EAN '92
30th Conference of Experimental Stress Analysis
30. konference o experimentální analýze napětí
2. - 5. 6. 1992 ČVUT Praha Czechoslovakia

EXPERIMENTAL SHAPING OF A DIESEL ENGINE PISTON

Tomasz Czarniecki

The paper presents the techniques of the experimental designing of a Diesel engine piston. The photoelasticity and holographic interferometry were used for optimizing the shape and determining the stresses under thermal and mechanical loads, and finally for verification by using models made of real materials. The possibility of manufacturing modern cast iron and structural composite pistons was taken into consideration.

Keywords: piston, experimental designing

The process of generating a new piston of the internal combustion engineis a complex problem and may involve different techniques among which two main directions can be distinguished. One of them assumes the possibility of using the strength calculation the piston, the analytic design of the heat transfer, and anticipation through the hither to experience the deformations ot the piston skirt during its operation [1].

The calculation methods ranging from the basic physical dependences and strength formulas to the present-day computer simulation techniques, assume the acceptance of certain modelling procedures. The simplifications concern the physisc of phenomenas as well as the reduction of the problem to solving arbitrary accepted equations. At least a partial departure from the above mentioned problems quarantees the acceptance of the experimental or experimental and analytical method of the designing procedure. By basing his design work on a continuons, constant experimental verification carried out on physical models the designer is protected against making undue simplifications and, in reality, made to speed up its ultimate optimization.

A universal algorithm of the experimental design of combustion engine pistons developed on the basis of our own experience contains a complete process of the experimental designing of pistons which was based on investigations carried out with the use of optical measuring method. The algorithm divides the designing process into the phase of preliminary calculations, model testing, tests carried out on models made of real materials, as well as testing of prototypes in the running engines [2,3].

In preliminary stage two conceptions of the pistons for medium speed Diesel engine were worked out.

The first version, the monolithic nodal cast iron piston is destinated for Diesel engine using gas oil and optionaly rape oil. Three main forms of a piston pin intersection were examinated, with optimization of the best (3) version (fig. 1). A fig.2 presents view of a X-type piston, worked out using two-dimensional photoelastic models and stress frozing method. This version has a rib-reinforcing structure and thin walled skirt with limited area [2].

The other conception, a structural composite piston with a cast iron crown and light alloy corp, connected by using ALFIN technology, is an answer for a necessary of limitation of a piston weight in compare with a cast iron one. Scheme of crown-corp joint is presented in fig.3.

Based on the experimental planning method a collection was prepared of constructional solutions in which characteristic dimensions of pistons oscyllate about the calculation quantities. Two-dimensional photoelastic method was used for optimization of three dimensions the thickness of the piston bottom (calculated) and the thickness of the cast iron cover plate in the toroidal combustion chamber and of the piston bottom (arbitrary quantities). The influence of thermal and mechanical loads was verified and later the best version was tested by using stress frozing method. After correction of design, the prototypes were manufactured and investigated by using thermography and holographic interferometry method. The influence of structure on deformations and on thermal state of piston was found out [3].

The process of designing the piston by continuosly verifying its development stages as well as by constant testing each solution, optimizing its cross-sections and transfer radia should not lead to faulty solutions but to force its correct formation in terms of strength. Each stage makes it possible to return to the preceding stage and improve the previonsly developed versions. It is also possible to consider in further design phases the formation obtained previously. In the experimentally aided designing system it is possible to work out the regression function for certain solutions, which makes it casier to transfer the experimental results to other design of pistons approximating the operation conditions. The optical measuring method proposed as research tools, mainly photoelasticity and holographic interferometry, are considered to be the most universal from all the hither to known research methods.

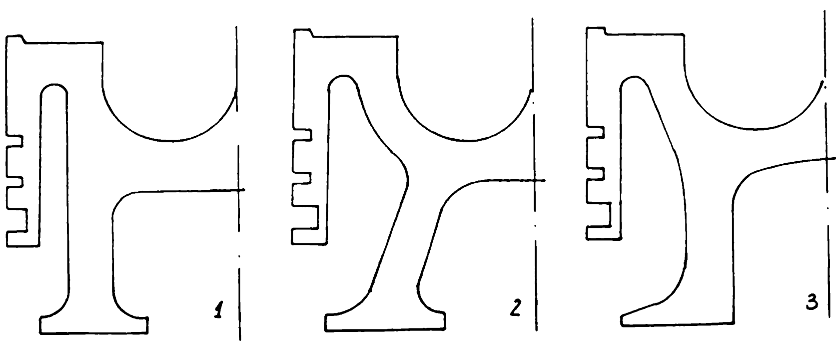
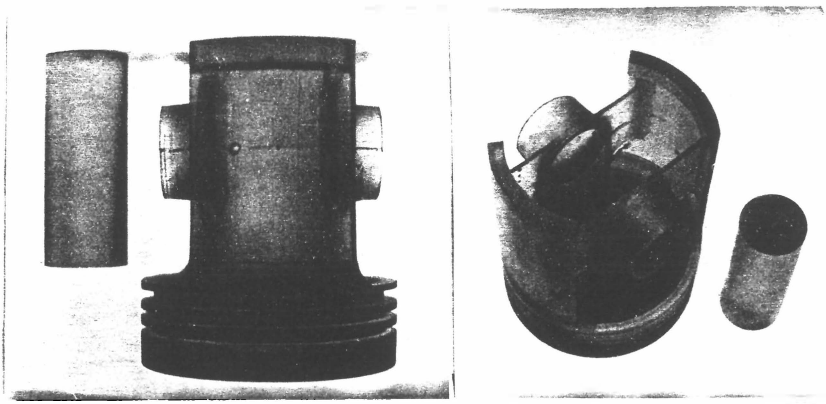


Fig. 1. The versions of a nodal cast iron piston, tested by using photoelasticity.



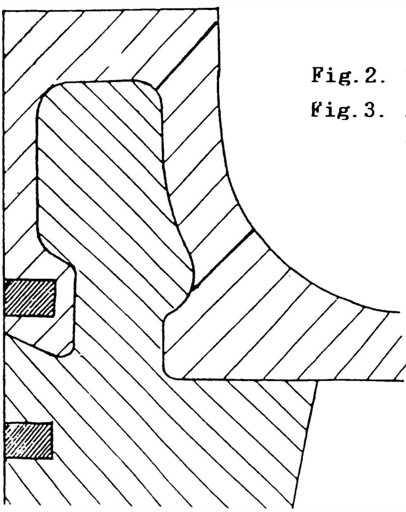


Fig.2. The model of a cast iron piston.
Fig.3. A cross section of a composite piston.

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Tomasz Czarniecki, M.Sc.E., Technical University of Wrocław, Institut of Machine Design and Operation, ul Lukasiewicza 7/9 50-370 Wroclaw, phone 048-71-202983, fax 048-71-227645.