northeast corner was found up to the top; cracks also occurred on the southeast wall; protruding eaves above the second story all dropped; and eaves above the 8th story and on the east side partly fell down.

7. Eastern Tombs of the Qing Dynasty in Zunhua County

Eastern tombs of the Qing Dynasty were located at Malanyu in Zunhua County and were first built in the 2nd year of Kangxi in the Qing Dynasty (1663). The total area of the tombs was about 2,500 km² including five emperor tombs, four empress tombs, five imperial concubine tombs, and one princess tomb (235 buildings total). The Tombs Park is one of the largest existing and perfectly planned in China. Damage to five main tombs is outlined as follows.
(1) Xiaob Tomb (the tomb of Emperor Xunzi)

The stone tablet pavilion was a wood structure with a gable-and-hip roof that had glazed tiles. The perpendicular ridge and the 'cang' ridge of the building were destroyed in the earthquake. Longen Gate was a wood structure, a small portion of the main ridge collapsed and the perpendicular ridge and 'cang' ridge were damaged; the beast ornaments on the eaves at the southeast corner and southwest corner were twisted and partially fell down; tiles in the northwest slope also fell down; south of the platform the drum-like stone at the bottom of the balustrade in the middle steps slid down. The three glazed-veneer gates were masonry structures, the middle supporting wall was cracked, the glazed veneers fell down and the ridge over the door was damaged (Photo 6). The memorial shrine in front of the tomb was a wood structure with a double eaved roof and glazed tiles. The main ridge, perpendicular ridge and 'cang' ridge in the upper story eaves collapsed. The side ridge and head tiles and drainage tiles on the lower story eaves fell down in the earthquake. Longen Hall of the tomb was also a wood structure with a double eaved roof and glazed tiles. The beast ornaments on the upper eaves in the southwest corner and the 'cang' ridge in the northeast corner of the lower story dropped down in the earthquake. The enclosing wall was a masonry wall. The top of the wall and tiles on it partly collapsed, the east enclosing wall was loosened and the plaster peeled off exposing the entrance for supplying materials during construction.

(2) Jing Tomb (the tomb of Emperor Kangxi)

Longen Hall of the tomb was a wood structure with a gable-and-hip roof and yellow glazed tiles. It remained basically intact after the quake. The three glazed veneer gates were masonry structures, the supporting walls on the left and right cracked in the earthquake. The memorial shrine in front of the tomb was a wood structure with double eaves and a gable-and-hip roof; ridge tiles were loosened and tiles on the slope of the roof slid down; interlocking tiles crossing the ridge and beast ornaments on the hip in the southeast and southwest corner fell down; the central part of the ridge on the second story in the east partly collapsed. Cracks existed in the center of the vault of a channel; bricks were crushed and fell. The stone tablet pavilion of the tomb was a wood structure with a gable-and-hip roof and glazed tiles, the upper ridge was damaged and the ornament on the eaves fell down.

(3) Yu Tomb (the tomb of Emperor Qianlong)

The west detached side hall was a wood structure. The beast ornaments on the front eaves dropped down. The three glazed gates were masonry structures. In the earthquake the east beast ornaments on the south slope of the middle gate fell down. The memorial shrine in front of the tomb was a wood structure. The main ridge on the upper eaves, the east beast head ornament and overhanging beast ornament were all damaged; the overhanging beast ornament on the back slope of the roof fell down and the interlocking tiles were loosened; the east and west beast ornaments on the lower eaves dropped down and the west ridge on the lower eaves was damaged.

(4) Dingdong Tomb (the tomb of Empress Ci'an)

The west hall was a wood structure with a flush gable roof and glazed tiles. The decorated bricks on the upper part of the south gable wall cracked. The three glazed veneer gates were
masonry structures. During the earthquake the two beast ornaments on the left gate cracked and the overhanging ridges of the left and right gates both fell.

(5) **Dingxi Tomb (the tomb of Empress Cixi)**

The Longen Hall was a wood structure with a double eave roof and glazed tiles. Small cracks appeared on the east and west gable wall after the quake. The memorial shrine in front of the tomb was also a wood structure with a double eave roof and glazed tiles; the overhanging ridge at the back of the shrine was damaged.

8. **Jingjue Temple in Yutian County**

The Jingjue Temple was located east of Manziying Village in Yutian County. It was built in the Tang Dynasty and rehabilitated in both the Ming Dynasty and Qing Dynasty. The existing structures of the Temple were the main gate, the stone memorial gateway, the bell tower, the drum tower, the great hall, the east and the west detached side hall and the bible hall, etc., most of which were rebuilt in the Guangxu period of the Qing Dynasty. All the above structures were intact before the quake.

Damage to all structures in the quake is outlined as follows:

*The main gate.* There were cracks ranging from tens of centimeters to five meters in length which appeared on the brick wall and the eaves head. Part of the head tiles and drainage tiles fell down.

*The stone memorial gateway.* Individual columns were split; the drum-like stone under the column displaced; the connection of the stone column and wood beam was loosened and pulled apart; stones for fixing the pole were locally split or cracked.

*The great hall.* The beast ornaments on the roof and those on the ridges at four corners all fell down. The stone beam on the wall of the porch was offset by 4 cm from west to east. The beast ornaments above the east door and overhanging ridge all dropped to the ground.

*The bible hall.* The main ridge and the beast ornaments on the hall were damaged (Photo 7). The ornamental bricks of the west gable wall were cracked.

*The bell tower.* The veneer bricks on the cross ridge partly fell down; tiles on the overhanging ridge at the southeast corner fell down; eleven drainage tiles on the south eaves dropped.

*The drum tower.* The overhanging ridge on the upper eaves cracked and four ridges on the lower eaves all slid down.

*The east detached side hall.* The beast ornaments on the south end of the main ridge, the ornamental bricks on the end of the slope of the gable wall, and the drainage tiles of the north overhanging ridge all fell to the ground. The column embedded in the gable wall at the back was split by 1 cm.
The west detached side hall. The main ridge and the end of the eaves were cracked; 3 cracks were found on the gable wall one of which passed from the bottom to the top. The stone tie beam at the bottom of the eave columns were offset by 7 cm from west to east.

Ridges and gable board of the east and west detached rooms, corner gates, side rooms and other buildings were partly damaged; gable walls and walls under the window were cracked.

(Translator: Lu Rongjian)
Photo 1. A general view of the Ancestral Hall of the Liu Family after the quake (A beam was pulled out of the connection to the central column).

Photo 2. The interior wood frame of the hall was basically intact after the quake.
Photo 3. The no-beam pavilion on Chezhou Hill was demolished in the earthquake.

Photo 4. The upper part of the Hua Pagoda on Chezhou Hill collapsed.
Photo 5. There was damage to the Dhanari column in Lulong County.

Photo 6. The three glazed veneer gates at Xiao Tomb of the Eastern Tombs of the Qing Dynasty were damaged.
Photo 7. The main ridge and the beast ornaments of the bible hall at the Jingjue Temple fell down.
Figure 1. Distribution of ancient buildings in Tianjin.
DAMAGE TO ANCIENT BUILDINGS IN TIANJIN
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Ancient buildings in Tianjin which include Tianhou Palace, Yuhuang Pavilion, Confucius Temple, Guild-Hall of Guangdong Province, the Muslim Temple, etc. are distributed mainly in the old area of the city. Located in the suburb counties are Dule Temple, the White Pagoda, Jinzhuangzi Pagoda in Ji County, Tianzhun Pavilion in Ninghe County and the No-beam Pavilion in Wuqing County, etc. Figure 1 shows the distribution of ancient buildings in Tianjin.

During the Tangshan earthquake damage to ancient wood structure buildings (such as Dule Temple, the Great Hall of Tianhou Palace, etc.) was relatively slight. Walls cracked, beast ornaments and tiles on the roof fell, parts of frames inclined or beams pulled out from the mortise; but the main structure, foundation and base platform were basically intact. However, damage to ancient masonry buildings (such as the No-beam Pavilion, Jinzhuangzi Pagoda, etc.) was relatively serious. Some of these buildings even cracked and collapsed.

Damage to 13 ancient buildings in Tianjin is summarized as follows.

1. Dule Temple in Ji County

Dule Temple is located in the town of Ji County and is one of the national key historical buildings protected in China. Guanyin Pavilion at the temple is the oldest existing multi-story wood structure in China. Dule Temple was first built in the Tang Dynasty and rebuilt in the Liao State (in 984), and was rehabilitated several times. A relatively large scale rehabilitation was carried out in the 18th year during the reign of Qianlong in the Qing Dynasty in which four corner columns were installed to strengthen the Guanyin Pavilion. The only buildings that exist at present at the temple are the Guanyin Pavilion and the main gate. The Guanyin Pavilion is 23 m high with three stories, doubled eaves. The pavilion is rectangular in shape. There are five bays in the longitudinal direction and the transverse direction. The pavilion has a gable-and-hip roof with 24 types of bracket sets installed at different locations. The pavilion is hollow in the center where a sculpture of Guanyin (a Bodhisattva) with eleven faces was installed. The main gate is 10 m high with a hip roof and single eaves. It has three bays the longitudinal direction and two bays in the transverse direction. The exterior and interior eaves are supported by seven kinds of bracket sets. The whole structure was erected on a platform laid by stones. Dule Temple had experienced 36 earthquakes recorded in literature since its rehabilitation up to the end of the Qing Dynasty. Before the Tangshan earthquake the Guanyin Pavilion (Photo 1) and the main gate were basically intact.

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During the Tangshan earthquake the Dule Temple was slightly damaged; the Guanyin Pavilion was basically intact, only vertical and lateral cracks appeared on the inner and outer surface of the exterior wall on the upper stories and cracks also appeared on most of the partition walls. The iron band around the waist of the sculpture of Guanyin was broken and the existing transverse crack on the waist of the sculpture was apparently increased. The top of the columns of the Main Gate at the southwest and northwest corners displaced in the north direction. Displacement of the column at the northwest corner was larger. The column was originally inclined internally but now it became almost vertical. The base stone of columns at the northwest, northeast and southeast corners cracked. The upper part of the wall above the window to the south collapsed; a vertical crack was found in the middle of the west gable wall; the east partition wall in the corridor cracked seriously. The foundation of the Guanyin Pavilion and Main Gate was still sound; no abnormality was observed in frames and bracket sets.

2. White Pagoda in Ji County

The White Pagoda was located at a distance 380 m south of the Dule Temple and there was no record for the date of construction. From its architectural style and brick sculptures modelled on woodcraft it is inferred that the pagoda was built during the Liao State. It was rehabilitated five times in the Liao State, the reign of Jiaging and Wanli in the Ming Dynasty and the reigns of Qianlong and Jiaqing in the Qing Dynasty. The lower part of the pagoda was built like that of a pavilion and the upper part was in a style of Lamasery. The foundation was built with a compacted mixture of lime, sand and soil. Blocks of granite laid the high base with decorated moldings. The pagoda was built with bricks above the high base. Total height of the pagoda was 30.6 m with an octagonal plan. On the top of the three stories there were doubled eaves, and then above was a “converted bowl,” “thirteen fortune wheels,” the mast of the pagoda, etc. Prior to the quake the pagoda was basically intact. It was one of the municipal key ancient buildings protected in Tianjin.

After the quake the foundation and base of the pagoda were basically intact. The upper part of the pagoda inclined in a southeast direction by 37.8 cm. Many cracks existed above the doubled eaves of the first story. A large crack on the south side passed from the “converted bowl” to the eaves of the first story. Parts of bricks were loosened and shifted and most of the eave bricks in the upper part fell down. The top and three out of the thirteen fortune wheels of the pagoda were destroyed. The north bronze mast fell to the ground (but the mast was intact).

3. Tianzhun Pavilion in Ninghe County

Tianzhun Pavilion was located at the southeast corner of Fengtai Town in Ninghe County on open terrain not far from the east bank of the Ji Canal. It was 37 km from Tangshan and was the nearest ancient multi-story wood frame building to the epicenter. It is not known when the Tianzhun Pavilion was built but it was rehabilitated during the reign of Kangxi in the Qing Dynasty. The 3-story wood framed pavilion facing south was built on a masonry foundation platform rectangular in shape. It was 17.40 m high and had five bays in the longitudinal direction and 4 bays in the transverse direction in the first story with a balcony around it. The plan of the second story was the same as the first story except that there was no balcony in the transverse direction. The number of bays was reduced to two in the third story. The pavilion
had eight columns 12.07 m in length and 0.40-0.58 m in diameter up to the roof of the building. The column was not made of a solid wood but with several iron bands around the column for strength. The number of columns in the second and third story was reduced story by story. The doors and windows on the south elevation were made of wood but on the other elevations there were only brick walls and reduced story by story. The roof was a gable-and-hip roof with gray semi-cylindrical tiles and three eaves. Before the quake the pavilion was basically intact. It was one of the municipal key protected ancient buildings in Tianjin. The foundation of the pavilion was compact and no inclination of wood frames and loosening of mortise was found after the quake. The structure was fundamentally intact and the main damage to the structure is as follows:

(1) On the first story, part of the bricks in the gable wall at the southeast corner and part of the tiles on the north eaves fell down.

(2) On the second story, part of the north enclosing wall collapsed and tiles on the north and south eaves fell down.

(3) On the third story, the north enclosing wall and a great part of the east and west gable walls collapsed (Photo 2), the tiles on the north eaves fell down. Separation was observed between the connection of the column and the beam in the frame. Part of the beast ornaments on the roof dropped and were broken.

4. No-beam Pavilion in Wuqing County

The No-beam Pavilion, also named Yuhuang Pavilion, was located at the crossroad in Huanghuadian, Wuqing County. The date of construction is not known but on an inscribed board hanging in the pavilion there was a statement that read “Rebuilt in the 56th year of the reign of Kangxi, Qing Dynasty.” On a square brick at the top of the pavilion the following words were engraved “Yuhuang Pavilion was struck by lightning on July 22 in the 20th year of the reign of Guangxu (Qing Dynasty) and was rebuilt up to the roof on March 22 in the 24th year of Guangxu.” Before the quake the pavilion was basically intact and was one of the municipal key ancient buildings in Tianjin. The pavilion was a 3-story building arched with gray bricks, the bracket sets, eaves and rafters of which were engraved bricks. The plan of the pavilion that was facing south was rectangular in shape. It had three bays in the longitudinal direction and one bay in the transverse direction. Thickness of the wall was 2 m and the total height of the pavilion was 18 m. The interior of the pavilion was arched with bricks with a gable-and-hip roof.

During the M7.8 earthquake the pavilion was cracked and the east floor fell down with the roof.

During the M6.9 earthquake the collapsed part at the southeast corner fell down. The roof collapsed almost completely and the ridges at the southwest corner were only supported by the surviving west gable wall (Photo 3).
5. The Great Hall of Tianhou Palace

Tianhou Palace, also called Tianfei Palace or Niangniang Palace, was located northeast of old Tianjin City on the west bank of the estuary connecting the North Canal, South Canal and the Haihe River. Tianhou Palace was a temple with its door facing the Haihe River in the east. The Great Hall in the Palace was built in 1326 (Yuan Dynasty), rebuilt in 1403 (Ming Dynasty), and rehabilitated in the reign of Zhengtong (1445) and Wanli, Ming Dynasty, respectively. During rehabilitation during the period of Wanli, two buildings i.e. a porch and Fengwei Hall were built connecting the Great Hall in the front and at the back respectively. In the Great Hall there were three bays (13.6 m) both in longitudinal and transverse directions; on the roof there were seven purlins and a single eave with a hip roof. From the base platform to the ridge the total height was about 9.2 m. The porch also had three bays in the longitudinal direction and only one bay in the transverse direction. Fengwei Hall had one bay in both directions. Its roof was supported by an overhanging gable. Fengwei Hall was an inverted “T” in shape and the total width was 19.50 m. In the Great Hall the door in front was a latticed door. Gable walls were built with bricks and gray tiles were laid on the roof.

After the quake the foundation of the Great Hall apparently settled and settlement at the southwest and northeast corners was especially severe. The great girder in the south was pulled apart from the connection with the column (Photo 4). The purlins on the eaves on the back of the porch were also pulled apart by 2-3 cm. A brick wall at the northwest corner collapsed.

6. Relics of Dagu Fort

Relics of Dagu Fort are in the estuary of the Haihe River 60 km southeast of downtown Tianjin. The fort was built in the Ming Dynasty and rebuilt in the Qing Dynasty (1858). There had been five forts at the site, namely, Wei Fort, Zhen Fort, Hai Fort, Men Fort, and Gao Fort. Around each fort there were deep trenches and high walls for protection. The forts were built using a compacted mixture of lime, sand and soil, layer by layer so that they were strong enough. After the signing of the Xinchou Treaty (1901) the forts were forced to be demolished. Only the Hai Fort in the middle remained i.e., the relics of Dagu Fort as called today.

After the quake the fort cracked seriously. In addition to a large crack on the fort, large cracks up to the sea level occurred in the foundation soil under the canon, the widest of which was approximately 10 cm. At the door of a warehouse there was a vertical crack with a width of several centimeters.

7. Other Ancient Buildings

Damage to other ancient buildings such as the Confucius Temple, Muslim Temple, Guild-Hall of Guangdong Province and Jinghuangzi Pagoda, etc., is listed in Table 1.

(Translator: Lu Rongjian)
Table 1. Earthquake damage to parts of ancient buildings in Tianjin.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Building</th>
<th>Location</th>
<th>Date of Construction</th>
<th>Structural Details</th>
<th>Description of Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Confucius Temple, Dachen Hall</td>
<td>East Gate Lane in Nankai District</td>
<td>First built in the 1st year of Zhentong, Ming Dynasty; rebuilt in the Qing Dynasty</td>
<td>7 bays longitudinally, and three bays transversely, single eave with a gable-and-hip roof</td>
<td>Ornaments on the main ridge fell down, vertical ridge in the east and west collapsed</td>
</tr>
<tr>
<td>7</td>
<td>Confucius Temple, Ningxing Gate</td>
<td>Ditto Ditto</td>
<td>A 3-story wood structure with four columns and a glazed tile roof</td>
<td>Roof with glazed tiles was damaged</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Confucius Temple, Screen Wall</td>
<td>Ditto Ditto</td>
<td>A masonry structure</td>
<td>Tiles on top of the wall were damaged</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Yuhuang Pavilion</td>
<td>10, Yuhuang Pavilion St., Nankai District</td>
<td>Rebuilt in the 2nd year of Xuande, Ming Dynasty, and rehabilitated in Qing Dynasty</td>
<td>A wood structure with a gable-and-hip roof and glazed tiles. 4 bays in longitudinal and 2 bays in transverse direction</td>
<td>One of the bricks on the west overhanging ridge of the roof fell down</td>
</tr>
<tr>
<td>8</td>
<td>Mosque, Praying Hall</td>
<td>Dahuo Lane, Hongqiao-zhuang</td>
<td>First built in the 42nd year of Kangxi and then rehabilitated in the 8th year of Jiaqing, Qing Dynasty</td>
<td>A wood structure</td>
<td>Tile roof of the corner building collapsed, stone balustrade plates and stone tablet fell down</td>
</tr>
<tr>
<td></td>
<td>Mosque, Bathing Room</td>
<td>Ditto Ditto</td>
<td>Ditto</td>
<td></td>
<td>The front wall collapsed</td>
</tr>
<tr>
<td>10</td>
<td>Lobby of the Guild-hall of Guangdong Province</td>
<td>East Gate Inner St., Nankai District</td>
<td>In the period of Guangxu, Qing Dynasty</td>
<td>A wood structure with corridors in front and back and roof supported by gable walls. 3 bays in longitudinal and 1 bay in transverse direction</td>
<td>The overhanging ridge on the east gable wall collapsed, the east beast ornament of the main ridge fell down</td>
</tr>
<tr>
<td>11</td>
<td>Jinzhuanzi Pagoda</td>
<td>Jinzhuanzi of Wubahui, Ji County</td>
<td>First built in the Liao State and rebuilt in the Republic of China</td>
<td>Octagonal brick structure</td>
<td>Top of the pagoda collapsed, northeast wall cracked and partly collapsed, southeast wall cracked</td>
</tr>
<tr>
<td>12</td>
<td>The Great Wall</td>
<td>Gangjian-Huangtuling of Xiayingqian, Ji County</td>
<td>Built in the Northern Qi Dynasty, the wall was coated with bricks in the Ming Dynasty</td>
<td>Interior of the wall: compacted lime-sand and soil; exterior of the wall: bricks and stones</td>
<td>One of the masonry look-out towers and a section of stone wall 120 m in length collapsed</td>
</tr>
<tr>
<td>13</td>
<td>Wanhailou Church</td>
<td>On the north bank of the Shizilin Bridge, Hebei District</td>
<td>Built in 1869, and rebuilt in 1904</td>
<td>A Gothic type church of wood-brick structure</td>
<td>The tower in the facade and one of the franc at the back inside the church collapsed</td>
</tr>
</tbody>
</table>
Photo 1. The Guanyin Pavilion at the Dule Temple was basically intact after the quake.

Photo 2. The north brick wall on the third story of the Tianzhun Pavilion collapsed.

Photo 3. Collapse of the no-beam pavilion.
Photo 4. The large girder of the Great Hall in the Tianhou Palace pulled out from the mortise.

Photo 5. A perspective view of Tian Zun Ge (Tian Zun Pavilion).
Figure 1. Location of ancient buildings investigated in Beijing City.
Figure 2. Location of ancient buildings investigated outside Beijing City.
DAMAGE TO ANCIENT BUILDINGS IN BEIJING

Wu Menglin*

Beijing has a long history. It was a town named Ji in the Yan State two thousand years ago and was an important city in the north (named You Zhou) in the Tang Dynasty one thousand years ago. It was the capital of Liao State (the southern capital), Jin State (the central capital), Yuan Dynasty (the great capital), Ming Dynasty and Qing Dynasty (the northern capital). A lot of ancient buildings such as palaces, temples, tombs, parks and pagodas had been built in Beijing.

From the Liao State (1057) to the end of the Qing Dynasty, Beijing had experienced more than 20 earthquakes. The relatively large ones were the 1057 Gu'an, Hebei Province earthquake of M=6.75, the 1484 Jurongguan Gate, Beijing earthquake of M=6.75, the 1679 Sanhe, Hebei Province and Pinggu, Beijing earthquakes of M=8, and the 1730 Beijing (west suburb) earthquake of M=6.5.

After the Tangshan earthquake a seismic archaeological group was organized by the State Historical Relics Administration Bureau to investigate earthquake damage to 41 key ancient buildings in Beijing. The framed wood buildings were usually intact or slightly damaged during the earthquake but the masonry buildings were damaged rather seriously. A description of damage to these key ancient buildings is listed in Table 1 and the location of these buildings is shown in Figures 1 and 2. Damage to six key buildings is stated in detail in this paper.

1. Beihai Park

Beihai Park is a famous royal park on a grand scale with a long history. It is one of the key ancient buildings protected in China. In the Tangshan earthquake a lot of buildings in the park were damaged. Damage to the Yong'an Temple, the Shanyin Hall built on Qiong Island, and the Bai Pagoda are mainly summarized in this paper.

Yong'an Temple: It is an important temple building on Qiong Island on Baihai Lake consisting of a main gate and several halls. During the quake the gable of the main gate cracked. The west beast ornaments on the north slope of the roof of Yong'an Hall fell down. The back gable wall collapsed. The top of the east gable wall (in the south) in the east court fell down. The gable ridge northwest of Falun Hall collapsed and the beast ornaments dropped (Photo 2). The east and west overhanging ridge and the front end of the gable board of the eaves of Zhenjue Hall were damaged. The west glazed brick balustrade and the drum-like stone located between Zhenjue Hall and the Zhizhao archway cracked. The east beast ornaments on the main ridge of Pu'an Hall fell down and the east gable wall collapsed. Both gable boards of the west detached hall collapsed, the main ridge fell down and the top of the south gable collapsed. The gable board of the main ridge of the east detached hall collapsed and the overhanging ridge fell.

* Beijing Historical Relics Brigade
Shanyin Hall: It was located behind Yong'an Temple. During the quake the end of the glazed eaves, rafters, the southeast corner beam and those north of the Hall fell down (Photo 3). The glazed brick veneers on the north wall fell down; the west column with glazed veneers in the south drifted to the south and cracked.

White Pagoda: The White Pagoda built in 1658 (Qing Dynasty) was located above the Yong'an Temple and behind Shanyin Hall. It was damaged in the 1679 Sanhe-Pinggu earthquake of M=8 and was rehabilitated after the earthquake. It was again damaged in the 1730 Beijing earthquake of M=6.5 and rebuilt after a complete dismantling. The existing Pagoda is a masonry structure 35.9 m high having a high base with decorated moldings. Above the base is an inverted alms bowl (as the body of the Pagoda). In the front there is a door decorated with a relief sculpture of flowers. The pagoda body consists of the slender “thirteen heavens” and two layers of “bronze umbrella,” etc. On the top of the “thirteen heavens” there are six forged iron hooks supporting the umbrella. In the Tangshan earthquake unit stones above the base at the northwest corner cracked and dislocated and vertical cracks appeared on the west surface. The base was loosened compressing the iron plate of the base. The “lotus” was also cracked. Ornaments on the top of the pagoda such as the decorated flame, sun and moon fell. The basin displaced 20 cm to the west. Six supporting iron hooks twisted fracturing the high base.

In addition, part of the east enclosing wall collapsed; Bizhao Hall, Yilan Hall, Daoning Study, Chanfu Temple and Kuaixue Hall were all slightly damaged.

2. Bell Tower

The Bell Tower was located at the north end of the central axis of Beijing City and north of the Drum Tower. It was built in 1420 (Ming Dynasty) and then demolished in a fire. It was rebuilt in 1747 (Qing Dynasty) and exists up to the present.

The Bell Tower is a masonry building modelled on a wood structure (Photo 4) the lower part of which is a high tower base with arched doors on four sides. The tower is square in shape and there are three bays in both directions. The tower has a hip-and-gable roof with multi-eaves and there are beast ornaments on the two ends of the main ridge. The floor is supported by four cross-shaped vaults and there is a stone staircase from the north door up to the second floor. In the center of the tower a large-sized bronze bell was hung cast in the reign of Yongle, Ming Dynasty.

In the Tangshan earthquake the beast ornaments on the west end of the main ridge fell down destroying the eaves in the north and west (Photo 5). Cracks of different sizes appeared on top of the four arched doors (Photo 6); the protruding stone girder on top of the north door cracked and part of the girder fell down (Photo 7); the waist stone at the northwest corner of the tower base cracked.

3. Arrow Tower of Deshengmen Gate

Deshengmen Gate was first built in 1436 (Ming Dynasty) and rehabilitated in 1592 (Ming Dynasty). In 1679 (Qing Dynasty) it was demolished in an earthquake and was rebuilt after the quake.
The base of the Arrow Tower was solid, 12.60 m high supported by cypress piles. It was built with earth tampered layer by layer and surrounded by brick walls. The tower itself was 19.30 m high but from ground level to the main ridge it was 31.90 m in height. It was a large fortified tower for resisting the attack of an enemy.

The Arrow Tower was an inverted “T” in shape and seven bays (total length 29.77 m) in a longitudinal direction and 2 bays (total length 7.50 m) in a transverse direction, a hip-and-gable roof with nine purlins and ridges were supported by multi-eaves. Connected to the tower was a hall 23.07 m in length (5 bays) and 6.60 m in width with a single slope roof having four purlins. Gray tiles were laid on the roof with glazed green tiles around the four sides. Inside the Tower wood members, decorations and floor were made of yellow pine and bracket sets and corner beams were made of cypress. The bracket sets consisted of a single arm and a slanting lever, and beams and columns were strengthened by iron bands. The Tower was a typical imperial building of the Qing Dynasty.

Columns up to the eaves were a total of 14.00 m high and were divided into four sections. Each section was connected with other columns by beams forming four stories. There were six load-bearing beams in each story. The exterior beams were spandrel beams enclosing the tower so that rigidity and integrity of the whole wood framed structure was relatively good. The whole wood frame was enclosed by brick walls forming an enclosing wall 2.38 m thick. Arrow windows were installed in each story. The Tower was a multi-story building with an exterior brick wall and interior wood frames.

After the quake the wood frame in the Tower was basically intact, only the brick wall and tile roof were damaged rather severely (Photo 8). The main damage to the Tower was as follows: tiles slid from the roof and the glazed beast ornaments on the ridge fell down; most parts of the wall and gable on the upper story collapsed; the lower ridge fell destroying the roof and the flying rafter was damaged, tiles broke; the east gable wall inclined and cracked and the columns embedded in the gable wall inclined to the southwest; beams were pulled out from the mortise; strengthening iron members deformed, etc.

4. White Pagoda in Miaoying Temple (Baita Temple)

The White Pagoda was a relic of the Yuan Dynasty, 50.9 m high, composed of a foundation base, body and mast. It was a brick stupa pagoda and is the earliest and largest Lama pagoda now existing in China.

Damage to the wood framed hall of the Miaoying Temple was not obvious but that to the White Pagoda was more serious. The upper and lower layer of the high base with decorated moldings of the Pagoda partly collapsed and vertical cracks existed near the corner. All corner columns fractured laterally and broke. Mass of the base in the north fell down. A large part of the wire mesh protecting the Pagoda body dropped (the wire mesh was added during repairs in 1965). The shoulder of the Pagoda cracked seriously and some of the iron bands around the Pagoda fractured. The top of the “thirteen heavens” was loosened and cracked severely, less than one-third of the “thirteen heavens” remained intact and collapse was avoided only as there were eight forged iron rods supporting the “thirteen heavens.” The bronze mast inclined by 20 cm fracturing six out of eight chains tightening the pagoda.
5. Buddha's Warrior Attendant Base of Zhenjue Temple (Five-Pagoda Temple)

The Buddha's warrior attendant base of the Zhenjue Temple was located outside Xizhimen Gate and was built in 1473, Ming Dynasty. It was also called the Five-Pagoda Temple as there were five pagodas built upon the base. Below the pagodas there was a rectangular high base with decorated moldings upon which was another huge throne base. Total height of the two bases was 9.80 m. The throne base was 15.60 m in width and 19.39 m in length while the size of all sides of the upper base was 10% less than that of the lower base, and receding of the upper base was apparent. The shape of the whole base seemed to be compacted and stable.

The Buddha's warrior attendant base was a thick-walled arched brick structure with white stones laid with lime mortar around the outer surfaces. There were arched doors to the north and south respectively. Entering the south door there was a cross room with a vault behind it which were the square footings of the pagodas with passage around them. Over the footings was the arched roof. On the east and west side of the room stone staircases were built passing through a glazed-roof pavilion up to the top of the base.

Around the platform of the base there was stone balustrade. In the middle and at the four corners of the platform five pagodas were erected the central one was a 13-story pagoda larger than the rest with a height of 12.7 m and those at the corners were 11-stories with a height of 10.56 m. On the mast of the pagoda was a small Lama pagoda consisting of a decorated lotus base, double lotus base, fortune wheels, imperial umbrella and precious pearls, etc. and the style was splendid.

After the quake a crack was found on the wall in the northeast corner with a length of 2.8 m. The arched top of the north door settled and fractured locally and the wall inclined outward; cracks also appeared on the platform of the base; the decorations of the pagodas in the northeast and northwest offset while those in the southwest dropped.

6. Summer Palace (Renshou Hall, the Great Dock and the Great Stage)

The Summer Palace is the largest existing imperial park in Beijing and a key ancient building for state protection in China.

More than 800 years ago it was a seasonal palace of the Jin Dynasty then it was rehabilitated in several dynasties. In 1861 it was destroyed by the allied troops of Great Britain and France in a fire. It was rebuilt in 1884 but destroyed again by the Eight-Power Allied Forces (in 1900) and after three years it was renovated with a new look as it exists today.

The Summer Palace grounds included Wanshou Hill and Kunming Lake. There are more than three thousand buildings of different types. The main buildings are Fuxiang Pavilion, Paiyun Hall, Renshou Hall, Leshou Hall, the Great Deheyuan Stage and the Great Dock, etc.

In the Tangshan earthquake the Summer Palace only suffered slight damage. Damage details are as follows:

Renshou Hall: The Hall is located inside the Donggong Gate of the Summer Palace facing east and having seven bays in a longitudinal direction and three in a transverse direction. Its
semi-cylindrical roof is supported by gable walls and a porch was built around the Hall. After
the quake the beam under the outer eaves was pulled out from the mortise.

The Great Dock: It was built facing west with 14 bays in the longitudinal direction and three
in the transverse direction. Water came from the south gable forming a dock. After the quake
the beam was pulled out from the mortise seriously.

The Great Deheyuan Stage: The Stage is a cross in shape with three bays both in longitudinal
and transverse directions. The protruding part in front is a stage and that in the back are rooms
for actors. It is a three-story building with a semi-cylindrical roof supported by gables. The total
height of the building is 21 m and the width of the stage is 17 m. After the quake some of the
beams connecting the golden column and exterior column of the stage were pulled off while
some bracket sets were fractured and deformed. The exterior decorated board under the eaves on
the 2nd floor cracked.

In addition, the exterior decorated board under the eaves on the 2nd floor of Fuxiang Hall
and the overhanging board from the eaves of Huazhongyou fell down. A portion of the
enclosing brick wall of the Yingxulou and rubble wall of Fupi (in the southeast) collapsed.
Ridges of Qinghua Study, Shizhang Pavilion, Paiyun Gate fell down and supporting hooks of a
gateway outside Donggong Gate fell off.

(Translator: Lu Rongjian)
Table 1. Damage survey of ancient buildings in Beijing.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Building</th>
<th>Period of Construction</th>
<th>Location</th>
<th>Type of Structure</th>
<th>Description of Earthquake Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Confucius Temple</td>
<td>Yuan Dynasty and Ming Dynasty</td>
<td>Dongcheng District</td>
<td>wood framed structure</td>
<td>No obvious damage to the Main Hall; most of the enclosing wall of the Stone Tablet Pavilion in front of Dacheng Hall collapsed (Photo 1); 21 stone tablets out of 198 in the Temple overturned.</td>
</tr>
<tr>
<td>2</td>
<td>Beihai Park</td>
<td>Jin Dynasty and Yuan Dynasty</td>
<td>Xicheng District</td>
<td></td>
<td>See related paragraph.</td>
</tr>
<tr>
<td>3</td>
<td>Forbidden City</td>
<td>Ming Dynasty and Qing Dynasty</td>
<td>city center of Beijing</td>
<td></td>
<td>See the related paper in this Chapter.</td>
</tr>
<tr>
<td>4</td>
<td>Bell Tower</td>
<td>Ming Dynasty and Qing Dynasty</td>
<td>north of the middle axis of Beijing</td>
<td>masonry structure modeled on wood structure</td>
<td>See related paragraph.</td>
</tr>
<tr>
<td>5</td>
<td>Arrow Tower of Deshengmen Gate</td>
<td>Ming Dynasty and Qing Dynasty</td>
<td>north of the middle axis of Beijing</td>
<td>brick-wood structure</td>
<td>See related paragraph.</td>
</tr>
<tr>
<td>6</td>
<td>Pagoda in Tianning Temple</td>
<td>Liao State and Song Dynasty</td>
<td>Xuanwu District</td>
<td>13-story octagonal brick pagoda with closely spaced eaves</td>
<td>Height: 57.8 m, the mast on the roof fell down, part of the mast base, high base with decorated moldings and lotus base collapsed destroying the eaves. Surface of the pagoda body was peeled away.</td>
</tr>
<tr>
<td>7</td>
<td>Pagoda for Buddhist relics in Yousheng Religion Temple</td>
<td>built in the late Zhou Dynasty (6th century), and rebuilt in Qing Dynasty</td>
<td>northwest corner of the town of Tong County</td>
<td>13-story octagonal brick pagoda with closely spaced eaves</td>
<td>Height: 49 m. The mast of the pagoda fell and the high base with decorated moldings cracked and loosened, the base displaced horizontally to the west. Small cracks occurred on eight surfaces of the wall in the first story.</td>
</tr>
<tr>
<td>8</td>
<td>Pagoda in Miaoying Temple (Baita Temple)</td>
<td>Yuan Dynasty and Ming Dynasty</td>
<td>Xicheng District</td>
<td>lama brick pagoda</td>
<td>See the following related paragraph.</td>
</tr>
<tr>
<td>9</td>
<td>Pagoda in Baita Nunnery</td>
<td>not recorded</td>
<td>outside of Xizhimen Gate</td>
<td>lama masonry pagoda</td>
<td>Height: 20 m. mast of the pagoda damaged. The umbrella shaped roof and the 13 fortune wheels on the top cracked and offset obviously.</td>
</tr>
<tr>
<td>10</td>
<td>Buddha's warrior attendant base in Zhenjue Temple</td>
<td>Ming Dynasty</td>
<td>outside of Xizhimen Gate</td>
<td>masonry pagoda</td>
<td>See related paragraph.</td>
</tr>
<tr>
<td>11</td>
<td>Imperial Ancestral Temple</td>
<td>Ming Dynasty and Qing Dynasty</td>
<td>Dongcheng District</td>
<td>wood structure</td>
<td>Bracket sets of the eaves in the Back Hall deformed; the west beast ornament on the main ridge fell damaging the roof.</td>
</tr>
<tr>
<td>No.</td>
<td>Name of Building</td>
<td>Period of Construction</td>
<td>Location</td>
<td>Type of Structure</td>
<td>Description of Earthquake Damage</td>
</tr>
<tr>
<td>-----</td>
<td>----------------------------------</td>
<td>------------------------</td>
<td>---------------</td>
<td>------------------</td>
<td>---------------------------------------------------------------------</td>
</tr>
<tr>
<td>12</td>
<td>Zhongshan Hall, Zhongshan Park</td>
<td>Ming Dynasty</td>
<td>Dongcheng District</td>
<td>wood structure</td>
<td>Small cracks occurred on gable wall, corner beam and ornaments on the southeast ridge.</td>
</tr>
<tr>
<td>13</td>
<td>Drum Tower</td>
<td>Qing Dynasty</td>
<td>Dongcheng District</td>
<td>wood structure</td>
<td>The east and west end of the south wall on the upper story cracked.</td>
</tr>
<tr>
<td>14</td>
<td>The Imperial College</td>
<td>From Yuan Dynasty to Qing Dynasty</td>
<td>Dongcheng District</td>
<td>wood structure</td>
<td>One of the beast heads on the memorial glazed gateway fell down; eaves of the east detached hall collapsed.</td>
</tr>
<tr>
<td>15</td>
<td>Yonghe Lamasery</td>
<td>Qing Dynasty</td>
<td>Dongcheng District</td>
<td>wood structure</td>
<td>End ridge of the west detached hall of Wanyau Hall collapsed; beast ornaments on the roof of Houzhao Hall cracked; 50 m of the west enclosing wall collapsed; the north gable wall of Mathematics Hall collapsed.</td>
</tr>
<tr>
<td>16</td>
<td>Longfu Temple</td>
<td>Ming Dynasty and Qing Dynasty</td>
<td>Dongcheng District</td>
<td>wood structure</td>
<td>Ornaments on the east and west gable wall in the front hall fell; bracket sets of the eaves at the back were damaged; mortise connections of wood frames in front and at back of the hall were loosened.</td>
</tr>
<tr>
<td>17</td>
<td>Muslim Temple in Dongsi</td>
<td>Ming Dynasty and Qing Dynasty</td>
<td>Dongcheng District</td>
<td>wood structure</td>
<td>Cracks appeared on top of the brick vault in the Great Hall.</td>
</tr>
<tr>
<td>18</td>
<td>Dongyue Temple</td>
<td>from Yuan Dynasty to Qing Dynasty</td>
<td>Chaoyang District</td>
<td>wood structure</td>
<td>A stone tablet erected in the reign of Chongzheng, Ming Dynasty southeast of the main hall overturned and cracked.</td>
</tr>
<tr>
<td>19</td>
<td>Zhihua Temple</td>
<td>Ming Dynasty</td>
<td>Dongcheng District</td>
<td>wood structure</td>
<td>Not seriously damaged, only cracks occurred on the wall surface of Wanyiao Pavilion.</td>
</tr>
<tr>
<td>20</td>
<td>ancient observatory</td>
<td>Ming Dynasty</td>
<td>Dongcheng District</td>
<td>masonry structure</td>
<td>The drum-like brick base cracked, masonry piers of the observatory instrument also cracked.</td>
</tr>
<tr>
<td>21</td>
<td>corner gate-tower southeast of the old city</td>
<td>Ming Dynasty and Qing Dynasty</td>
<td>Dongcheng District</td>
<td>wood structure</td>
<td>Ridges collapsed completely.</td>
</tr>
<tr>
<td>22</td>
<td>Zhengyangmen Gate</td>
<td>Qing Dynasty</td>
<td>Dongcheng District</td>
<td>wood structure with multi-eaves</td>
<td>Curtain wall on the second floor of the gate-tower inclined and separated with the columns inside the wall; lintels on the two sides fell down; beast ornaments on the main ridge to the west fell also.</td>
</tr>
</tbody>
</table>
Table 1. Continued.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Building</th>
<th>Period of Construction</th>
<th>Location</th>
<th>Type of Structure</th>
<th>Description of Earthquake Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Temple of Heaven (west detached hall of Qinian Hall, Qinian Gate)</td>
<td>Ming Dynasty and Qing Dynasty</td>
<td>Qongwen District</td>
<td>wood structure with glazed hip-and-gable roof</td>
<td>Cracks occurred on columns; 4 large columns under the eaves to the north displaced and offset; one of these in the northeast corner offset in a northeast direction the other three in a northwest direction. Small cracks existed between the wall and the column.</td>
</tr>
<tr>
<td>24</td>
<td>Xiannongtan Temple (Qingcheng Hall)</td>
<td>Qing Dynasty</td>
<td>Xuanwu District</td>
<td>wood structure at the upper part of the Hall</td>
<td>Beast ornaments on the main ridge west of the main hall inclined outward, those on the main ridge east of the back hall inclined to the north.</td>
</tr>
<tr>
<td>25</td>
<td>The Southern Hall</td>
<td>Republic of China</td>
<td>Xuanwu District</td>
<td>brick-wood structure</td>
<td>Cracks occurred on the northeast corner of the Hall.</td>
</tr>
<tr>
<td>26</td>
<td>Guangji Temple</td>
<td>Qing Dynasty</td>
<td>Xicheng District</td>
<td>wood structure</td>
<td>Cracks occurred in the middle of the gable wall in the west detached hall; part of the enclosing wall collapsed.</td>
</tr>
<tr>
<td>27</td>
<td>Xihuang Temple</td>
<td>Qing Dynasty</td>
<td>Chaoyang District</td>
<td>wood structure</td>
<td>The south gable wall of the east detached hall collapsed; both gable walls of the west detached hall collapsed.</td>
</tr>
<tr>
<td>28</td>
<td>Great Bell (Dazhong) Temple</td>
<td>Qing Dynasty</td>
<td>Haidian District</td>
<td>wood structure</td>
<td>No anomaly found.</td>
</tr>
<tr>
<td>29</td>
<td>Dahui Temple</td>
<td>Ming Dynasty</td>
<td>Haidian District</td>
<td>Wood structure</td>
<td>Connection between the top of the column and the plate beam loosened.</td>
</tr>
<tr>
<td>30</td>
<td>Moke Nunnery</td>
<td>Ming Dynasty</td>
<td>Haidian District</td>
<td>the Great Hall, wood structure; the corner tower, masonry structure</td>
<td>Beast ornaments on the southwest ridge of the Great Hall cracked; existing crack on the base platform of the northeast corner tower widened.</td>
</tr>
<tr>
<td>31</td>
<td>Pagoda in Cishou Temple</td>
<td>Ming Dynasty</td>
<td>Haidian District</td>
<td>masonry structure</td>
<td>Three overhanging bells fell down.</td>
</tr>
<tr>
<td>32</td>
<td>Bixia Temple (Xiding Temple)</td>
<td>Ming Dynasty and Qing Dynasty</td>
<td>Haidian District</td>
<td>wood structure</td>
<td>Ornaments on the top of the Great Hall cracked; brick joints on the west gable wall split; ornaments west of the Bible Hall cracked.</td>
</tr>
<tr>
<td>33</td>
<td>Maizhuang Pagoda, Tong County</td>
<td>Liao State</td>
<td>Tong County</td>
<td>masonry structure</td>
<td>The pagoda split; two-thirds of the pagoda collapsed.</td>
</tr>
<tr>
<td>34</td>
<td>Jietai Temple</td>
<td>Qing Dynasty</td>
<td>Mentougou District</td>
<td>wood structure</td>
<td>East gable wall of the Great Hall collapsed.</td>
</tr>
<tr>
<td>35</td>
<td>Fahai Temple</td>
<td>Ming Dynasty</td>
<td>Shijingshan District</td>
<td>wood structure</td>
<td>Intact basically.</td>
</tr>
<tr>
<td>No.</td>
<td>Name of Building</td>
<td>Period of Construction</td>
<td>Location</td>
<td>Type of Structure</td>
<td>Description of Earthquake Damage</td>
</tr>
<tr>
<td>-----</td>
<td>------------------</td>
<td>------------------------</td>
<td>----------</td>
<td>------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>36</td>
<td>Badachu (8 magnificent scenes) on Xishan Hill</td>
<td>Qing Dynasty</td>
<td>Shijingshan District</td>
<td></td>
<td>Parapet wall of the temple gate fell.</td>
</tr>
<tr>
<td>37</td>
<td>Biyun Temple and its pagoda</td>
<td>Qing Dynasty</td>
<td>Haidian District</td>
<td>masonry structure</td>
<td>The hook hanging from the stone pagoda fell down; overhanging beast ornaments on the buildings on both sides of the stone gateway fell.</td>
</tr>
<tr>
<td>38</td>
<td>Wofo (declining Buddha) Temple</td>
<td>Qing Dynasty</td>
<td>Haidian District</td>
<td>masonry-wood structure</td>
<td>Seven beast ornaments on the ridge of the glazed stone gateway fell down.</td>
</tr>
<tr>
<td>39</td>
<td>Ming Tombs (Yong Tomb)</td>
<td>Ming Dynasty</td>
<td>Changping County</td>
<td>masonry structure</td>
<td>Ornaments on the main ridge of the back gate fell down; west ornaments on the shrine fell down.</td>
</tr>
<tr>
<td>40</td>
<td>Weng Tower in Juyong Pass</td>
<td>Yuan Dynasty and Ming Dynasty</td>
<td>Changping County</td>
<td>masonry structure</td>
<td>North wall of the north Weng Tower collapsed by more than 10 meters; bricks on the external surface of the east wall of the south Weng Tower collapsed by 6–7 m; the stone arch cracked.</td>
</tr>
<tr>
<td>41</td>
<td>The Great Wall in Badaling</td>
<td>Ming Dynasty</td>
<td>Yuanqing County</td>
<td>masonry structure</td>
<td>Mud surface layer of the second floor to the south peeled; cracks appeared on the interior surface of the west vault; cracks also occurred on the pier at the corner.</td>
</tr>
<tr>
<td>42</td>
<td>Summer Palace</td>
<td>Jin, Ming and Qing Dynasty</td>
<td>Haidian District</td>
<td></td>
<td>See related paragraph.</td>
</tr>
</tbody>
</table>
Photo 1. Stone tablets at the pavilion in front of Dacheng Hall, Confucius Temple, overturned.

Photo 2. The top of the northwest corner of Falun Hall at Yong'an Temple collapsed.
Photo 3. Eaves at Shanyin Hall in front of the White Pagoda were damaged.

Photo 4. A general view of the Bell Tower before the quake.
Photo 5. Beast ornaments west of the main ridge fell down.

Photo 6. Cracks on top of the north arched door of the Bell Tower.

Photo 7. The protruding stone girder below the eaves in the north cracked.
Photo 8. The Arrow Tower of Deshengmen Gate after the quake.
Figure 1. Distribution of damaged buildings in the Forbidden City.
The Forbidden City was the Imperial Palace of the Ming Dynasty and Qing Dynasty. It was first built in the 4th year of the reign of Yongle (1406) in the Ming Dynasty and was basically completed in 1420 having a history of more than 500 years. It had been rehabilitated and expanded several times in the Ming Dynasty and Qing Dynasty but the overall layout of buildings in the Palace was kept unchanged up to present. The Forbidden City had an area of more than 720,000 m², more than 4,000 rooms and the total building area was about 150,000 m². It is the largest scale ancient building group existing which has been preserved intact.

The Forbidden City experienced five strong earthquakes of magnitude above 6, the greatest of which was the 1679 Sanhe earthquake of M=8 in the Qing Dynasty. In this earthquake buildings in Beijing were seriously damaged but no record has been found about earthquake damage to buildings in the Forbidden City.

In the Tangshan earthquake damage to buildings in the Forbidden City was extensive in range. Based on field survey there were 27 locations where enclosing brick walls collapsed (Photos 1 and 2), 13 locations where walls inclined (Photo 3) and 45 locations where walls cracked; 14 locations where ridges of tile roofs collapsed (Photo 4); 26 locations where individual tile ornaments dropped (Photo 5) and 30 locations where tile roofs cracked; 1 location where a glazed gate-tower collapsed; 2 locations where screen walls cracked and 10 locations where tile ornaments on top of screen walls fell down; 8 locations where wood beams pulled out from mortise or moved; 1 location each where white marble balustrade collapsed and inclined; 1 location where part of a rockery collapsed. Position of the above locations are drawn in Fig. 1 where the damaged buildings (except enclosing walls) are shown by block lines and the type of damage is indicated by figures. Damage to the gate-tower of Shenwumen, Jiaotai Hall and the west gate of Huangji Hall with their structural details are illustrated as typical examples in the following.

1. **Gate-Tower of Shenwumen**

Shenwumen was the north gate of the Forbidden City (Gugong) built in the 18th year of Yongle, Ming Dynasty (1420). Although two large-scale rehabilitations had been carried out in the reign of Kangxi and Tongzhi in the Qing Dynasty, Shenwumen still belongs to the Ming's architectural style according to its structural form (Photo 6).

The gate-tower was built on the rostrum of Shenwumen, 10 m in height. It had seven bays in a longitudinal direction and three bays in a transversal direction with a double-eaves hip-and-
gable roof. The total height of the gate-tower from the rostrum to the top was 31 m. The total building area was 848 m².

In the Tangshan earthquake decorative oil paintings in Shenwumen, the new base layer for oil painting on the tie beam between the bottom of eave columns in the south was mostly cracked. The west eave columns at the back of the gate-tower shifted to the southwest generally, the largest displacement of the columns was up to 4 cm.

2. Jiaotai Hall

Jiaotai Hall was first built in the reign of Yongle in the Ming Dynasty. It was rebuilt during the Qing Dynasty (1797) and was one of the buildings of significance on the central axis of the Forbidden City.

Jiaotai Hall was a single-story building with a pyramid roof, the area of which was 426 m² (Photo 7). The frame of the hall was delicately made and firmly mortised. In order to prevent loosening of the mortised joint iron tie bars were installed at the connection of the beam and the golden column.

The frame of the hall remained intact after the earthquake, only four golden columns shifted slightly with a maximum shifting distance up to 2 cm. In addition, two cracks were found on the gable wall and the upper part of the wall between the columns cracked and deformed generally.

3. The West Gate of Huangji Hall

The west gate of Huanji Hall, located on the exterior east street in the Forbidden City was a gate with glazed veneers in front of Ningshou Palace, it was one of the doors of the enclosing wall. It was built in the middle reign of Qianlong in the Qing Dynasty (1773-1777).

During the quake all glazed members above the bracket sets to the south fell down completely and some of them to the north also fell. The main cause was that the glazed members had not been connected with the enclosing wall but simply laid on the wall only. Such construction was seldom seen in the Forbidden City.

(Translator: Lu Rongjian)
Photo 1. The east wall of the West Garden collapsed (half of the width of the wall).

Photo 2. The wall in the court behind the Hongben warehouse collapsed.
Photo 3. The gable wall of the side building in Dongsansuo inclined to the east by 15cm.

Photo 4. The overhanging ridge of the north gable wall of the north side building in Nansansuo dropped down.
Photo 5. Beast ornaments at the roof southwest of the detached hall at the back of Chengqian Palace fell down.

Photo 6. The gate-tower of Shenwumen.

Photo 7. Jiaotai Hall.
Figure 1. Location of Summer Mountain Resort and the Eight Outer Temples.
DAMAGE TO ANCIENT BUILDINGS IN CHENGDE

Zhang Shengtong*

Chengde City is located 115 km northwest of Tangshan surrounded by mountains with the city district in the valley. The famous Summer Mountain Resort for Qing emperors and the Eight Outer Temples are situated in the north suburb of the city. These buildings were first built in the 42nd year of Emperor Kangxi (1703) and completed in the 55th year of Emperor Qianlong (1790) of the Qing Dynasty.

Of the 11 original temples of the Eight Outer Temples only 7 remained intact i.e., Puning Temple, Fushou Temple, Zhongcheng Temple, Shuxian Temple, Pule Temple, Puren Temple and Anyuan Temple (Figure 1).

In the Tangshan earthquake Chengde City was in the area of intensity VI. Damage to buildings in the city was slight but brick walls of old buildings were seriously cracked or collapsed. However, damage to ancient buildings at the Summer Mountain Resort and Eight Outer Temples was relatively severe.

1. Summer Mountain Resort

There were 120 buildings and scenic spots at the Resort originally. These buildings were gradually ruined during the last period of the Qing Dynasty and the remaining buildings were concentrated in the main palace district in the south and the lake district in the southeast. After liberation the Resort was rehabilitated and there were approximately 30 existing buildings and scenic spots. The building groups in the main palace district were basically in the quadrangle style, most of which were single-story buildings with single eave and hip-and-gable tile roofs, only a few were two-story buildings. In the Lake District buildings were concentrated on the four islands on the lake. In addition, a few pavilions scattered along the lake and on the mountain slope, and a stupa (pagoda) of the Yongyou Temple remained in the plain district. The stupa was an octagonal brick pagoda with multi-eaves and a glazed tile roof. Southwest of the stupa was the Wenjin Cabinet along the hill-side, the main building of which was two-stories with a tile roof supported by gables.

In the Tangshan earthquake damage to the above-mentioned buildings was not apparent except that several locations of the enclosing wall were damaged or collapsed. The enclosing wall was a total of 20 li (1 li = 0.5 km) long, 3-4 m high and 2 m thick with brick battlements on the enclosing wall. Before the quake the enclosing wall had been destroyed in many places and had a lot of ruined openings. After the quake the top of the enclosing wall in the north (on top of the hill) and west, about 650 m in length, collapsed and some of the wall proper also collapsed (Photo 1).

* Ancient Building Construction Team, Chengde Historical Relic Bureau
2. Puning Temple

The Puning Temple was built in the 20th year of the reign of Emperor Qianlong of the Qing Dynasty (1755). The main buildings on the central axis of the Temple were the Gate (a building with a single eave and a glazed tile roof supported by gables), the Stone Tablet Pavilion (a building with multi-eaves and a glazed tile roof supported by gables), Daxiong Hall (a building with seven bays, multi-eaves and glazed tile roof supported by gables), Dacheng Cabinet built on a high stone base behind Daxiong Hall (a building with six eaves and five square roofs), and Tianwang Hall built on the hilltop at the back of Dacheng Cabinet (a building with 3 bays and a pyramidal glazed tile roof). Around the temple there was a two-story platform, a small white marble platform and a Lama pagoda. The quadrangles in the right and left were the East Miaoyan Room and the West Bible Hall. The monk room was a five-bay building with a porch in the front and a semi-cylindrical roof with six purlins supported by gables.

After the quake there was no damage found to the Stone Tablet Pavilion. One of the stone tablets moved slightly; some mortar in the brick joint fell down; small debris near the iron plate installed at the base of the stone tablet fell off. The decorations on the roof of Daxiong Hall were split; a beast ornament on the roof dropped down; the head of the ridge in the southeast corner of the upper eave cracked and nearly fell (Photo 2). The vault of Tianwang Hall cracked and the mortar in the brick joint fell off. Part of the eave at the four corners of the monk room collapsed. The plaster on the gable wall dropped and most parts of the temple wall collapsed.

3. Pule Temple

It was built in the 31st year of the reign of Emperor Qianlong (1766). On the central axis of the Temple were the Gate Hall, Tianwang Hall, Zhongyin Hall and a high rostrum. On the rostrum there was an altar and upon the altar there was a two-story square tower laid with stones then on the upper story was a round hall with 12 columns, a multi-eave and pyramidal roof with glazed yellow tiles, i.e. Xuguang Pavilion. On the second floor of the square tower 8 Lama pagodas with glazed veneers were built at the four corners and the four doors. In the middle of each pagoda a wood column was erected. Pagodas were laid by line-mud mortar and waste bricks were used to fill up the interior of the pagoda. Glazed veneers were connected with wires. Due to a long history the wood column was rotted, the wires corroded and the mortar weathered. There were four Gate Halls each at one side of the tower. At the back of the tower was Tongfan Gate.

After the quake eight pagodas all collapsed, only the glazed lotus bases and part of the pagoda body survived. The pearl in the middle of the roof ridge of Tongfan Gate broke and fell down. One of the tiles on the main ridge of Tianwang Hall and two ornaments on the roof fell down. A big iron incense burner in front of Zhongyin Hall displaced southwestward by approximately 30 mm and the top of the incense burner inclined to the northeast. At the tower the stone tablet in the west gate hall shifted by approximately 20 mm and the glazed tiles on the two gates fell.
4. Fushou Temple

Fushou Temple was built in the 45th year of the reign of Emperor Qianlong in the Qing Dynasty (1780). On the central axis of the Temple there were the Gate Hall (a single eave hall with a hip roof) and Dabei Cabinet (a multi-eave roof supported by gables) in front; a glazed gateway, Dahong terrace in the middle and Zongyuan Hall (a two-story building with single eave and a hip-and-gable roof with glazed tiles) at the back, and the last was a glazed pagoda (a seven-story pagoda with multi-eaves; on the pagoda surface there were glazed Buddhas). Around Dahong terrace was a three-story building with a flat roof. In the middle of the terrace was Zhuangyan Hall a 3-story building with a multi-eave and pyramid roof with glazed tiles. Northwest of the terrace was Faxi Hall with a multi-eave and hip-and-gable roof with golden fish scale tiles. There was a wood porch on the first floor of the pagoda. It was an octagon pagoda with golden bracket sets and glazed tiles.

After the quake an eave beam north of the corner hall on Dahong terrace was pulled from the mortise (Photo 3); the west parapet wall on the top of the white platform at the southeast corner collapsed for a length of about 6 m.

5. Zhongcheng Temple

The Temple was built in 1767-1771. On the central axis of the Temple grounds the main buildings were the Gate Hall, Dabei Pavilion, Wuta (five-pagoda) Gate, and a glazed gateway. Along the winding path up to the hill several tens of buildings such as Wuta (five-pagoda) White Platform, Santa (three-pagoda) White Platform, and Danta (single pagoda) White Platform, Little White Platform, etc. buildings were scattered in the east and west. Finally, on top of the hill a Great Red Platform was erected on which a seven-bay square hall was built.

After the quake the bronze pagoda top of Wuta Gate and the five pagodas on the White Platform all fell down and the “thirteen fortune wheels” of Wuta Gate were demolished (Photos 4 and 5).

(Translator: Lu Rongjian)
Photo 1. Collapse of the wall of the Summer Mountain Resort.

Photo 2. The decoration at the roof of the Puning Temple was split, the head of the ridge at the corner fractured nearly falling down.
Photo 3. An eave beam in the southwest corner hall at Fushou Temple pulled out from the mortise.

Photo 4. The tops of five pagodas at Wuta Gate of Zhongcheng Temple fell down.
Photo 5. The upper part of the west pagoda on the Wuta White Platform at Zhongcheng Temple was demolished.