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Dynamic Analysis of Suspension Bridges and Full Scale Testing

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ABSTRACT

This paper is concerned with the earthquake analysis of suspension bridges, in which the effects of large deflections are taken into account. The first part of the study deals with an iteration scheme for the nonlinear static analysis of suspension bridges by means of tangent stiffness matrices. The concept of tangent stiffness matrix is then introduced in the frequency equation governing the free vibration of the system. At any equilibrium stage, the vibrations are assumed to take place tangent to the curve representing the force-deflection characteristics of the structure. The bridge is idealized as a three dimensional lumped mass system and subjected to three orthogonal components of earthquake ground motion producing horizontal, vertical and torsional oscillations. By this means a realistic appraisal is achieved for torsional response as well as for the other types of vibration. The modal response spectrum technique is applied to evaluate the seismic loading for the combination of these vibrations. Various numerical examples are introduced in order to demonstrate the method of analysis. The procedure described enables the designer to evaluate the nonlinear dynamic response of suspension bridges in a systematic manner.

KEYWORDS

Suspension Bridges; Dynamic Analysis; Tangent Stiffness; Cable Structures; Bridge Testing

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References

[1] I. Konishi and Y. Yamada, "Earthquake Responses of a Long Span Suspension Bridge," Proceedings of the Second World Conference on Earthquake Engineering, Tokyo, Vol. 2, 1960, pp. 863-875.

[2] D. M. Brotton, "A General Computer Programme for the Solution of Suspension Brdige Problems," Structural Engineer, Vol. 44, No. 5, 1966, pp. 161-167.

[3] S. A. Saafan, "Theoretical Analysis of Suspension Bridges," Journal of the Structural Division, Vol. 92, No. ST4, 1966.

[4] S. S. Tezcan, "Stiffness Analysis of Suspension Bridges by Iteration," Proceedings, Symposium on Suspension Bridges, Laboratorio Nacional de Engenharia Civil, Avenue Du Brasil, Lisbon, November 1966.

[5] J. A. Blume, N. M. Newmark and L. H. Corning, "Design of Multistorey Reinforced Concrete Buildings for Earthquake Motions," Portland Cement Association, Chicago, 1961, p. 245.

[6] G. W. Housner, "Behaviour of Structures during Earthquakes," Journal of the Engineering Mechanics Division, Vol. 85, No. SM4, 1953, pp. 109-129.

[7] W. G. Hurty and M. F. Rubinstein, "Dynamics of Structures," Prentice-Hall Inc., New York, 1964.

[8] I. Konishi and Y. Yamada, "Earthquake Response and Earthquake Resistant Design of Long Span Suspension Bridges," Proceedings of the 3rd World Conference on Earthquake Engineerings, Vol. 3, 2004, pp. 312-323.

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[9] R. K. Livesley and B. D. Chandler, "Stability Functions for Structural Frameworks," Manchester University Press, Manchester, 1956.

[10] M. J. Turner, E. H. Dill, H. C. Martin and R. J. Melosh, "Large Deflections of Structures Subjected to Heating and External Loads," Journal of the Aero-Space Sciences, Vol. 27, No. 2, 1960, pp. 97-106.

[11] S. S. Tezcan, "Discussion of Numerical Solution of Nonlinear Structures," Journal of the Structural Division, Vol. 94, No. ST6, 1968, pp. 1613-1623.

[12] D. B. Steinman, "Modes and Natural Frequencies of Suspension Bridge Oscillations," Journal of the Franklin Institute, Philadelphia, Vol. 3, No. 4, 1959, pp. 148-174. doi:10.1016/S0016-0032(59)90395-3

[13] A. Hirai, T. Okumura, M. Ito and N. Narita, "Lateral Stability of a Suspension Bridge Subjected to Foundation Motion," Proceedings of the 2nd World Conference on Earthquake Engineering, Tokyo, 1960, pp. 931-945.

[14] K. Kubo, "Aseismicity of Suspension Bridges Forced to Vibrate Longitudinally," Proceedings of the 2nd World Conference on Earthquake Engineering, Tokyo, 1960, pp. 913-929.

[15] S. S. Tezcan, "Computer Analysis of Plane and Space Structures," Journal of the Structural Division, Vol. 92, No. ST2, 1966, pp. 143-174.

[16] M. Zribi, N. B. Almutairi and R. M. Abdel, "Control of Vibrations Due to Moving Loads on Suspension Bridges," Journal of Engineering Mechanics, Vol. 132, No. 6, 2006, pp. 659-670. doi:10.1061/(ASCE)0733-9399(2006)132:6(659)

[17] N. P. Jones and C. A. Spartz, "Structural Damping Estimation for Long-Span Bridges," Journal of Engineering Mechanics, Vol. 116, No. 11, 1991, pp. 2414-2433. doi:10.1061/(ASCE)0733-9399(1990)116:11(2414)

[18] R. S. Harichandran, A. Hawwari and B. N. Sweidan, "Response of Long-Span Bridges to Spatially Varying Ground Motion," Journal of Structural Engineering, Vol. 122, No. 5, 1991, pp. 476-484. doi:10.1061/(ASCE)0733-9445(1996)122:5(476)

[19] A. M. Abdel-Ghaffar, S. F. Masri and A. S. M. Niazy, "Seismic Performance Evaluation of Suspension Bridges," Proceedings of the 10th World Conference on Earthquake Engineering, Madrid, 19-24 July 1992, pp. 4845-4850.

[20] J. F. Fleming and E. A. Egeseli, "Dynamic Behavior of a Cable-Stayed Bridge," Earthquake Engineering and Structural Dynamics, Vol. 8, No. 1, 1980, pp. 1-16. doi:10.1002/eqe.4290080102

[21] A. M. Abdel-Ghaffar and A. S. Nazmy, "3-D Nonlinear Seismic Behavior of Cable-Stayed Bridges," Journal of the Structural Division, Vol. 117, No. 11, 1991, pp. 3456- 3476. doi:10.1061/(ASCE)0733-9445(1991)117:11(3456)

[22] S. S. Tezcan and E. Ar?o?lu, "Chanakkale Ataturk Bridge," Proceedings of the 3rd Symposium on Strait Crossings, Norwegian Road Research Laboratory, Alesund, 12-15 June 1994, pp. 21-35.

[23] S. S. Tezcan and K. Kaptan, "A Submerged Floating Tunnel Proposal for the Gibraltar Crossing," Proceedings, 4th Inernational Congress on the Gibraltar Straits Fixed Link, Seville, Vol. 3, 16-18 May 1995, pp. 347-356.

[24] S. S. Tezcan, M. ?pek, J. Petrovski, T. Paskalov and T. Durgunoglu, "Ambient and Forced Vibration Survey of Istanbul Bogazici Suspension Bridge," Proceedings of the 5th European Conference on Earthquake Engineering, Istanbul, Chapter 9, September 1975.

[25] J. M. W. Brownjohn, A. A. Dumano?lu, R. T. Severn and A. Blakeborough, "Ambient Vibration Survey of the Bosphorus Suspension Bridge," Earthquake Engineering and Structural Dynamics, Vol. 18, No. 2, 1989, pp. 263- 283. doi:10.1002/eqe.4290180210