

An accident of the fall of the Toki Messe sky bridge

【At about 20:20, August 26th, 2003

Toki messe in Bandaijima, Niigata City, Niigata Prefecture】

Masahiko Kunishima • Michihide Miura ^(*1)

The Toki Messe opened May 1st, 2003, but only 5 months later, at 20:20 on August 26th, 2003, the sky bridge in the Toki Messe suddenly fell down at a part of the sky bridge between Niigata Convention Center and the multilevel car-parking tower (48m) and at a connection part of the multilevel car-parking tower (15m). The Toki Messe sky bridge connecting Toki Messe and Sado Steamer is 220m. The safety of people was confirmed by using 160t crane about 2 hours after the accident and no one got injured or died in this accident. On November 10th, the governor of Niigata Prefecture decided to pay ¥143,900,000 for running repairs (including the clearance of the accident scene and the installation of the timbering). ¥68,400,000 was added to the cost of recovery by the revised budget in September. The total cost of the measurement became ¥212,300,000. The contract cost of the place was ¥340,345,000. Niigata Prefecture (the owner) required compensation for damage of ¥894,550,000 (total cost) from the traders who undertook design and construction. The first oral pleading was carried out in the Niigata district court on November 26th, 2004.

1. Event

At 20:20 on August 26th, 2003, there was a phone call from Sado Kisen Co. to Bandaijima Redevelopment Office, Development Division, Bureau of Port and Airport Development, Niigata Prefectural Government. The information was that there was a part of the sky bridge between Niigata Convention Center and the multilevel car-parking tower had collapsed. No one got injured or died in this accident.

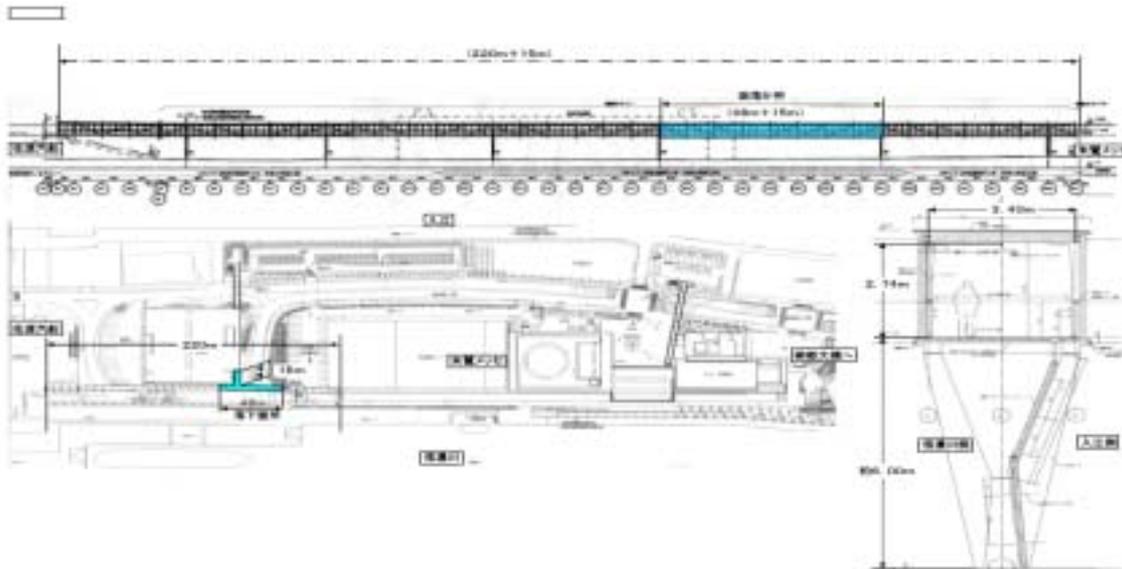


Figure-1 The plan of the fallen place (Source: HP of Room of re-developing Bandai island, Ports and Harbors Bureau promotion section of Niigata Prefecture.)



Picture-1 The field right after the accident (Source: HP of Room of re-developing Bandai island, Ports and Harbors Bureau promotion section of Niigata Prefecture.)

2. Course

Niigata prefectural government decided to construct a center of international exchange at Bandai Island. Then, the Toki Messe project started in 1992 and the Toki Messe opened on May 1st, 2003. The Toki Messe opened on May 1st, 2003, but only 5 months later, at 20:20 on August 26th, 2003, the sky bridge in the Toki Messe suddenly fell down.

Niigata prefecture organized “The Toki Messe sky bridge Accident Investigation group” on August 28th and “The Toki Messe sky bridge Accident Investigation Committee (The Chairman: Hisaichi Maruoka the sub principal of Nagaoka Science Technology College)” started to investigate on September 1st. The first meeting of the Toki Messe sky bridge Accident Investigation Committee was held. The chairman of the Toki Messe sky bridge Accident Investigation Committee gave commentary.

3. Cause

” The Accident Investigation Task • Force” Japan Structural Consultants Association (J S C A) which originally installed was not accepted the request of the accident investigation by Nigata Prefecture, could not get a little information, and could not investigate the condition right after the accident because ” The Toki Messe sky bridge Accident Investigation Group” and “The Toki Messe sky bridge Accident Investigation Committee (Picture-2) ” installed.

That is why, ” The Accident Investigation Task • Force” could not specify the precise cause of the accident, but said that the direct factor of the accident could be one of following three factors, by considering the scene of the accident.

- 1) The failure of the fixing concrete of the diagonal rod.
- 2) The failure or buckling of the chord on the steel frame.
- 3) The flexure fracture of the PC floorboards or the failure of the line of PC steel for pressure bonding.

In addition, according to the structure analysis, if the construction is carried out rightly, it is concluded that the sky bridge would not fall only because of its weight. Therefore, it is not too much to say that the falling accident was brought about by the damage which was made by the first jacking down during the construction. It was estimated that excessive bending cracks were generated near the diagonal rods of PCa floor slab by the effect of large bending stress of the lower chord material PCa (precast concrete), which was generated in 2000(the first jacking down) and in 2002(completion). As the result, this crack developed over time. It is natural to think the falling was caused by the decrease of the effective shear area of concrete in the anchorage zone.

Hisakazu Maruyama, the chairman, said “The endurance of the structure analysis was not enough, so it is most possible that the cause was the continuous dead weight” and “It is possible for the sky bridge to transform even if it was constructed according to the design.”

The 10th committee concluded that the origin of the process of the falling of the sky bridge and the cause of the destruction of the PCa floor slab after 2 years and 4 months were as follows.

1. The shortage of the endurance of the anchorage zone in the diagonal rods.
2. Bar arrangement failure of the U-shaped reinforcing bars in the anchorage zone of the diagonal rods.
3. The first jacking down which was carried out thoughtlessly.

The investigation committee (including the Toki Messe sky bridge Accident Investigation

Committee) pointed out the following problems, apart from the structural problem by wrong construction.

1. The construction was started without enough communication between the parties concerned.
2. The design for execution and the construction progressed simultaneously.
3. The supervision system lacked the suitable structural supervisor.

The committees think the combination of these problems also caused the accident.



Picture-2 The situation investigation by investigation team (Source: HP of Room of re-developing Bandai island, Ports and Harbors Bureau promotion section of Niigata Prefecture.)

4. Immediate Action

After a phone call about the accident from Sado Kisen Co, on the same day, the prefectural government ordered Niigata Bandaijima Sougoukikaku Co, which manages the site, to see the accident site and ensure the safety around the accident site. The prefectural government also sent staff to the accident site. The next day, an investigation team for the Toki Messe sky bridge accident was set up in the Bureau of Port and Airport Development. Whole floors of the Bandaijima car park (a multilevel car-parking tower) re-opened from September 1st.

5. Countermeasure

On August 28th, 2003, Niigata prefectural government set up an investigation team for the Toki Messe sky bridge accident in the Bureau of Port and Airport Development to consider the way for recovery, and to clarify the factors of the accident. On September 1st, 2003, Niigata prefectural government also set up the Toki Messe sky bridge Accident Investigation Committee to ensure the transparency and objectivity of the cause clarification process, and to decide the way for recovery.

The Niigata prefectural government set up the study team for the reinforcement of the Toki

Messe sky bridge to obtain the technical instructions, advice and objective assessments for the design from the professionals who have advanced knowledge. This is because the sky bridges in front of the atrium and bay side needed to be reinforced for the adequate safety.

6. Generalization

The Toki Messe was completed with a large expectation of promotion of international exchange, promotion of trade and industry, invigoration of the local area economy and promotion of culture. As many other structures, Toki Messe endured various forces during the in-service period and also was exposed many degradation factors. Generally, when designing the structures, the structures are designed from the whole shape to the dimension of each material plus the material which will be used, and the details such as the construction technique so that the structures can resist these degradation factors during the life time of the structure. In this process, new material, new technology or active ingenuity is introduced with old experience, and the new structures are made. The sky bridge of Toki Messe was constructed through such a process. After several months, it fell without special force (a large earthquake, a storm, snow storm, over loading). Niigata Prefecture, which is the owner of the structure, set up the investigation committee immediately. At first the investigation committee thought it was difficult to find the cause because large load more than expected force did not affect and the in-service period was too short for the performance of the structure to deteriorate. However, it is sure that the real stress of members or structure was smaller than the affecting force. Then, the investigation committee started to investigate the reason why the falling physically occurred and where the cause was in the process of the design and the construction.

7. Background

〈 Application 〉

The Toki Messe was constructed at the Bandai Island at the mouth of the Shinano River and has an exhibition hall, a conference hall and an atrium in the tower. The sky bridges are not the only access ways between each facility as there are also the urban corridors over the Shinano River for strolling along the water front. Moreover, the silhouette of the Toki Messe is the core of the new landscape of the whole island.

〈 History 〉

Niigata prefectural government decided to construct a center of international exchange at Bandai Island. Then, the Toki Messe project started in 1992 and the Toki Messe opened on May 1st, 2003.

〈 Structure 〉

The sky bridges have contiguous beams with random spans (30m, 36m, and 48m) to create space for car lanes on the ground level. The sky bridge has a plane truss structure that the steel frames, as the upper chord member, are unified with the PC floor boards, as the bottom chord member, by the bundle member and slinging rods. At the center of the span, there is no bend so the slinging structure is also used.

〈 Meteorological phenomenon situations 〉

Temperature : 24.9°C

Humidity : 84%

Wind direction : North

Wind speed : 2.0m/s

Precipitation : 0.0mm

8. Knowledge

- (1) The structural safety should be achieved with economic efficiency, construction efficiency, environmental friendliness and visual beauty.
- (2) The promoter should secure the sufficient period and the materials for the design, construction management and installation.
- (3) The promoter should have a working environment where the designer, site manager and installation workers can communicate deeply with each other.
- (4) Especially, in the case of construction of the comprehensive and unique structure like Toki Messe, the promoter should check the adequacy of the installation result by hearing the professionals' opinions.
- (5) It is important to make a system so that the designing and construction management are implemented under the technically responsible group.
- (6) It is important to ensure the safety by the investigation commission which includes a professional.

〈 Reference 〉

“About an accident of the fall of the Toki Messe sky bridge” (HP of Room of re-developing Bandai island, Ports and Harbors Bureau promotion section of Niigata Prefecture.)

“An accident of the fall of the Toki Messe sky bridge report of the accident”

“A report of the result of an accident of the fall of the Toki Messe sky bridge (The progress report) ”

“A report of an accident of the fall of the Toki Messe sky bridge”

JSCA HP

“An investigation of an accident of the fall of the Toki Messe sky bridge Report” by TASK •

FORCE (JSCA)

NHK Ni igata “Kitto Niigata”

Articles of newspaper

(*1) : Department of civil engineering, the Univ. of Tokyo.