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# MODELING CONNECTING ROD DAMAGE DUE TO HYDROLOCK USING A FINITE ELEMENT MODEL

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***Annotation***. *The patterns of deformation of the connecting rod stem during the compression of air with liquid in an internal combustion engine cylinder are considered. The modeling of the axial compression of the conrod stem using the finite element method was carried out, the shape of the stem and stress were determined, and the dependence of longitudinal bending on the axial compression of the stem was found. The modeling results with experimental data on damage to connecting rods during engine operation are compared, and the possibility of practical application of damage modeling in investigating the causes of engine failures is substantiated.*

***Keywords***: *internal combustion engine, connecting rod, hydrolock, buckling, finite element model.*

The practice of operating internal combustion engines of various vehicle types shows that, under certain conditions, various liquids can enter the engine cylinder, including water, motor oil, fuel, coolant [1]. This causes a phenomenon called "hydrolock" (Fig. 1).

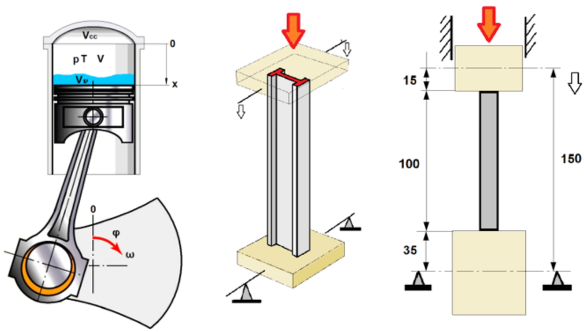


Fig.1. Scheme of hydrolock in the engine cylinder when the piston moves upward during the compression stroke (left) and the calculation scheme for modeling the conrod stem buckling (right)

Despite the fairly numerous mentions of hydrolock in information sources [2], its description is often limited to only a brief mention of some of its features, and even then, in most cases, incomplete. At the same time, no quantitative estimates or characteristics of this phenomenon are usually provided. In addition, studies of conrod deformation, including cases of buckling under axial compression [3], are often limited only to deformation and do not address in detail the mechanism that causes it [4]. As a result, when investigating the failures caused by hydrolock, it is not possible to identify many of the features of this phenomenon.

In accordance with this, the purpose of this work is to study the patterns of deformation of the connecting rod stem during a hydrolock in an engine cylinder in order to identify the quantitative characteristics of this phenomenon. This goal is achieved by solving the task of modeling the conrod stem buckling.

Due to the fact that the stem deformation of a given profile was expected only in the direction along the axis of the conrod heads, the setting of boundary conditions was simplified to stationary seals of the stem edges, but with the possibility of moving the upper edge along the axis (Fig. 1).

The analysis of buckling was carried out using the ANSYS software package in version R18.0 Student in several stages [5].

At the first stage, the stem was divided into finite elements (Fig. 2). A total of 27,132 elements were allocated and allowed us to meet the limitation of the used software version (32,000 elements).

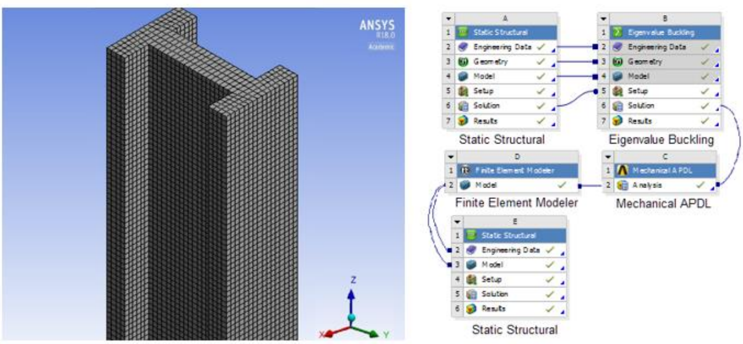


Fig.2. Mathematical model of the conrod stem (left) and general calculation diagram in ANSYS (right)

Next, the shape of the stem was determined during buckling; for this purpose, a static task was solved (Static Structural calculation module), where a unit force (F) was specified as the load. After solving the static task, linear buckling analysis (Eigenvalue Buckling) was performed, and the shape of the stem corresponding to buckling was determined. Then the finite element mesh was transformed for the selected buckling mode using the Finite Element Modeler calculation module. After this, a nonlinear buckling analysis was carried out in the Static Structural module, including determining the critical force. The general calculation diagram is presented in Fig. 2.

In the calculation, the values of axial compression of the stem were sequentially specified, simulating deformation during a hydrolock, in the range from 0 to 5 mm with a step of 0.5 mm. For each value of a given axial compression, the support reaction occurring at a given deformation was calculated, including the change in shape and the stress-strain state of the stem. The results of calculating the stresses and strains of the connecting rod stem after buckling for an axial deformation of 4.5 mm are presented in Fig. 3 as an example.

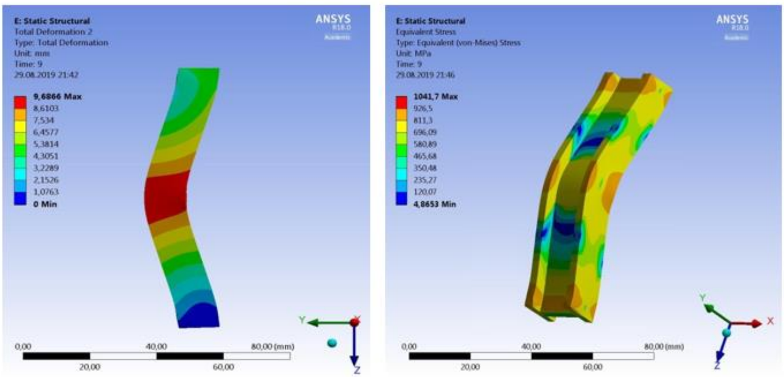


Fig.3. Total deformation (left) and von Mises stress (right) with an axial compression of the stem of 4.5 mm [5].

In the calculations, it was found that the buckling of a stem with given dimensions, taking into account the compressive force, occurs at an axial deformation of about 0.5 mm (Fig. 4). In this case, in the middle of the stem, a stress of 736-826 MPa arises with the maximum manifestation of compressive force (support reaction), related to the square of the cross section of the stem, approximately 680 MPa, after which the force drops (Fig. 4). At the same time, the stress in the middle of the stem before buckling is equal to compressive force. But then, after buckling, it becomes noticeably higher, reaching 840-870 MPa, and further, with longitudinal bending, it decreases little.

Fig. 5 clearly shows that, at least in terms of the shape, the deformed stem is in satisfactory agreement with the research results.

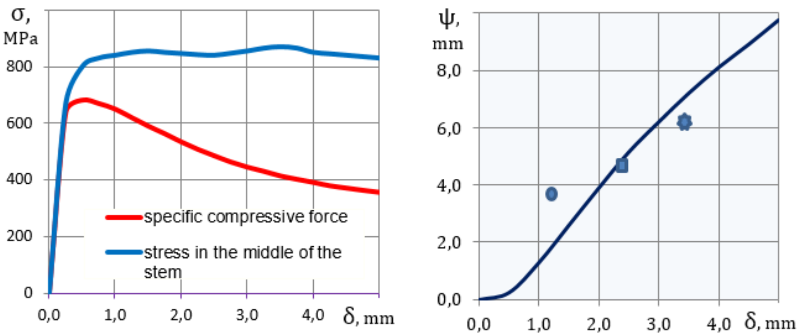


Fig.4. Dependence of compression stress and specific compressive force (support reaction) on the axial deformation of the stem (left) and the magnitude of the longitudinal bending of the stem axis on its axial compression (right) in comparison with expert research data [2]


Fig.5. The typical shape of a connecting rod during buckling due to a hydrolock in cylinder [5] fully corresponds to the calculated one (left), and the expansion of the carbon deposits in the upper part of the cylinder (right) when working with a conrod deformed during a hydrolock makes it possible to unambiguously measure its deformation even after destruction

Due to the fact that the conrod stem buckling is accompanied not only by bending of the stem, but also by its axial deformation, the center-to-center distance between the axes of the conrod crank and piston heads decreases. In this case, the indirect method is quite suitable for measurements [6], when it is enough to measure the height of the carbon deposit in the upper part of the cylinder and compare it with those cylinders where no water hammer was detected (Fig. 5). The difference will exactly correspond to the axial deformation of the connecting rod. Thus, the exact amount of liquid that has entered the cylinder and the cause of engine failure can be determined using data obtained from the simulation by measuring the deformed conrod and/or height of carbon deposits on the top of the cylinder.

References:


1. Greuter E., Zima S. Engine Failure Analysis. Internal Combustion Engine Failures and Their Causes. Warrendale: SAE International, 2012. 582 p.
2. Khrulev A. Internal combustion engines: Fault expertise and analysis. V.2. Practical determination of fault causes. Chisinau: LAP LAMBERT Academic Publishing, 2023. 562 p. ISBN: 978-620-6-15367-2.
3. Khrulev A., Dmitriev S. Study of the conrod deformation during piston interaction with liquid in the internal combustion engine cylinder. Journal of Mechanical Engineering and Sciences, 2019. Vol. 14. Issue 2, pp. 6557-6569. DOI: https://doi.org/10.15282/jmes.14.2.2020.03.0515.
4. Khrulev, A. E. Simulation of the connecting rod damage when fluid enters the engine cylinder. Vehicle and Electronics. Innovative Technologies, 2020. 17, pp. 5–18. doi: https://doi.org/10.30977/veit.2226-9266.2020.17.0.5.
5. Khrulev A., Saraev O. Building a mathematical model of the destruction of a connecting rod-piston group in the car engine at hydraulic lock. Eastern-European Journal of Enterprise Technologies, 2022. 3/7 (117). pp. 40–49. DOI: https://doi.org/10.15587/1729-4061.2022.259454.

6. Khrulev A. Internal combustion engines: Fault expertise and analysis. V.1. Methods and means of expert research. Chisinau: LAP LAMBERT Academic Publishing, 2023. 429 p. ISBN: 978-620-6-15137-1.