VARIATIONS OF STRESS STATE COMPONENTS DURING STEP CYCLIC LOADING OF POWER PLANT STEEL

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1. Introduction

The essential attempt for reduction of forces acting in the selected metal forming processes has been done by Korbel and Bochniak [1] who modified procedures of forging and extrusion by an application of cyclic torsion. Nowadays, this subject is still widely investigated by other research groups i.e. [2-4] since it seems to be very promising for many other possible applications. Better knowledge of this subject is important for both industrial and research groups, since it may improve selected manufacturing processes and the numerical simulation by taking into account new effects observed in materials. Therefore, it was decided in this paper to investigate how the amplitude and frequency of torsion cycles influence the axial stress–axial strain characteristic of power engineering steel. A significant difference of this research in comparison to previous papers is related to the levels of magnitude of the cyclic strain amplitude. In all our experiments it was less than 1%.

2. Experimental procedure and results

All tests were carried out at room temperature using thin-walled tubular mini-specimens (Fig. 1) made of the 10H2M steel subjected to biaxial stress state controlled by strain signals. Monotonic tension was combined with cyclic torsion, Fig. 2. Four blocks of cyclic torsion of amplitude equal to: ±0.1%, ±0.2%, ±0.4%, ±0.8% were considered.

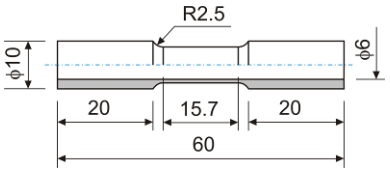


Fig. 1. Geometry and dimensions of mini-specimen.

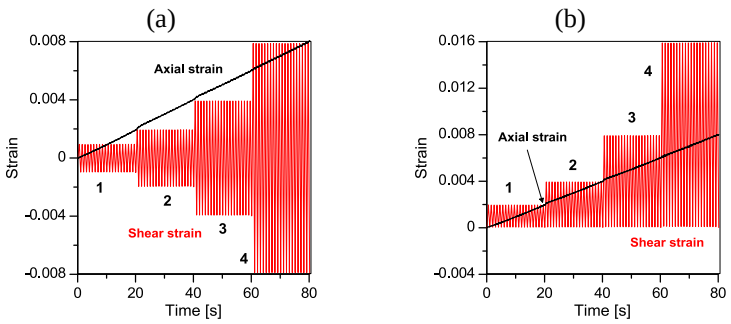


Fig. 2. Two types of loading programme comprised monotonic tension and: (a) symmetric torsion cycles; (b) asymmetric torsion cycles.

The stress responses into the strain controlled programme shown in Fig. 2 are presented in Fig. 3.
A comparison of the conventional tensile characteristic with similar curve determined while the torsion cycles were applied shows a gradual decrease of the axial stress when the shear strain amplitude increases. It attained the level of 400 MPa what was almost equivalent to the unloaded state in the tensile direction for the highest strain amplitude considered, Fig. 3. Such behaviour was observed independently on the type of cyclic loading (symmetric and asymmetric).
Besides of an influence of the cyclic strain amplitude on the monotonic tension, effects of cyclic loading frequency were also investigated at wide range of magnitudes, i.e. from 0.005Hz to 15Hz. Investigations were carried out for the 10H2M steel and their results are illustrated in Fig. 4.

(a) (b)

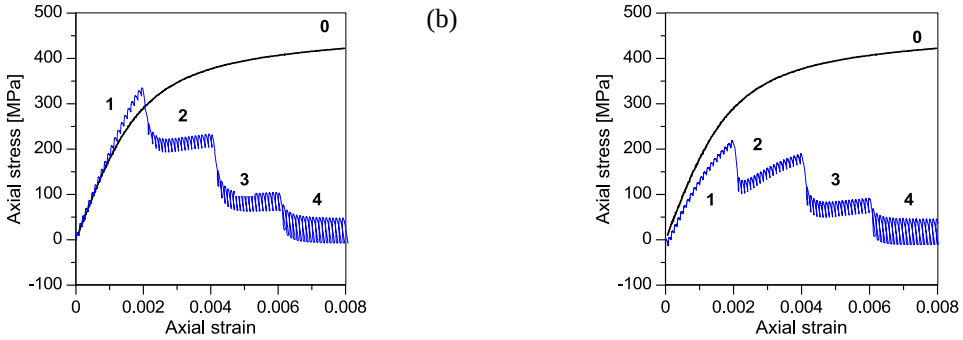
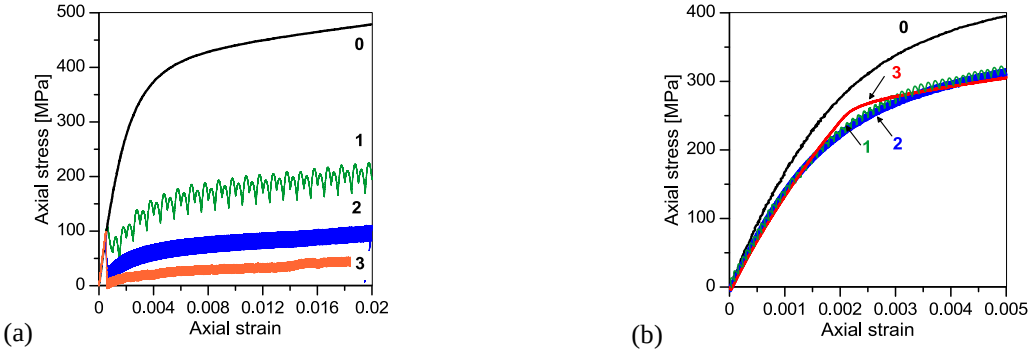


Fig. 3. Comparison of partial tensile characteristics determined without (0) and with assistance of torsion cycles for loading paths shown in: (a) Fig. 2a and (b) Fig. 2b. Numbers 1, 2, 3, 4 correspond to strain amplitudes: ±0.1%, ±0.2%, ±0.4%, ±0.8%, respectively.



(a) (b)

Fig. 4. An influence of frequency of torsion cycles on tensile curve of the 10H2M steel for: (a) strain amplitude of ±0.4% and frequency equal to: (1) - 0.005Hz, (2) - 0.05Hz, (3) - 0.5Hz; (b) strain amplitude of ±0.1% and frequency equal to: (1) - 1Hz, (2) - 5Hz, (3) - 15Hz.

3. Conclusions

(a) An increase of the amplitude of cyclic loading leads to gradual lowering of the axial stress.

(b) Asymmetrical step-increased torsion cycles caused similar effect as that observed under symmetrical torsion cycles.

(c) An influence of the frequency of torsion cycles on the tensile curve was discovered; it played important role especially for the magnitudes within the range from 0.005Hz to 0.5Hz.

Acknowledgements

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4. References

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