The Introduction and Disappearance of Mixed-Structure Buildings Made from Brick Walls and RC Slabs Between 1900 to 1926 in Japan

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Abstract. After the Meiji Restoration in 1868, masonry techniques were introduced to Japan by the West, and Japanese architectural engineers were taught new techniques in construction. However, Japan is an earthquake-prone country and the Great Kanto Earthquake that occurred on September 1, 1923, in particular, caused devastating damage from Tokyo to Kanagawa. Consequently, masonry structures were deemed unsuitable in Japan, and reinforced concrete (RC)—which was introduced from around 1900—moved into mainstream fire-resistant construction. In the first quarter of the twentieth century, when the architectural structure was in a state of transition, a mixed structure that comprised brick walls and RC slabs was attempted, but the full picture was not clarified. Through an analysis of articles that were published by the *Journal of Architectural Institute of Japan* and drawings of mixed-structure buildings, this study examines the characteristics and changes of the mixed structure. Until 1910, concrete that was poured over shallow vaulted brick or corrugated iron plates that were combined with steel beams were widely used in the construction of fire-resistant floors. Simultaneously, there were examples of RC structures that were used in the construction of stair landings and entire staircases. After 1910, fireproof floors that were built with RC slabs on steel beams made way for RC slabs that used both small and large beams and haunching beams.

Keywords: Fireproof Floor · Taisho Period · *Journal of Architectural Institute of Japan* · Building Division of Government Offices · Head Office of Takaoka Kyoritsu Bank · Sapporo Court of Appeal

1 Introduction

After the Meiji Restoration in 1868, masonry techniques were introduced to Japan by the West, and they were taught to eager Japanese architectural engineers who were keen to learn new architectural methods. However, Japan is an earthquake-prone country and despite the progress of modernization, it continues to suffer from frequent earthquakes.

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One of these, the Great Kanto Earthquake that occurred on September 1, 1923, devastated the entire area from Tokyo to Kanagawa, and reduced the city into a mountain of rubble. Consequently, masonry structures were considered unsuitable for Japan due to the frequent occurrence of huge earthquakes. Hence, the use of reinforced concrete (RC)—which was introduced toward the end of the Meiji era around 1900—became the mainstream method in fire-resistant construction [1].

During the Taisho period from 1912 to 1926, an attempt was made to build a mixed structure from the use of masonry structure for walls and RC for the stairs and slabs. Although the fact that the building division of the government offices had adopted this construction technique was established after restoration work was performed on cultural property buildings, however, the information is fragmented and the full picture of this mixed structure has not been elucidated. In this study, based on the construction reports that were published in the *Journal of Architectural Institute of Japan* and drawings of eleven mixed-structure buildings—which were courthouses and university buildings designed by architectural engineers from the Ministry of Justice and the Ministry of Education—I examined the transitional process of joining methods for the RC slab with the brick wall.

2 Early History of Mixed-Structure Buildings and Fireproof Floor

Takeyoshi Hori describes the structure of Japanese architecture in the late Meiji era as follow: "After 1897, American-style steel structures began to appear. This structure was often used when the Meiji era changed to the Taisho era. Many large buildings and multistory buildings rely on their construction. Later, around 1907, RC began to become popular, and in 1911, four-story office buildings appeared. It was during the Taisho period that such structures began to be widely used." [2] Based on his description, the steel structure was introduced prior to the use of RC, and it was highly developed by the Taisho period. Here, I focus on the construction of Maruzen Co., Ltd. Building in the Nihonbashi district of Tokyo that was begun in August 1907 and completed in December 1909. During its construction, RC slabs were used by Hori who was also responsible for the building of other steel-framed buildings in the Meiji period. The Maruzen Building was designed by Toshikata Sano, who was a master of steel and RC in Japan. Unfortunately, since drawings of the joints between the steel frame structure and RC slabs lacked details, the reinforcement method could not be determined.

Hori summarized the structure of the masonry fireproof floor as follow: "Brick buildings are basically made by inserting joists into brick walls and laying floorboards to create wooden floors. Because the roof truss is also placed on the brick wall, the floor load and roof load are basically supported by the brick wall. This support relationship does not change even if the floor trusses and roof trusses are replaced with steel frames. Therefore, the steel floor trusses and steel roof trusses themselves are not involved in the structural concept of the main structure as long as they are supported by brick walls. Therefore, for the time being, fire floors in which brick vaults or corrugated iron plates are laid between steel beams and lightweight concrete are placed, and RC slabs can be dealt with only for a matter of floor structures." [2] He particularly pointed out the potential of using RC slabs as fireproof floors for brick buildings. In the instances of fireproof floors in the

Meiji era that he cited after this description, although the use of some RC slabs were reported, however, actual examples were not shown. The landing of the staircase in the Yokohama Bank Meeting Hall—a two-storied brick building with a basement that was designed by Oto Endo and completed in 1905—was made from RC. Although the floor structure of the Yokohama Shinko Wharf brick warehouses—which were designed by the Temporary Construction Department of the Ministry of Finance and completed in 1913—was made from RC, however, the steel floor framing was still used. Furthermore, he stated that the Kyoto Commodity Exhibition Hall—which was designed by Goichi Takeda and completed in 1909 using brick construction—used RC beams and vaulted floors.

Although the advent of RC fireproof floors were recognized by the Meiji period, however, it was thought that the construction of mixed-structure buildings did not occur in the Taisho period even though they had been widely developed by then.

3 Articles on Mixed-Structure Buildings in the *Journal of Architectural Institute of Japan*

Between the late Meiji period to the early Taisho period, the latest information on RC was frequently published in the *Journal of Architectural Institute of Japan.* Properties that were newly built were introduced by articles that were included at the end of every issue in the journal, and many buildings with brick walls and fireproof floor structures were shown. By focusing on floor structures, Table 1 shows the trends that occurred in mixed-structure buildings from 1907—when Sano designed the Maruzen Building—to 1921, when their occurrences could no longer be confirmed.

Prior to 1910, buildings with so-called "fire floors" were constructed with either corrugated iron plates or brick vaults that spanned I-beams, and concrete was poured over them. Since the branch building of the Mitsubishi Joint Stock Company in Osaka used triangular mesh steel wire reinforcement for part of its concrete floor, it should be called wire mesh concrete rather than RC. However, it can at least be described as a structure that is clearly different from the conventional "fire floor." After 1910, the construction of floors of buildings that had commenced by the end of the Meiji era and designed by Yorinaka Tsumaki and Kingo Tatsuno were assessed as "fire floors." Nevertheless, an increasing number of buildings that were completed in the Taisho era were found to have RC slabs that spanned steel beams. Since this was only textual information, it was possible that concrete may have been poured on the so-called "fire floor" and rebars were inserted. Incidentally, although the Morimura Bank building in the Nihonbashi district in Tokyo—which was built by Shimizu Gumi Design and Construction in 1911 and completed in 1914—was made from RC, however, the floor structure was "reinforced concrete placed over steel beams." [3].

Table 1. List of mixed-structure buildings that were published in the *Journal of Architectural Institute of Japan* from 1907 to 1921

Building name	Location	Completion date	Wall structure	Floor structure	Architect/firm	Publication date
Tanaka Photo Plate Factory	Tokyo	Undescribed	B	Steel beams and concrete floor	Tatsuno Kasai Office	Oct. 1907
Naval Museum	Tokyo	Apr. 1908	SB	Concrete was poured into corrugated iron plates that spanned I-beams	Undescribed	Sep. 1908
Marquis Maeda Residence	Tokyo	May 1907	B	Concrete was poured into arc-shaped iron plates that spanned steel beams	Undescribed	Nov. 1908
Yokohama City Hall	Yokohama	Jul. 1911	RB	Concrete with an average thickness of 30 cm was poured into corrugated iron plates that spanned I-beams	Minoru Ikeda, Kyukichi Adachi	May 1909
Kobe City Hall	Kobe	Dec. 1909	S	Fire-resistant construction with brick vaults that spanned 60-pound rail beams	Kintoku Akiyoshi	Aug. 1910
Tokyo Central Telephone Office (Kyobashi Branch Office)	Tokyo	Sep. 1910	B	The floor beams were I-beams, and the bearing columns were bricks that were covered with concrete	Shigenori Yoshii, Shiro Uchida, Yoshihiro Kitabatake	Dec. 1910

(*continued*)

Table 1. (*continued*)

Building name	Location	Completion date	Wall structure	Floor structure	Architect/firm	Publication date
Mitsubishi Joint Stock Company (Osaka Branch)	Osaka	Dec. 1907	SB	Using I-beams, concrete that measured 5 inches in thickness was poured over 2 mm-thick corrugated iron plates across the beams, and steel RC that measured 5 inches in thickness was poured over steel beams by using triangular mesh steel wire reinforcement	Tatsuzo Sone, Katsuya Yasuoka	Feb. 1911
Shueisha Head Office	Tokyo	Nov. 1911	B	Fireproof floors were constructed from steel frame concrete	Kuichi Kitada	Apr. 1912
The Jugo Bank (Nihonbashi Branch)	Tokyo	Mar. 1909	B	Arc-shaped corrugated plates were inserted between the I-beams, and coal ash concrete was poured	Yorinaka Tsumaki, Kimpei Kobayashi	Sep. 1912
Life Insurance Companies Association	Tokyo	Nov. 1912	B	Fireproof floors were constructed from steel beams and concrete	Kingo Tatsuno, Manji Kasai, Yasushi Kataoka	Aug. 1913

(*continued*)

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Building name	Location	Completion date	Wall structure	Floor structure	Architect/firm	Publication date
Port Opening Memorial Yokohama Hall	Yokohama	Jul. 1917	SB	Steel beams and RC	Yoshitoki Nishimura	Dec. 1913
Takada Shokai Head Office	Tokyo	Mar. 1914	B	Steel beams were used and concrete was poured over flat vaulted bricks	George de Lalande	Jul. 1014
Nakai Bank (Urawa Branch)	Urawa	May 1914	B	Floor beams were made from RC and wood	Katsuya Yasuoka	Sep. 1914
Nippon Life Insurance (Nagoya Branch)	Nagoya	Apr. 1910	SB	Steel beams and concrete	Kingo Tasuno, Yasushi Kataoka	Oct. 1914
Osaka Ceramics	Osaka	Oct. 1913	SB	Steel beams were spanned, and the floor was made from RC	Undescribed	Nov. 1914
Yasuda Corporation (Osaka Branch)	Osaka	Jan. 1913	SB	RC with steel beams	Kingo Tatsuno, Yasushi Kataoka	Nov. 1914
Nippon Life Insurance (Kyoto Branch)	Kyoto	Jun. 1914	SB	Steel beams and RC	Kingo Tatsuno, Yasushi Kataoka	Mar. 1915
Osaka Court of Appeal	Osaka	May 1916	B	Steel beams and RC	Keijiro Yamashita, Tsutomu Yokohama, Moritato Kanesashi	Jul. 1916

(*continued*)

Table 1. (*continued*)

Building name	Location	Completion date	Wall structure	Floor structure	Architect/firm	Publication date
Mr. Iwamoto's main residence	Muko, Hyogo	Dec. 1914	B	RC fireproof floor	Undescribed	Aug. 1916
Mitsui Bank (Osaka West Branch)	Osaka	Jun. 1916	B	RC construction	Kantaro Matsui	Aug. 1916
Takaoka Kyoritsu Bank (Head Office)	Takaoka	Dec. 1914	SB	RC construction	Junkichi Tanabe	Sep. 1916
Tanaka Bank	Tokyo	Aug. 1916	SB	RC construction	Fukuzo Watanabe	Nov. 1916
Tokyo Bank meeting place	Tokyo	Sep. 1916	B	Steel beams spanned the brick wall and the floors were made from RC	Kantaro Matsui	Jan. 1917
Mitsui Bank (Kobe Branch)	Kobe	Nov. 1916	B	RC construction	Uheiji Nagano	Feb. 1917
Meiji Fire Insurance (Kobe Branch)	Kobe	Jan. 1917	B	RC construction	Yokokawa Construction	Apr. 1917
Kagisan Bank	Niigata	Feb. 1917	B	RC construction	Minoru Tanaka	May 1917
Sumitomo Bank (Tokyo Branch)	Tokyo	Sep. 1917	SB	RC construction with steel beams	Magoichi Noguchi, Yutaka Hidaka	Oct. 1917
Nakai Bank	Tokyo	Oct. 1917	SB	RC construction	Katsuya Yasuoka	Oct. 1917

(*continued*)

Table 1. (*continued*)

Building name	Location	Completion date	Wall structure	Floor structure	Architect/firm	Publication date
Teiyu Bank (Head Office)	Tokyo	Nov. 1916	B	Inland steel beams were spanned and US-made high-rib metal laths were placed between nearly every beam. Reinforcement was made by inserting rib bars into key points and pouring concrete	Yorinaka Tsumaki, Kenkichi Yabashi, Kimpei Kobayashi	Jan. 1918
Temporary Mitsubishi headquarters	Tokyo	Apr. 1918	SB	RC construction	Mitsubishi Joint Stock Estate	Apr. 1918
Yokohama Specie Bank (Kobe Branch)	Kobe	Jul. 1919	B	RC construction	Uheiji Nagano	Oct. 1919
Daiichi Bank (Kumamoto Branch)	Kumamoto	May 1919	B	RC construction	Yoshitoki Nishimura	Feb. 1920
Yokohama Specie Bank (Shimonoseki Branch)	Shimonoseki	Jan. 1920	B	RC construction	Uheiji Nagano	Oct. 1920
Industrial Bank of Japan (Osaka Branch)	Osaka	Mar. 1920	S	RC construction	Uheiji Nagano	Oct. 1920

Notes. B: Brick Masonry, SB: Steel-framed Brick Masonry, RB: Reinforced Brick Masonry, RC: Reinforced Concrete, S: Stone Masonry

During the transitional period from the Meiji era to the Taisho era, the method of floor construction in mixed and RC structures was developed through a process of trial and error. The floor structure in the head office of Takaoka Kyoritsu Bank was simply described as “reinforced concrete construction.” A nondestructive inspection of this existing building had confirmed the placement of the rebar and the use of RC slabs, albeit only on a part of the second floor. In Fig. 1, the drawing shows that the I-beams were placed inside the girder which can be attributed to the steel-framed brick masonry structure of the building. [4] I would like to emphasize that the head office of Takaoka

Kyoritsu Bank was the first mixed-structure building in Japan that used RC slabs for its floor in 1913. Hence, the practice of laying RC slabs—instead of steel beams—on brick walls in mixed-structure buildings was introduced and promoted in the Taisho period (1912–1926).

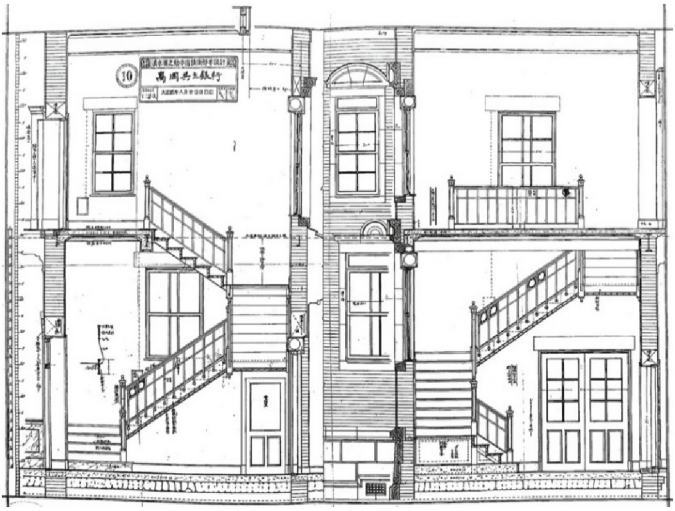

Fig. 1. A cross-sectional drawing of the head office of Takaoka Kyoritsu Bank.

4 Mixed-Structure Buildings Constructed by the Ministry of Justice Building Division

The Supreme Court building—which was designed by the German architects Hermann Ende and Wilhelm Böckmann—was launched in 1887 and completed in 1896. It was claimed as the first mixed-structure building that was supervised by the Ministry of Justice Building Division. [5] However, it was difficult to imagine that RC slabs were used in its construction since the floor of the main building of the Ministry of Justice—which is an important cultural property that was also designed by both German architects and completed in 1895—had a "fire floor" which was made from a vaulted brick ceiling that spanned steel beams.

The floor specifications of the Osaka Court of Appeal building—which was designed by Kozo Kawai and completed in 1900—stated that "the ceiling is covered with iron plates," and it was possible that the building had a "fire floor" that was made of vault-shaped corrugated iron plates that spanned I-beams. [6] Although the Kobe District Court building—also designed by Kozo Kawai and completed in 1904—was demolished, however, its outer walls have been retained. According to a drawing of its floor specifications that are shown in Fig. 2, the second floor was a wooden structure with cross-bridging while the first floor, which had a semi-basement, was a brick-vaulted "fire floor." [7] The buildings of the Osaka Court of Appeal—which was designed by Keijiro

Yamashita et al. and completed in 1916—, the Miyagi Court of Appeal (completed in 1925), the Nagoya Court of Appeal and the Kyoto District Court (both were completed in 1926), and the Sapporo Court of Appeal (completed in 1926) are examples of mixed-structure construction. The courthouses in Osaka, Kyoto, and Sendai, however, have been demolished. The courthouses in Nagoya and Sapporo are discussed later in this paper. Since the Osaka Court of Appeal building was featured by a magazine, I would like to further its discussion.

The construction of the Osaka Court of Appeal building began in April 1910 and was expected to last five years. Due to the outbreak of World War I, it was eventually completed in May 1916. Architectural engineers such as Keijiro Yamashita, Tsutomu Yokohama, and Moritaro Kanasashi were tasked to supervise its design. The floor specification of the building was as follow: "The structure of the first floor is made by pouring concrete and laying stones or paving asphalt. The structures of the second and third floors were RC with steel beams." Since steel beams were used in its construction, it is presumed to have the same specifications as the Yokohama Shinko Wharf warehouses that were mentioned earlier [8].

The Tokyo Ward Court building—which was completed in 1920—was made entirely from concrete. Although its walls were made of plain concrete [9], however, the slab structure stood out. The floor specification was as follow: "Above the attic conference room is a slab with partial lattice beams; corridors are made of flat slabs; the first, second, and attic floors are beamed slabs; the outer corridors are cantilever slabs; the outside platform of the driveway is dome-shaped; the audience seats in the Grand Court is stepped; every floor is made of RC." [10] The ceiling specifications were as follow: "The upper part of the hall is hemispherical with a circular light window in the middle; finish the RC with plaster about 15-cm thick; the ceiling of the Grand Court and the entrance hall are made of RC." [10] Since there were no drawings, the details were not known. However, it was assumed that the specification of the RC floor slab was established as a technology after various attempts were made.

The floor and staircase specifications of the Nagoya Court of Appeal building, which were written in 1918 and owned by the Nagoya Municipal Archives, included the following statements:

> "The floor shall be RC (partially or entirely) on both the second and third floors, and reinforcing steel shall be selected according to the location, and auxiliary steel wire shall be fully constructed with annealing wire."
>
> "Each staircase shall be constructed with I-beams of appropriate cross-section according to the location, completely installed with attached ironwork, etc., and constructed carefully so as not to pose a danger."

There are eight drawings—four on detailed cross-sections, two on beam plans, and two on reinforcement plans—which are also owned by Nagoya City Municipal Archives, and they illustrate how the RC slabs and stairs are attached to the brick walls. Although there was a description of "steel beams" in the staircase specifications, however, this claim was not confirmed by the reinforcement diagram of the stairs. Since these rebar plans were not intended for the central grand staircase, it was not known whether I-beams were used. However, it can be surmised that there was an intention to use steel beams

for added reinforcement since there was unease over the structural soundness of the RC structure. According to the detailed cross-sectional drawings, the thickness of the RC slab was 12 cm and appropriate adjustments were made to the width and length of the beams according to the location. A total of 18 beam shapes were confirmed, including the difference in the number of reinforcements at the bottom (Fig. 3). As for the installation of the RC slab on the brick wall, the actual measurement from the drawing showed that the slab penetrated the brick wall by approximately 9 cm, and the brick that supported the slab overhung by approximately 9 cm (Fig. 4).

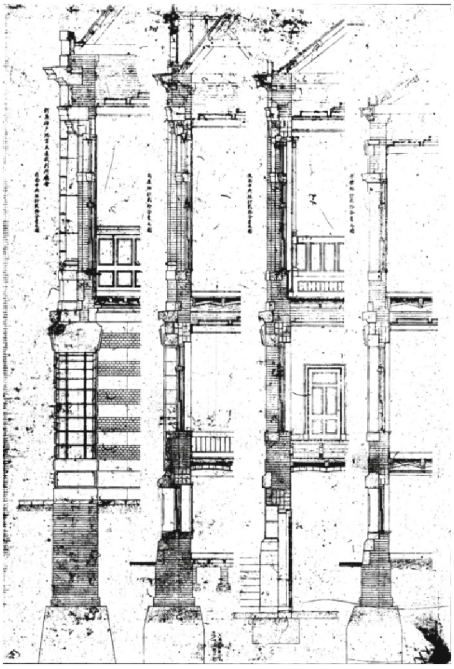

Fig. 2. A detailed drawing showing the RC floor of the Kobe District Court building.

The specifications of the construction of the Sapporo Court of Appeal building—which are owned by the Sapporo City Archives—included 15 documents and over 100 drawings. There were ten drawings—four on detailed cross-sections, four on reinforcement plans, and two on beam plans—which showed the specifications to join brick walls to RC slabs and stairs. The thickness of the RC slab was mainly 12 cm; in some short spans, it was 9 cm (Fig. 5). The specification of the RC slab that penetrated the brick wall differed greatly from the courthouse of Nagoya. At Nagoya, the joint basement had brick overhangs, whereas at Sapporo, haunching beams were attached to the ends of the slabs. Although the dimension of the penetration varied depending on the location, however, there were places where either the RC slab penetrated into half of the wall thickness or it was designed to divide the brick walls vertically, such as the circumferential girder (Fig. 6). Although it was a simple wall-to-slab joint in the case of Nagoya, however, in

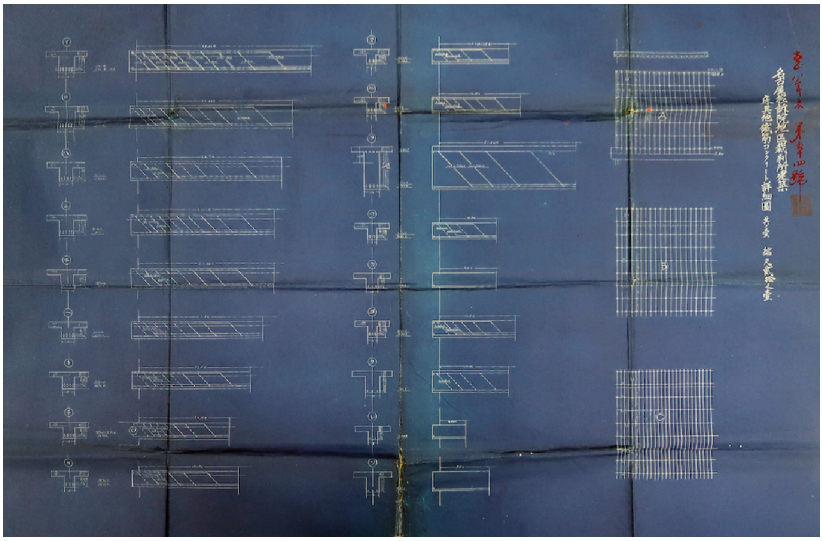

Fig. 3. A detailed drawing showing the RC floor of the Nagoya Court of Appeal building.

Fig. 4. A detailed cross-sectional drawing of the Nagoya Court of Appeal building

the case of Sapporo, it may be perceived as the use of a combination of RC and bricks in order to reinforce the structure.

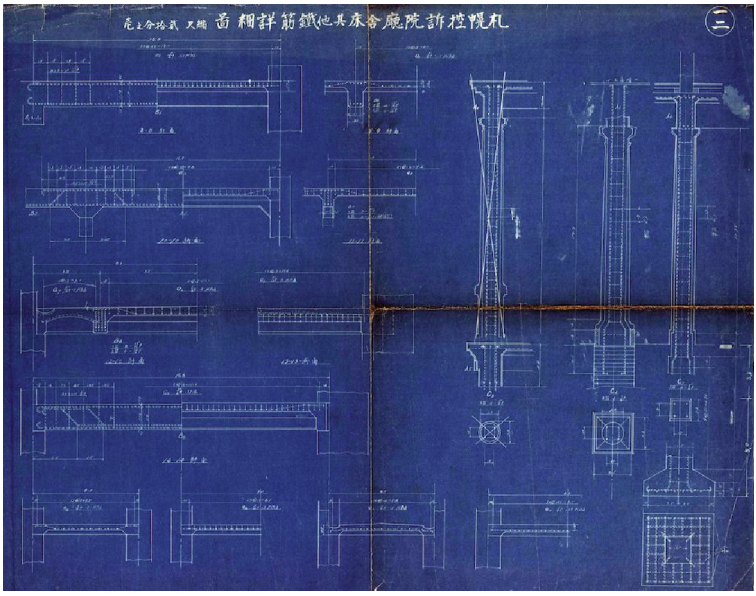

Fig. 5. A detailed drawing showing the floor and column reinforcement arrangements of the Sapporo Court of Appeal building.

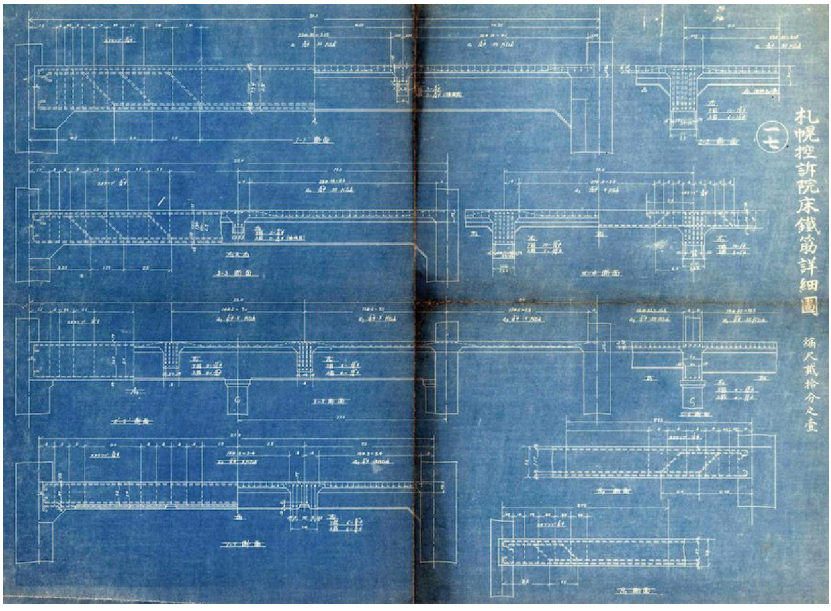

Fig. 6. A detailed drawing showing the floor reinforcement arrangement of the Sapporo Court of Appeal building.

5 Mixed-Structure Buildings Constructed by the Ministry of Education Building Division

At Kyoto Imperial University, mixed-structure buildings were confirmed from the drawings of the Law School (completed in 1915), the Metallography Research Institute (completed in 1918), and the schools of Geology and Mineralogy (completed in 1920), Biological Science (completed in 1922), and Physics (completed in 1922; upper-floor extension) in the Faculty of Science. [11] The Law School building used a simple RC slab that was similar to the Nagoya Court of Appeals building. In the Metallography Research Institute building, haunching beams were attached to RC slabs and they were connected to each other upon the columns to form a circumferential girder (Fig. 7). Large and small beams were used in the buildings of Geology and Mineralogy and Biological Science to accommodate large spans (Fig. 8). Consequently, over a short period of just seven years, a simple slab was developed into a beamed slab a beamed slab that incorporated the full attributes of RC. All the buildings were designed by Kyozo Nagase, an architectural engineer who was based at Kyoto Imperial University and provided a valuable example of how an architect from an organization made the transition from masonry structures to RC structures through a process of trial and error. As a side note, the building of the Department of Architecture—which was designed by Goichi Takeda and completed in 1922—was made from RC, which verified a move that was made by the Ministry of Education Building Division to use RC before the Great Kanto Earthquake occurred.

At Tohoku Imperial University, the main building of the Metals Institute (completed in 1921) was designed by Senjiro Nakajima who was an architectural engineer with the university, and it featured a secession-style façade design that was preferred by him. The second and third floor slabs, roof slabs, and stairs were made from RC. [12] Although the drawing that showed the bar arrangement had been lost, however, the joints between the brick wall and the RC slab were the same as those in the Sapporo Court of Appeal building (Fig. 9).

At Kyushu Imperial University, the buildings of the Department of Naval Architecture (completed in 1921) and its extension (completed in 1922) and the temporary laboratory of the Faculty of Engineering were designed by Ken Kurata, an architectural engineer who was based at the university. [13] In December 1923, the main building of the Faculty of Engineering (completed in 1914) was destroyed by a fire. At the strong request of Toranosuke Furukawa who also donated to its rebuilding, a temporary laboratory was built in 1925 that reused the brick walls of the burn-out main building. In the building of the Department of Naval Architecture, only the stairs—not the floors—were made from RC, and the connection with the brick wall was the same as the building of the Metals Institute at Tohoku Imperial University, which was completed in the same year. The slabs that were used to construct the extension of the Department of Naval Architecture were also made from RC, and the joints with the walls were the same as the Nagoya Court of Appeals building (Fig. 10). Although the construction of the temporary laboratory was premised on the reuse of old brick walls, however, the building of the Sapporo Court of Appeal had demonstrated that the vertical division of brick walls were based on the specifications of RC slabs (Fig. 11).

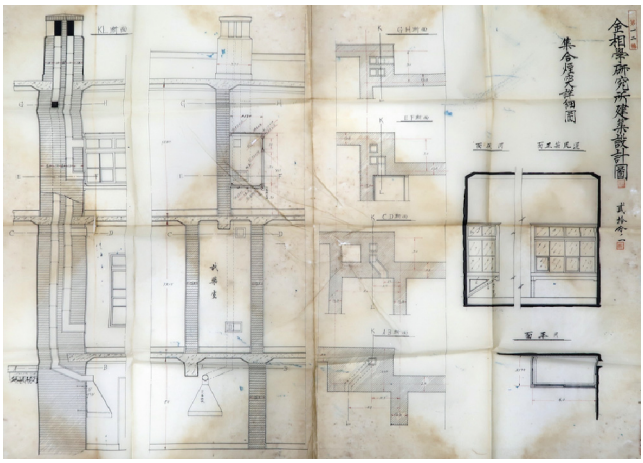

Fig. 7. A cross-sectional drawing of the Metallographic Research Institute building at Kyoto Imperial University.

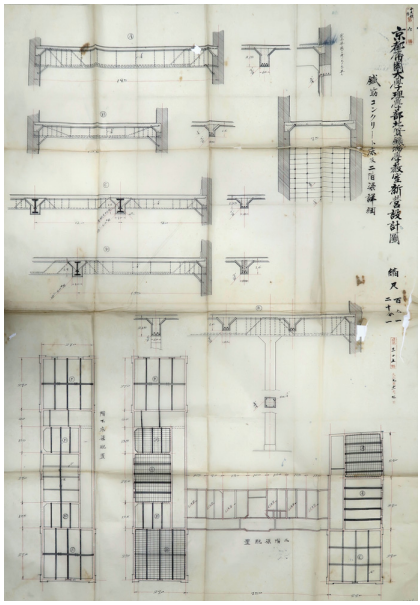

Fig. 8. A detailed drawing showing the RC floor and second floor beam of the Geological and Mineralogy building at Kyoto Imperial University.

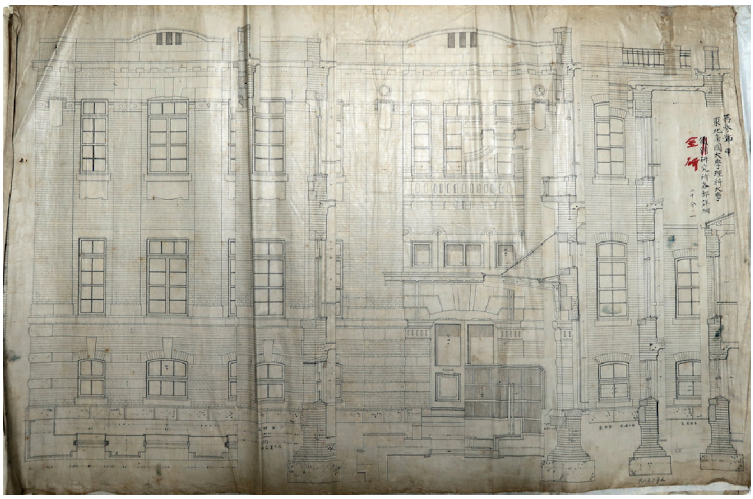

Fig. 9. A detailed cross-sectional drawing of the Metals Instal University.

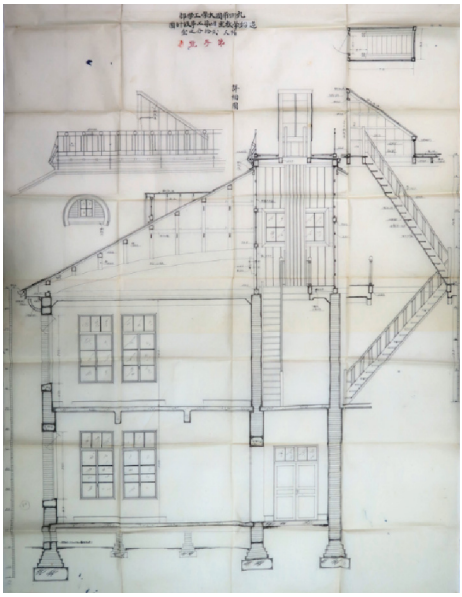

Fig. 10. A cross-sectional drawing showing the extension of the Department of Naval Architecture building at Kyushu Imperial University.

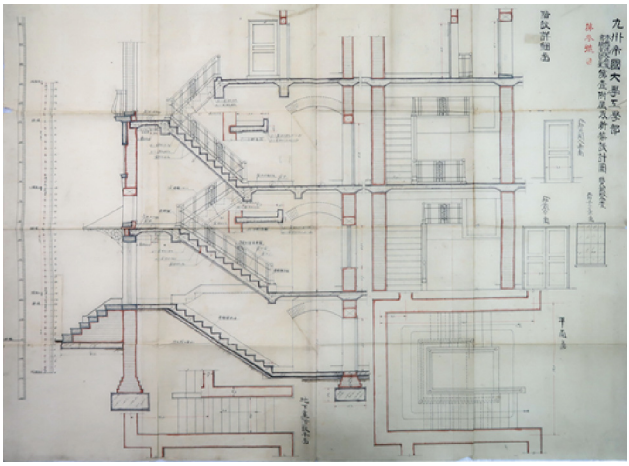

Fig. 11. A cross-sectional drawing of the temporary laboratory of the Faculty of Engineering at Kyushu Imperial University.

6 Conclusion

Prior to the first decade of the twentieth century, fireproof floors that were made from concrete that was poured over shallow vaulted bricks or corrugated iron plates which spanned steel beams were widely used, and RC was occasionally used to build stair landings and staircases. After 1910, the practice of using RC slabs with steel beams to construct fireproof floors was introduced. Subsequently, the steel beams were replaced by using both small and large beams and haunching beams with RC slabs. The mixed-structure building was likely a result of a partial incorporation of the merits of RC, which was introduced in the first two decades of the twentieth century. This study has demonstrated that the construction of mixed-structure buildings in Japan was introduced through the building of the head office of Takaoka Kyoritsu Bank, which was completed in 1914 and has a steel-framed brick masonry wall structure. The construction of mixed-structure buildings disappeared after the Sapporo Court of Appeal building was completed in 1926. All walls in mixed-structure buildings examined in this study were constructed with unreinforced brick, with the exception of the Takaoka Kyoritsu Bank head office. Due to variations in site conditions, a standardized numerical value for wall thickness cannot be determined. Before the Great Kanto Earthquake, however, mainstream fire-resistant construction had switched to the use of RC to build small- and medium-sized buildings. The Great Kanto Earthquake did not eliminate the possibility of constructing masonry buildings, and only remnants of mixed-structure construction are seen in large-scale buildings. Depending on how one looks at it, the damage to masonry buildings that was caused by the Great Kanto Earthquake can be described as the final blow that caused the demise of masonry buildings in Japan. It will be interesting to examine whether a similar phenomenon is also observed with mixed-structure buildings in other countries over the same period.

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