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TU311.3 A

STUDY OF AERODYNAMIC INTERFERENCE EFFECTS ON AERODYNAMIC COEFFICIENTS OF TWIN-DECK BRIDGES

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Abstract: There exist aerodynamic interference effects between the windward deck and the leeward deck of twin-deck bridges under wind load. Aerodynamic interference effects on aerodynamic coefficients of a twin-deck bridge were investigated with a series of section-model wind tunnel tests using both force-measurement method and pressure-measurement method. The results show that the aerodynamic interference effects on drag coefficients of twin-deck bridges could not be neglected. Compared with single deck alone, the drag coefficients of leeward deck are much smaller and those of windward deck decrease slightly. The aerodynamic interference effects on the lift and torque coefficients of twin-deck bridge could be ignored.

Key words: twin decks; aerodynamic coefficients; aerodynamic interference; force-measurement method; pressure-measurement method

[1－4]

Pearl Harbor Sarkar P P[5] Tsurumi Memorial Bridge Fred Hartman Bridge Fairway Bridge( )

( )

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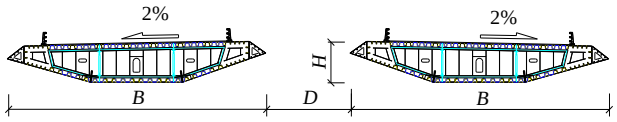
H=3.5m *B*=23m

D=7.5m

Akihiro Honda[6] Kansai International Airport Access Bridge( )



1

Fig.1 Cross section of girder

2%

[7−8] ( ) DS( ) DX( ) S( ) 1

D/*H*=1.0 *D*/*H*=2.143( ) *D*/*H*=4.0

(*D*/*H*=2.143)

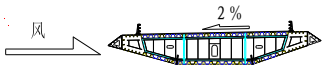
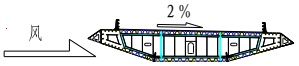
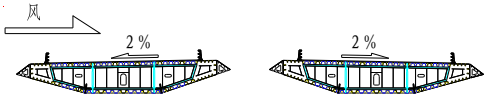
2 3

1 3

HD-2 17.0m 60.0m+120.0m+ 2.5m 3.0m 10m/s 120.0m+60.0m=360.0m 1 0.4%

1

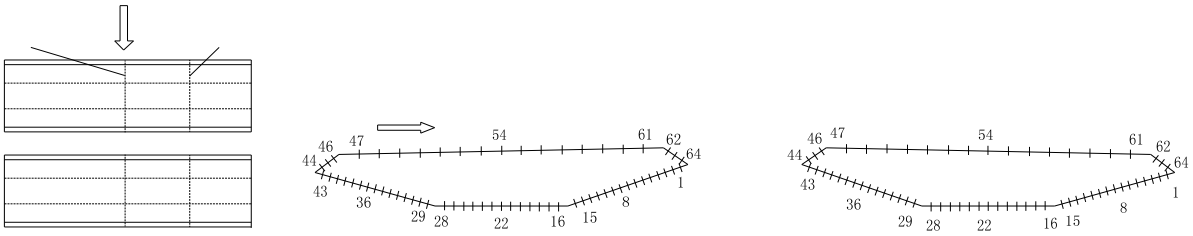
Table1 Cases of wind tunnel tests

1			DS	−10°—10°
2	1/50		DX	
3			S(*D*/*H*=1.0)	
4			S(*D*/*H*=2.413)	
5			S(*D*/*H*=4.0)	
6	1/25		S(*D*/*H*=2.413)	

(a) (b)

2

Fig.2 Photos of wind tunnel tests



(a) (b)

3

Fig.3 Pressure taps location and numbers

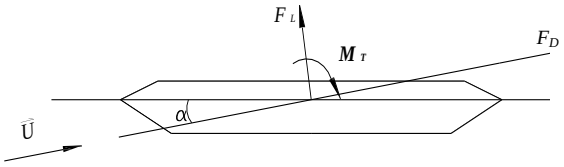
2

F F_D F_L

M_T 4 4

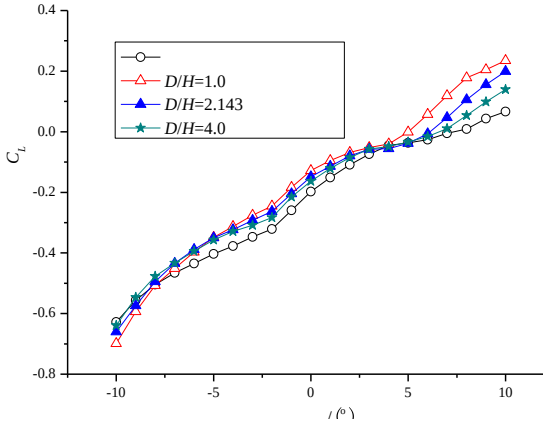
5

6

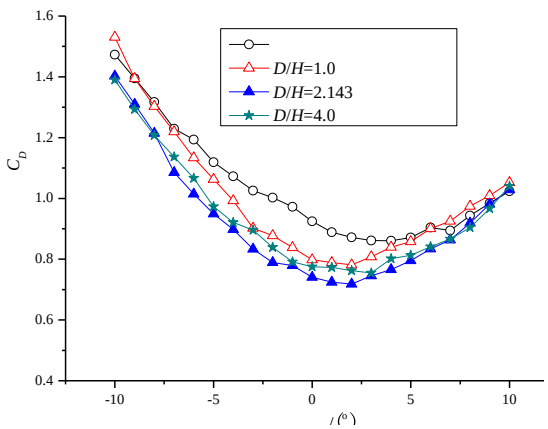


4

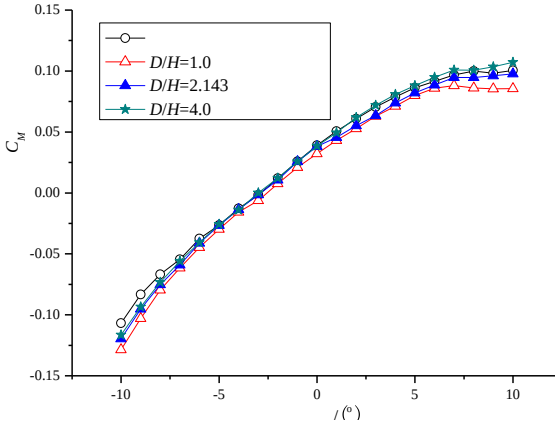
Fig.4 Aerodynamic forces in wind coordinate system



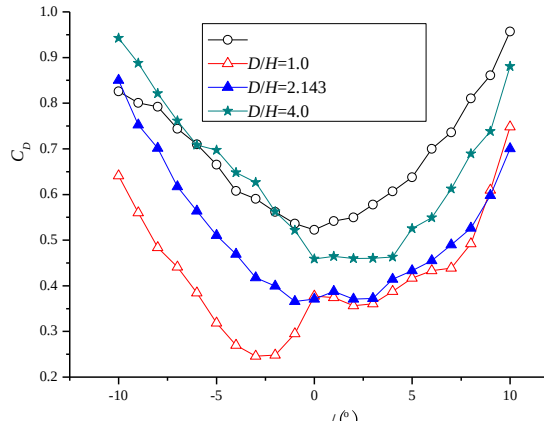
(b)



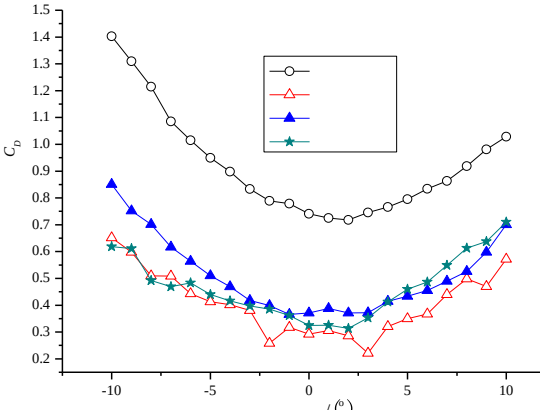
(a)



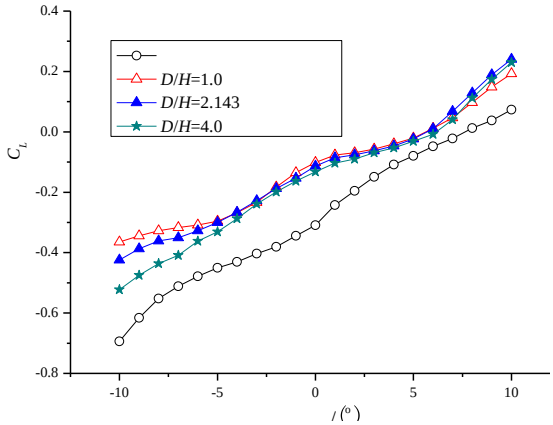
(c)



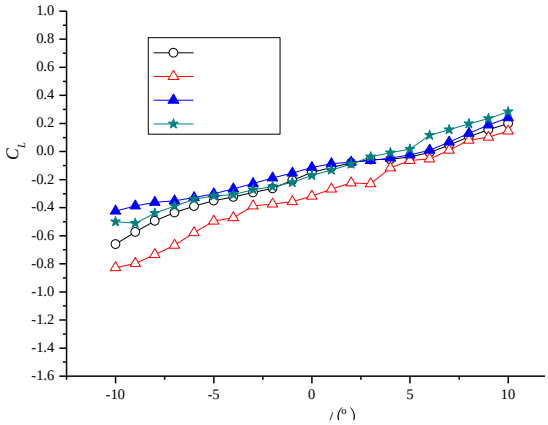
(d)



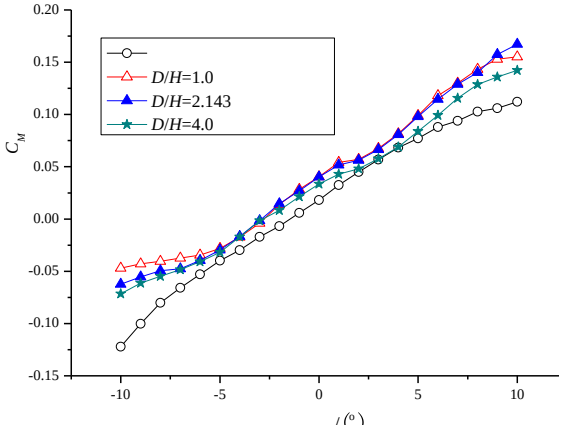
(a)



(e)



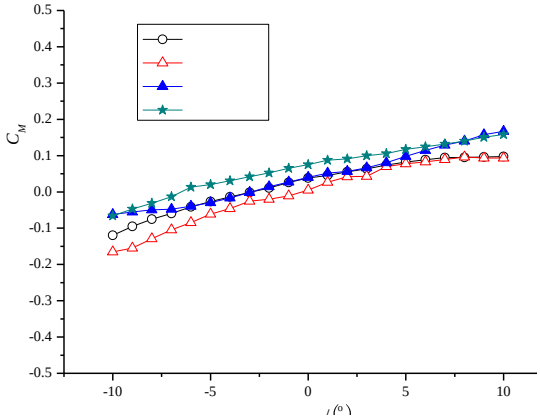
(b)



(f)

5

Fig.5 Force-measurement results



(c)

6

Fig.6 Comparisons of force-measurement results and pressure-measurement results

5

1)

$$C_D = 2F_D / \rho U^2 DL \quad (1)$$

$$C_L = 2F_L / \rho U^2 BL \quad (2)$$

$$C_M = 2M_T / \rho U^2 B^2 L \quad (3)$$

D B L

U ρ 1.225kg/m^3

“ ”

2) “ ”

3

3)

–5 ° 5 °

6 7 (*D*/*H*= 2.143) 0 ° –10 °

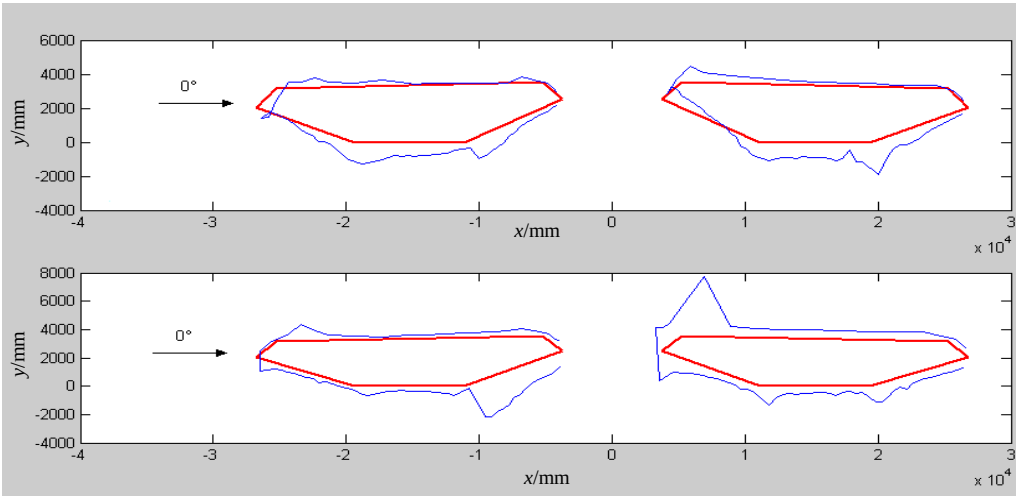
$$C_i = (P_i - P_\infty)/0.5\rho U^2 \tag{4}$$

C_i P_i P_∞ i

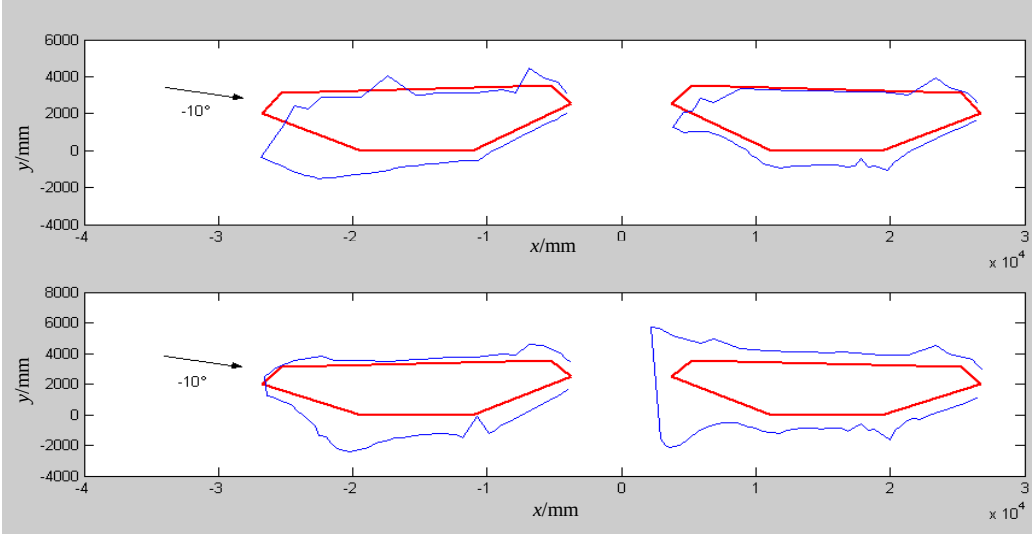
Hangan H Regio Calabria Ricciar- i
delli F[9] [10] 7

7

2/3 1500 15000



(a) 0 °



(b) –10 °

7

Fig.7 Mean and RMS pressure coefficient of twin decks at various wind attack angles

7

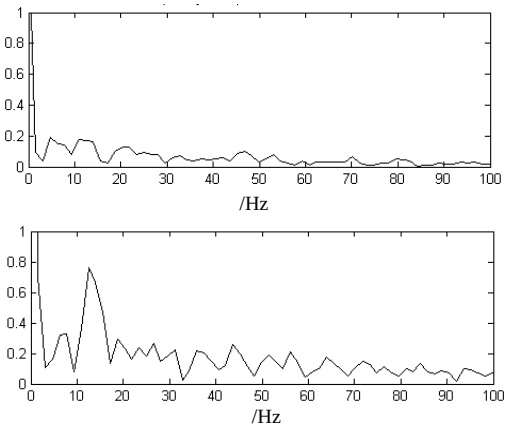
0 °

“ ”

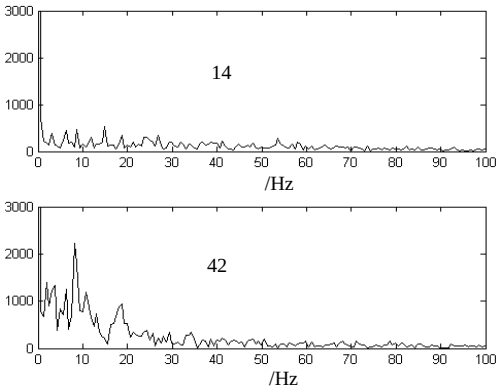
0 ° –10 °

“ ” 0 °

–10 °



(a) 0 °



(b) –10 °

8

8

Fig.8 Magnitude spectrum of aerodynamic coefficients and single tap pressure coefficients of twin decks

4

(1)

(2)

“ ”

(3)

[1] Zdravkovich M M. Review of flow interference between two circular cylinders in various arrangements [J]. ASME Journal of Fluids Engineering, 1977, 99(4): 618－633.

[2] Zdravkovich M M. Review of interference induced oscillations in flow past two circular cylinders in various arrangements [J]. Journal of Wind Engineering and Industrial Aerodynamics, 1988, 28: 183－200.

[3] , , .
[J]. , 2002, 30(5): 604－608.
Lou Xiaofeng, Cao Fengchan, Lin Zhixing. Numerical computation of the flow around bluff bodies in tandem arrangement [J]. Journal of Tongji University, 2002, 30(5): 604－608. (in Chinese)

[4] , , , .
[J]. , 2001, 29(3): 320－325.
Chen Suqin, Huang Ziping, Shen Jianhua, Gu Ming. Numerical computation of the flow around two square cylinders in tandem arrangement [J]. Journal of Tongji University, 2001, 29(3): 320－325. (in Chinese)

[5] Sarkar P P. Identification of aeroelastic parameters of flexible bridges [J]. Journal of Engineering Mechanics ASCE, 1994, 120(8): 1718－1742.

[6] Akihiro Honda. Aerodynamic stability of kansai international airport access bridge [J]. Journal of Wind Engineering and Industrial Aerodynamics, 1990, 33: 369－376.

[7] , , , , .
[C]. 12
, , 2005.
Niu Huawei, Chen Zhengqing, Liu Zhiwen, Han Yan, Liu Muguang. Experimental research on flutter stability of parallel box-girder bridges [C]. Proceedings of the 12th National Structural Wind Engineering Conference Symposium, Xi’an, 2005. (in Chinese)

[8] , , , .
[C]. 12
, , 2005.
Liu Muguang, Chen Zhengqing, Hu Jianhua, Liu Zhiwen. Wind tunnel test study on parallel cables in aerodynamic models [C]. Proceedings of the 12th National Structural Wind Engineering Conference Symposium, Xi’an, 2005. (in Chinese)

[9] Ricciardelli F, Hangan H. Pressure distribution and aerodynamic forces on stationary box bridge sections [J]. Wind and Structures, 2001, 4(5): 399－412.

[10] , .
[C]. 12 , , 2005.
Lin Zhixing, Jin Ting. Reynolds number effect study on strouhal number of box bridge girder [C]. Proceedings of the 12th National Structural Wind Engineering Conference Symposium, Xi’an, 2005. (in Chinese)