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VARIOUS CONTACT PROBLEMS APPEARING IN AEROSPACE ENGINEERING

900 - STRUCTURAL MECHANICS, DYNAMICS AND ENGINEERING

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ABSTRACT

Historically, a set of many engineering approaches have been developed to solve a particular problem in aerospace engineering. This set, being classified by the complexity, begins with the analysis of special specimens working in specific contact-impact conditions and ends with emergency landing or projectiles impact analysis – they all require full consideration of contact conditions. These approaches start from relatively simple combinations of 2D elastic continuum, engineering beam and shell theories possessing analytical solution together with the Hertz contact theory, however, bringing the sufficiently well experimentally validated results. More advanced models are including combination of more sophisticated models for continuum, various shell and beam theory together with the more advanced contact description [1], [2]. Corresponding shell theories are varying not only in kinematics but also are aiming to describe the inner delamination as well as embedded contact conditions [3]. Solution of these problems already require application of various numerical method, however, could be realized in frame of the mathematical software. Development of the modern computational mechanics has lead to branching into various methods: FEM, SPH, FCM high-order and iso-geometric FEM being combined together with the modern computational contact mechanics methods [4], which are realized in the special research finite element software as well as in complex FE [5] software such as LS-DYNA [6]. Contact-impact problems are not restricted to only solid continuum material models, but are expanded to multi-physics, e.g. models for soil and sand [7], [8].

Further on, it has been recognized recently the importance of the contact on various scale levels for the composite structures [9], namely the influence of micro contact conditions in

composite shells on the global behavior of the structure – this necessarily lead to the combination of the developed numerical multi-scale and homogenization methods with the corresponding computational shell theories and contact mechanics.
The goal of the Mini-symposium is to overview and discuss numerous contact problems which are related to the aerospace engineering. The symposium is aiming to attract researchers working with various methods including contact: analytical, numerical as well as experimental validations for contact problems related to the aerospace engineering.

REFERENCES

[1] D.V. Tarlakovskii, G.V. Fedotenkov "Non-stationary problems for elastic half-plane with moving point of changing boundary conditions", *PNRPU Mechanics Bulletin*, No. **3**, 188–206, (2016).

[2] S.A. Kutuyev, D.V. Tarlakovskii, "Elastic orthotropic or transversely-isotropic half-plane under the action of normal unsteady surface perturbations", *J. Appl. Math. Mech.*, Vol. 80 (6), 510–517, (2016).

[3] V.N. Paimushin, "Theory of moderately large deflections of sandwich shells having a transversely soft core and reinforced along their contour", *Mech. Compos. Mater.,* Vol. **53** (1), 1–16, (2017).

[4] Konyukhov A., Schweizerhof K. *Computational Contact Mechanics – Geometrically Exact Theory for Arbitrary Shaped Bodies*. Springer, Heidelberg, New York, Dordrecht, London, 2012, 443 p.

[5] V.G. Bazhenov, S.V. Zefirov, S.L. Osetrov, "Experimental and computing method for constructing true deformation diagrams at large strains on the basis of tests for hardness", *Doklady Physics*, Vol. 51 (3), 118-121, (2006).

[6] P.A. Mossakovsky, L.A. Kostyreva, A.M. Bragov, V.V. Balandin, L.A. Igumnov, A.Yu. Konstantinov, A.K. Lomunov, "Experimental and numerical investigations of fiber woven layered composites under impact", *LWAG Light-Weight Armour for Defence & Security*, 142–147, Grenoble, (2016).

[7] V.G. Bazhenov, V.L. Kotov, "Solution of problems of oblique penetration of axisymmetric projectiles into soft soil based on local interaction models", *J. Appl. Math. Mech.*, Vol. 74 (3), 278–285, (2010).

[8] A.M. Bragov, V.V. Balandin, L.A. Igumnov, V.L. Kotov, L. Kruszka, A.K. Lomunov, "Impact and penetration of cylindrical bodies into dry and water-saturated sand", *Int. J. Impact Eng.*, Vol. **122**, 197–208, (2018).

[9] V.N. Paimushin, N.V. Polyakova, S.A. Kholmogorov, M.A. Shishov, "Buckling modes of structural elements of off-axis fiber-reinforced plastics", *Mech. Compos. Mater.,* Vol. **54** (2), 133–144, (2018).