MECHANICAL BEHAVIOR OF EXTRADOSED BRIDGE HAVING RUPTURED CABLES

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1. INTRODUCTION

In 1980, the earliest concept of extradosed bridge (hereafter ED bridge) was incorporated for the strengthening of the bridge in Poland. In 1982-3, Jacques Mathivat developed a theoretical basis for the concept of ED bridge. In 1993, the first ED bridge constructed using J.Mathivat's concepts was in Portugal. After one year, this was quickly followed by the Odawara Blueway Bridge in Japan. In 1988, J.Mathivat is credited with inventing the ED bridge design concepts. J.Mathivat's design is to replace the normal prestressed internal tendons with "external" tendons installed outside and above the main girder and deviated by short towers located at supports. Tension forces in the girder act more to compress the bridge girder horizontally, rather than support it vertically; thus, the cables act as prestressing cables for a concrete girder because of the cables from lower towers that intersect with the girder only further out, and at a lower angle. Recently, it has been reported that rupture of cables due to corrosion in ED and cable stayed bridges. However, safety of such bridges with ruptured cables have hardly been clarified. The objective of this study is to clarify experimentally the mechanical behavior of the ED bridge having ruptured cables.

2. METHODOLOGY

An experiment was conducted to clarify the influence of the location of ruptured cables on the safety of bridge. Cables were de-tensioned to stimulate the condition of ruptured cables. For each scenario of ruptured cable, 100kN static load was applied. The deck and the pylons are made of SS400 steel with yield strength of 350 MPa. SWPR1BL Steel wires with a diameter of 7 mm and tensile strength of 1620 MPa are employed. An orthotropic steel deck box girder ED bridge of 4-meter-long with two 200mm height pylons A and B having the cross section of 70x100(mm) and the 12mm thickness of girder shell with the cross section of 220x74(mm) is designed. At the corresponding locations of cables, waiting-anchors for cable anchorages are welded. Cable arrangement, location of strain gauges, displacement gauges and details of the design are shown in Figures.

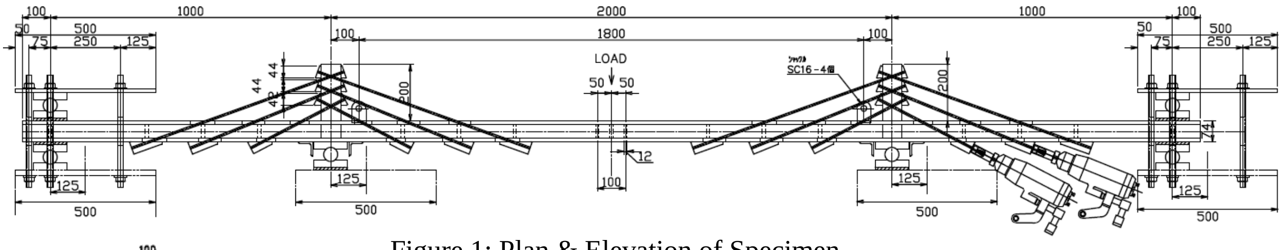

Figure 1: Plan & Elevation of Specimen

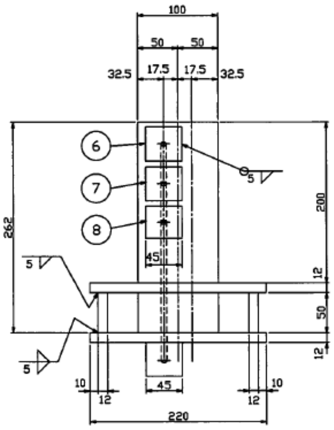

Figure 2: Cross section of girder and pylon

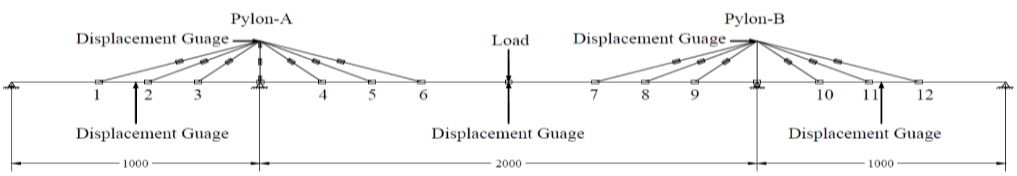

Figure 3: Location of strain gauges, displacement gauges and the cable arrangement

3. RESULTS AND DISCUSSIONS

The girder in an ED bridge can be thicker than that of a conventional cable-stayed bridge, but thinner than that of a girder bridge of a comparable span and extradosed bridge are like common girder bridges with external cable structure, therefore it is the girder which persistently resists the sectional force. Then, the role of the cables is not much influential on the safety of girder. It can be seen in Figure 3. The girder hasn't yield even when all the cables (Cable No. 1 to 6) at Pylon-A are ruptured, furthermore, the other half of the bridge is almost steady. Stress changes are not critical. The least influential case is when innermost cable (cable No.4) is ruptured.

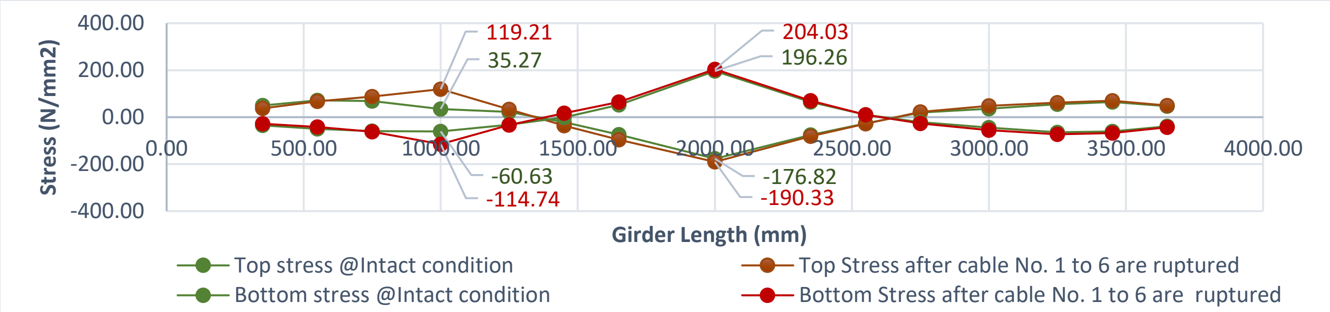

Figure 3: Top & Bottom girder stresses of all cases

Figure 4 shows cable stresses and stresses changes after cable No.4,5,6 are ruptured. According to the Figure 4 and Table 4, the influence on the stress changes after cables are ruptured is the highest at the outermost and the longest cable than the shorter ones. The stresses of remain cables do not reach the tensile strength of cable even for the scenario of three cables are ruptured as shown in Figure 4.

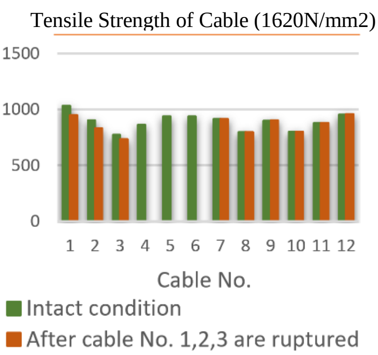

Figure 4: Cable stresses (N/mm2) after cable No. 4,5,6 ruptured

Legend; (For Table 1)

Case-1 = after cable No.6 are ruptured
Case-2 = after cable No.4,5,6 are ruptured
Case-3 = after cable No.4 are ruptured
Case-4 = after cable No.1 to 6 are ruptured

Table 1: Cable stress changes

No.	Case-1	Case-2	Case-3	Case-4
1	4.46%	8.27%	1.52%	
2	4.01%	7.68%	1.75%	
3	2.59%	5.28%	1.16%	
4	-3.25%			
5	-4.73%		-3.90%	
6			-2.32%	
7	-0.04%	-0.28%	0.30%	-0.57%
8	-0.02%	-0.22%	0.24%	-0.46%
9	-0.02%	-0.11%	0.13%	-0.17%
10	0.00%	-0.02%	0.27%	0.17%
11	0.18%	0.04%	0.53%	0.00%
12	-0.02%	-0.33%	0.24%	-0.73%

4. CONCLUSIONS

It can be concluded that the structure is still safe even if all the cables from one pylon are being replaced without considering any live loads and dynamics effect due to sudden rupture of cables. The girder and the pylon hasn't yield for all ruptured scenarios. The remain cables do not break even after the cables have been ruptured in accordance with the ruptured cable scenarios. The outermost and the longest cable has more influence on the stress of girder and remain cables than the innermost and the shortest ones. In other words, the more the location of the ruptured cable is far from the pylon, the more the influence on the safety of the structure.

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