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INFLUENCE OF LOCATION AND PARAMETERS OF STIFFENERS ON THE STABILITY OF A SQUARE PLATE UNDER SHEAR

Application of flexible-walled beams is rather effective because the reducing of wall thickness compared to ordinary welded beams leads to substantial reduction of metal expenditure for the walls and its more rational use.

The operation experience of such beams shows that the loss of local stability of a wall takes place near bearing cross section with characteristic diagonal type of half waves, indicating, that the reason for the stability loss is in shear deformation.

In plate girder with slender web big transverse forces appear, which leads to its buckling as a result of shear. One of the ways to increase stability of the parts of web near supports is to install stiffeners. In the given work the task of finding critical stresses of fixed square plate with installed inclined stiffener is considered. Investigations were performed with the help of finite element method and were experimentally checked. Recommendations were given on the choice of optimal size of the stiffener.

Key words: square plate, shear, stability, finite element method, stiffener, experiment, beam, flexible walls.

References

1. Chen W.F., Lui E.M. Handbook of Structural Engineering, 2nd ed. CRC Press, 2005, 1768 p.

2. Duggal S.K. Design of Steel Structures. Tata McGraw-Hill Education, 2000, 663 p.

3. Darko Beg. Plate and Box Girder Stiffener Design in View of Eurocode 3: Part 1.5. 6th National Conference on Metal Structures. 2008, vol. 1, pp. 286—303.

4. Hendy C.R., Presta F. Transverse Web Stiffeners and Shear Moment Interaction for Steel Plate Girder Bridges. Proceedings of the 7th International Symposium on Steel Bridges. Guimaracs. Portugal. 2008. ECCS, p. 8.

5. Evans H.R. Longitudinally and Transversely Reinforced Plate Girders. Chapter 1. Plated Structures, Stability&Strength. Ed R. Narayanan. Elsevier Applied Science Publishers, London, 1983, pp. 1—73.

6. Ravi S. Bellur. Optimal Design of Stiffened Plates. M. Sc. Thesis, University of Toronto, Graduate Department of Aerospace Science and Engineering, 1999, 100 p.

7. Mohammed M. Hasan. Optimum Design of Stiffened Square Plates for Longitudinal and Square Ribs. Al-khwarizmi Engineering Journal. 2007, vol. 3, no. 3, pp. 13—30.

8. Leitch S.D. Steel Plate Girder Webs with Slender Intermediate Transverse Stiffeners. Ottawa: National Library of Canada. Bibliothèque national edu Canada, 1999.

9. Virag Z. Optimum Design of Stiffened Plates for Different Load and Shapes of Ribs. Journal of Computational and Applied Mechanics. 2004, vol. 5, no. 1, pp. 165—179.

10. Kubiak T. Static and Dynamic Buckling of Thin-Walled Plate Structures. Cham, Springer, 2013, 250 p. DOI: http://dx.doi.org/10.1007/978-3-319-00654-3.

11. Åkesson B. Plate Buckling in Bridges and Other Structures. London, Taylor & Francis, 2007, 282 p.

12. Gaby Issa-El-Khoury, Daniel G Linzell, Louis F. Geschwindner. Computational Studies of Horizontally Curved, Longitudinally Stiffened, Plate Girder Webs in Flexure. Journal of Constructional Steel Research. February 2014, vol. 93, pp. 97—106. DOI: http://dx.doi.org/10.1016/j.jcsr.2013.10.018.

13. Aleksić S., Rogač M., Lučić D. Analysis of Locally Loaded Steel Plate Girders: Model for Patch Load Resistance. Journal of Constructional Steel Research. October 2013, vol. 89, pp. 153—164. DOI: http://dx.doi.org/10.1016/j.jcsr.2013.07.005.

14. Saliba N., Real E., Gardner L. Shear Design Recommendations for Stainless Steel Plate Girders. Engineering Structures. February 2014, vol. 59, pp. 220—228. DOI: http://dx.doi.org/10.1016/j.engstruct.2013.10.016.

15. Real E., Mirambell E., Estrada I. Shear Response of Stainless Steel Plate Girders. Engineering Structures. July 2007, vol. 29, no. 7, pp. 1626—1640. DOI: http://dx.doi.org/10.1016/j.engstruct.2006.08.023.

16. Chacón R., Mirambell E., Real E. Transversally stiffened plate girders subjected to patch loading. Part 1. Preliminary study. Journal of Constructional Steel Research. January 2013, vol. 80, pp. 483—491. : http://dx.doi.org/10.1016/j.jcsr.2012.06.008.

17. Tang K.H., Evans H.R. Transverse Stiffeners for Plate Girder Webs—an Experimental Study. Journal of Constructional Steel Research. 1984, vol. 4, no. 4, pp. 253—280. DOI: http://dx.doi.org/10.1016/0143-974X(84)90002-6.

18. Birger I.A., Panovko Ya.G., editors. *Prochnost', ustoychivost', kolebaniya. Spravochnik v trekh tomakh* [Strength, Stability, Fluctuations. Reference Book]. Vol. 3, Moscow, Mashinostroenie Publ., 1968, 567 p. (In Russian)

19. *SP 16.13330.2011. Stal'nye konstruktsii. Aktualizirovannaya redaktsiya SNiP II-23—81** [Construction Requirements SP 16.13330.2011. Steel Structures. Revised edition of SN&R II-23—81*]. *Minregion Rossii* [Ministry of Regional Development of Russia]. Moscow, OAO «TsPP» Publ., 2011, 172 p. (In Russian)

20. Pritykin A.I. Mestnaya ustoychivost' balok-stenok s shestiugol'nymi vyrezami [Local Stability of Wall Beams with Hexagonal Gains]. *Stroitel'naya mekhanika i raschet sooruzheniy* [Structural Mechanics and Calculation of Structures]. 2011, no. 1, pp. 2—6. (In Russian)

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