Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte

Band: 79 (1998)

Artikel: Seismic behaviour of long-span cable-stayed bridges

Autor: Fan, Li-Chu / Hu, Shi-de

DOI: https://doi.org/10.5169/seals-59872

Seismic Behaviour of Long-Span Cable-Stayed Bridges

Li-Chu FAN
Prof.
Tongji Univ.
Shanghai, China

Li-chu Fan, born 1933, received his bridge engineering degree form Tonji Univ. in 1955. Deputy director of academic committee, State Key Laboratory for Disaster Reduction in Civil Engineering.

Shi-de HU
Prof.
Tongji Univ.
Shangahi, China

Shi-de Hu, born 1942, graduated from Tonhji Univ. in 1965. She is the Chief of the Bridge Eng. Division.

Summary

Seismic studies of three of long-span cable-stayed bridges crossing Huangpu River in Shanghai were performed by our research group of State Key Laboratroy for Disaster Reduction in Civil Engineering. The effect of transverse restraint of auxiliary piers on seismic response of Xupu Bridge structure is investigated and discussed. The disaster lessons of Higashi Kobe Bridge during the Kobe earthquake is also discussed.

1. Bridge Description

Nanpu Bridge: Composite cable-stayed bridge, Spans:76.5+94.5+423+94.5+76.5m.
Yangpu Bridge: Composite cable-stayed bridge, Spans:99+144+602+144+99m.
Xupu Bridge: Hybrid* cable-stayed bridge, Spans:2@40+3@39+45+590+45+3@39+2@40m..
* The girder is a mixed structures composed of steel in the center span, no bearings are used in the main span, only sliding bearings are provided at extreme pier and/or auxiliary piers.
For Nanpu and Yangpu Brisges, two auxiliary piers are located in the both side span at 94.5m and 144m away from the tower, respectively. For XupuBridge there are four auxiliary piers in the both side span.

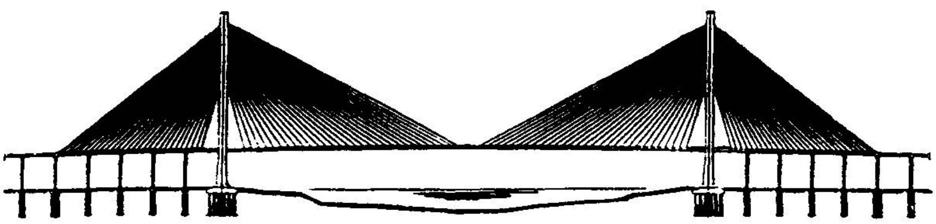

Fig.1 Elevation of Xupu Bridge

2. Lateral Seismic response of Side Piers and Auxiliary piers.

In order to investigate the effect of transvers restraint of auxiliary piers on seismic response of structures four cases are considered:

Case	Seismic	Side Pier		Auxiliary	Pier		Tower
	Response	#1	#2	#3	#4	#5	
I	Relative Displacement	166	0	0	0	0	0
	Bending Moment	3.71×10^{4}	1.51×10^{5}	1.19×10^{5}	8.84×10^{4}	5.77×10^{4}	4.46×10^{5}
II	Relative Displacement	512	392	0	176	0	
	Bending Moment	3.68×10^{4}	2.94×10^{4}	3.26×10^{5}	2.95×10^{4}	2.70×10^{5}	5.55×10^{5}
III	Relative Displacement	522	402	0	183	97	
	Bending Moment	3.67×10^{4}	2.92×10^{4}	3.33×10^{5}	2.94×10^{4}	2.95×10^{5}	5.91×10^{5}
IV	Relative Displacement	440	345	250	162	88	
	Bending Moment	3.41×10^{4}	2.68×10^{4}	2.70×10^{5}	2.74×10^{4}	2.73×10^{5}	6.94×10^{5}

From this analytical results it can be found that the lateral seismic force will be shared by side pier and auxiliaty piers when the transverse restrain all existed between the top of auxiliary piers and girder.

3. The Disaster Lessons of Higashi Kobe Bridge

The Higashi Kobe Bridge located in Kobe city, is a steel cable-stayed bridge with double deck. The center span of the bridge is 485m. The pendel type bearing pin at the end chore pier in bridge side sapn on Kobe side have dropped off(Fig. 2). It seems that the main cause is the effects of combine action by vertivcal and transverse earthquake shaking.

Generally, the pendel type bearing at the anchored pier is designed to restrain displacement in the longitudinal and withstand the vertical up-action but no to withstand the seismic force in the transverse direction. In transverse seismic response analysis of Yangpu Bridge, we found that the transverse seismic response of anchored pier is very large, therefore, a steel bar of which the ultimate tension force is 2000KN is erected between the top of anchored pier and main girder.

For cable-stayed bridges, under the longitudinal seismic action the bottom sections of tower are critical, under the lateral seismic action the critical section will appear at the bottom of anchor pier and/or auxiliary piers. Therefore, the designer must pay great attention to out-plane seismic response analysis for long-span cable-stayed bridges.

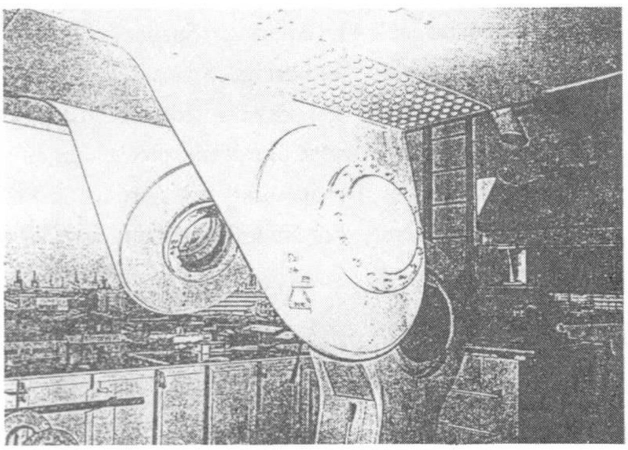

Fig. 2 Higashi-Kobe Bridge damage of pendel type bearing