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DIGITAL IMAGE CORRELATION FOR INVESTIGATION OF THE SHAPES OF THE STEEL PLATE GIRDERS' WALLS IN THE LATE STAGES OF FATIGUE

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Summary: *The paper presents implementation of the digital image correlation method and its application into in-plane deformation measurement, investigation of the shapes of the buckled wall of fatigued steel girders.*

1. Introduction

The final stage of the girder wall after many cycles of repeated loading reflects the loading history and gradual accumulation of damage that manifests itself in the shape of buckled wall and its detachment from the frame due to cracks propagating mainly though the welds. In order to simplify current labor-intense method for wall's shape investigation the optical method based on the digital image correlation (DIC) has been introduced promising to automate the measurement process. The main topic of this contribution is a presentation of the first results of this method's application and their discussion.

2. Digital image correlation

The DIC method is increasingly popular optical measurement method (Rastogi 2000). However fully automated commercial systems are available on the market, the main reason why to develop one's implementation is a need to have an open, modular, upgradable system independent on the used hardware, putting aside their high cost.

The method utilizes the fact that a correlation between the subsets in the pair of related images reaches the maximum value for the corresponding points on the object. This way can be constructed a mapping function relating identical points on the object's surface on the two images. Once the mapping function is known, displacement and strain fields can be deduced from it. The scripts performing calculation were written in MATLAB providing a suitable development environment thanks its powerful image processing and data presentation functions. The scripts subdivide the image on the subsets of the suitable size, in the next step find matching subsets and their location within the images. The vicinity of the subset is then examined for subpixel determination of the exact location. The subsets exhibiting the correlation coefficient under defined threshold value are excluded from subsequent processing. The lastly mentioned step allows consider only reliable subset pairs for the displacement field determination. As differentiating displacement field in order to get strain field inevitably enhances

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errors an interpolation of displacement fields has been included in the procedure. The interpolation allows sensitive adjustment between smoothing out measurement artifacts and respecting the real peaks indicating object's flaws and other strain concentrators. The displacement fields preconditioned this way are used for the strain calculation that is the final step.

3. Experiments

Firstly, the validity method was tested on the virtual object deformation. The correspondence between the known deformation and the one calculated was very good and detailed proving a correct implementation of the method into the scripts. Secondly, the method has been used for the evaluation of the in-plane deformations of the rubber block under applied load. Thirdly, the method was used on evaluation of the steel girder wall's shape. Measurement of these shapes is the main motivation of the DIC introduction. The well known fact of decisive role of production-based girders imperfections on the girders period of service emphasizes the need of a reliable measurement method of the imperfections (Škaloud & Zörnerová 2002, 2003). The results obtained using the method were compared to that attained by the existing method and their accuracy and time consumption was rendered satisfactory.

4. Conclusion

Implementation of the DIC seems to be a very promising tool for displacement and strains measurement enhancement.

5. Acknowledgement

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