

Aerodynamic stability of long-span box girder

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Objekttyp: **Article**

Zeitschrift: **IABSE congress report = Rapport du congrès AIPC = IVBH
Kongressbericht**

Band (Jahr): **12 (1984)**

PDF erstellt am: **21.09.2024**

Persistenter Link: <https://doi.org/10.5169/seals-12247>

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AERODYNAMIC STABILITY OF LONG-SPAN BOX GIRDER

Tozaki Bridge is the north approach to Ohnaruto Br. (suspension bridge) of Kobe-Naruto Route, Honshu-Shikoku Bridge Project, Japan. Tozaki Bridge is 2 sets of continuous box girders and has slender configuration with large overhanging brackets. The bridge was to be constructed along a steep ridge called Tozaki which faces the Pacific Ocean. Thus, strong wind is expected so that the basic wind speed which is defined as 10 minutes average speed expected to occur once or twice in 150 years is decided to be 50m/s. And, bad influence by the topography was also anxious.

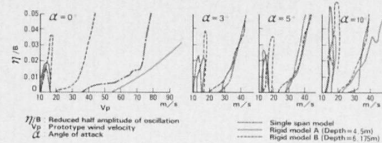
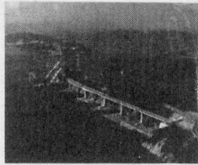


Fig. 2 Response of original section (without topography)

The original section was suspected to have unstable aerodynamic behavior, so, wind tunnel tests were conducted to reveal that the original section had vortex-induced oscillation at the wind speed of 15 to 20 m/s and galloping which should not occur below the speed of 92 m/s (10minutes average), the dynamic design wind speed.

Various stabilizers and their effects were tested in wind tunnels.

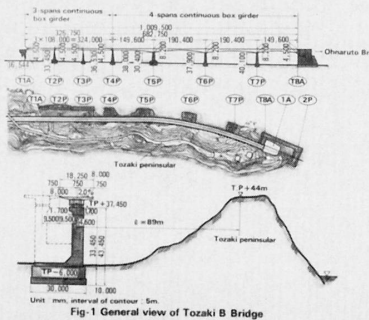


Fig. 1 General view of Tozaki B Bridge

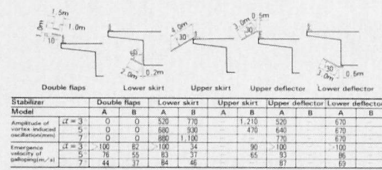


Fig. 3 Effect of lower skirt (model B)

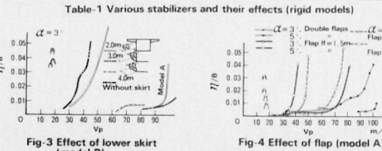


Fig. 4 Effect of flap (model A)

Table 1 Various stabilizers and their effects (rigid models)

Stabilizer Model	Double flaps		Lower skirt		Upper skirt		Upper deflector		Lower deflector	
	A	B	A	B	A	B	A	B	A	B
Amplitude of vortex induced oscillation	0	0	530	730	1170	520	470	670	0	0
Frequency	5	0	860	930	476	440	470	470	130	130
Emergency velocity of galloping/m/s	5	76	55	83	27	65	83	86	86	86
	7	44	17	84	66	97	97	97	97	97

As the results of a series of wind tunnel testings, the final stabilizers were determined as follows: Double flaps were attached to the whole length of the bridge in order to restrict the amplitude of vortex-induced oscillation less than 200 mm ($H/B=0.01$) which was the allowable value from the viewpoint of fatigue and runnability of automobiles. And, intermittent lower skirts to suppress galloping which might destroy the bridge in a short time if it appeared were provided to the 4-spans continuous girder. After the completion of the bridge in the summer of 1983, oscillation and wind have been observed, but no considerable oscillation has been generated so far, because no strong wind beyond 20 m/s has unfortunately blown.

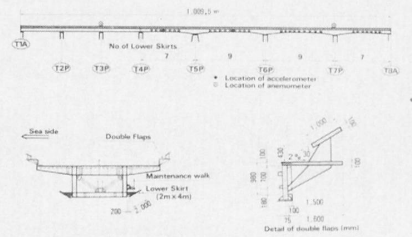


Fig. 5 Actually adopted stabilizers and location of sensors

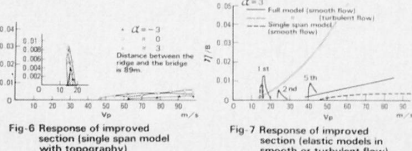


Fig. 6 Response of improved section (single span model with topography)

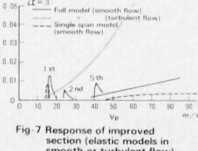


Fig. 7 Response of improved section (elastic models in smooth or turbulent flow)