ANNALS OF THE FACULTY OF ENGINEERING HUNEDOARA
2005, Tome III, Fascicole 2

ELASTICAL PROPERTIES OF THE CYLINDER HEAD GASKETS MATERIALS

János SZÁVA[1], Cecília HODÚR[2], Endre FORGÁCS[2],
Valeriu ENACHE[1], Zoltán FORGÓ[3], András KAKUCS[3],
Petru HLIPCĂ[1], Ferenc TOLVALY-ROŞCA[3], András LŐRINCZ[3]

[1] "TRANSILVANIA" UNIVERSITY OF BRAŞOV, ROMANIA
[2] SZÉF, UNIVERSITY OF SZEGED, HUNGARY
[3] "SAPIENTIA" UNIVERSITY, TÂRGU-MUREŞ, ROMANIA

ABSTRACT:

Cylinder head gasket represents the elastically element for burning room closing. Its elastic properties determine in a major measure the qualities and competitiveness of the engine with internal burning. The literature confers several interesting and useful results on cylinder head gaskets' investigations.

The authors conceived and realized an original stand for mechanical properties evaluation of the cylinder head gaskets. Also, using this stand, became possible to evaluate not only the basic material's properties, but the different kind of bored holes' with metal collar, too. So, based on these measurements, the authors plotted the experimental force - displacement, respectively strain - stress curves for the characteristic domains of cylinder head gaskets. Using this stand, the authors tested between others two types of materials (MARSIT, respectively DIROLASTIC), often used in Romanian truck's engines with 6 in-line cylinder.

KEYWORDS:
Cylinder head gasket, experimental investigations, mechanical properties

1.THEORETICAL APPROACH

The authors model the cylinder head gasket as a number of characteristic parallel-connected elastic elements.

These characteristic elements subjected to compression are: the basic material and the borded holes of different diameters, the ones at cylinder bore level included (with and without fire rings), presented in figure 1.

The authors have completed, between others a thorough compared study of the two types of Romanian cylinder head seals, made of MARSIT and DIROLASTIC respectively.

They are typically used for 6-in-line motor truck engines with dry, slip-fit type cylinder sleeves. These engines are endowed with two partial cylinder heads corresponding to three cylinders each and with only one seal, symmetrical with respect to the separation plane of the cylinder heads.

Figure 1 presents the front semiseal, where "*1*"…"*14*" are the cylinder head stud bolt seats (in the order of tightening) and "*a*", "*b*",…"*q*" are the considered characteristic bores.

In the calculus were accepted the following hypothesys:

- The cylinder head gaskes is formed from a number of parallel-connected elements;
- The upper part of the engine (the cylinder head) represent a high stiffness part, without deformation;
- By tithtening of the cylinder head stud bolts simultaneously, the cylinder head will change its place by a plane parallel motion;
- Each bolt will be pre-stressed in each stage (totally 14 ones) by equal quantities, which represents the 14th part of the force $\mathbf{F_g}$ produced in cylinders under gase pressure, multiplied 3.5 times (for an adequate safety coefficient), so the total prestressing force value for each bolt will be $F_0 = 80\,206\ N$;
- The total value of the tightening force (for a half of cylinder head gasket) will be $F = 14 \cdot F_0 = 1122884\ N$, corresponding to the 14 bolts of this half gasket;
- After a statistical evaluation of the different characteristic elements' height h_j, was established their probable values used in further calculuses.

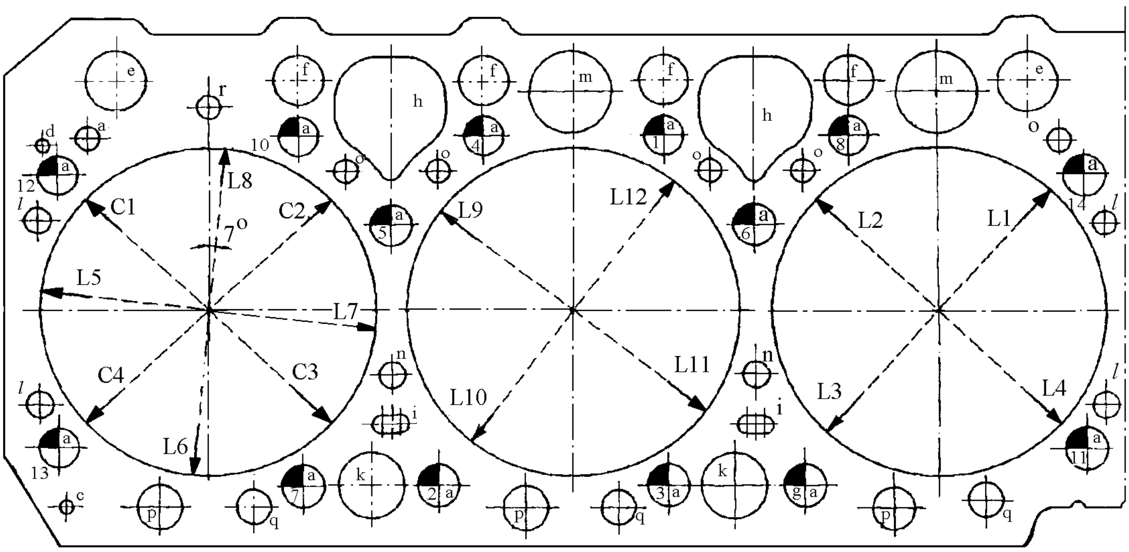

Fig.1. The characteristic elements of the cylinder head gasket

2. TESTING RESULTS

For each of the characteristic elements were performed tests (in an adequate number from statistical point of view for each type of them) using the device from figure 2. How we can observe, on the rigide steel plate /shell ***1*** is situated the cylinder head gasket nr. ***4*** with its characteristic element (here the hole nr. ***2***) loaded with force ***F*** by mean of the steel cylinder nr. ***3***. We have to specify, that the pushing cylinder's diameter is only a little more greater then the hole's diameter (of the piece nr. ***2***) and so, practically only its elastically properties will be taken into consideration. Were plotted the characteristic curves: force $F[N]$ versus displacement $\Delta\ell[mm]$ (fig.3) and stress $\sigma[MPa]$ versus strain $\varepsilon[-]$ (fig.4), corresponding to all characteristic elements. The figures offer some example of these curves.

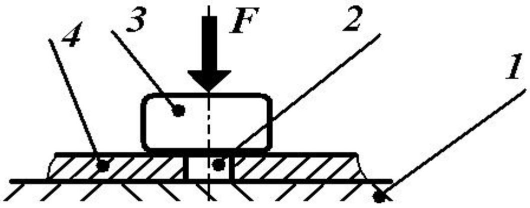

Fig. 2. The testing device

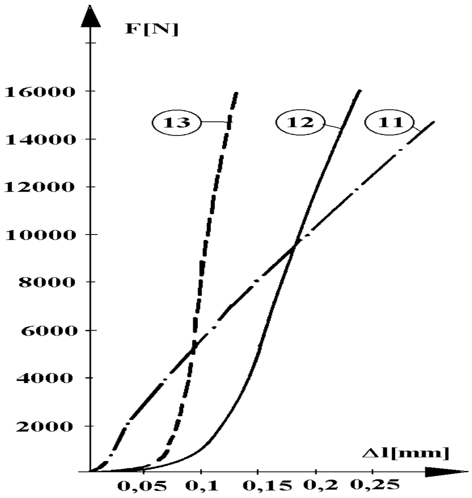

Fig.3. Force-displacement curves

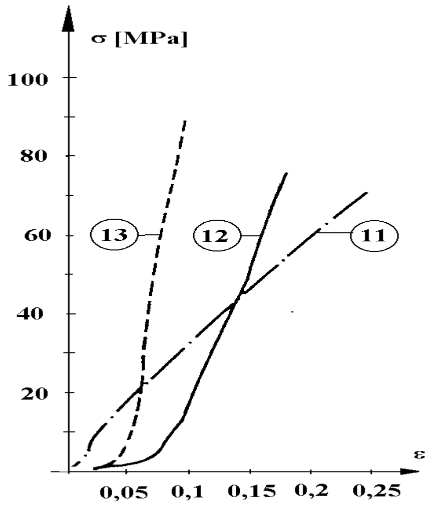

Fig.4. Stress-strain curves

3. NUMERICAL SIMULATION

Based on these elastical properties / behaviuors (the characteristic curves) of the characteristic elements, which build up the cylinder head gaskets, were performed calculus regarding on the force transmission mechanism.

The computation of the mechanism describing the taking over the stressesby the seal was based on a number of original simplifying hypotheses [1], the most significants of which were desrcibed above.

Four computation variants were accepted, depending upon overheightening ***s*** of the cylinder sleeve collar with respect to the upper plane of the cylinder block, i.e.:

- a) with $s=0$ *mm;*
- b) with $s=0.08$ *mm;*
- c) with $s=0.10$ *mm;*
- d) with $s=0.12$ *mm* respectively.

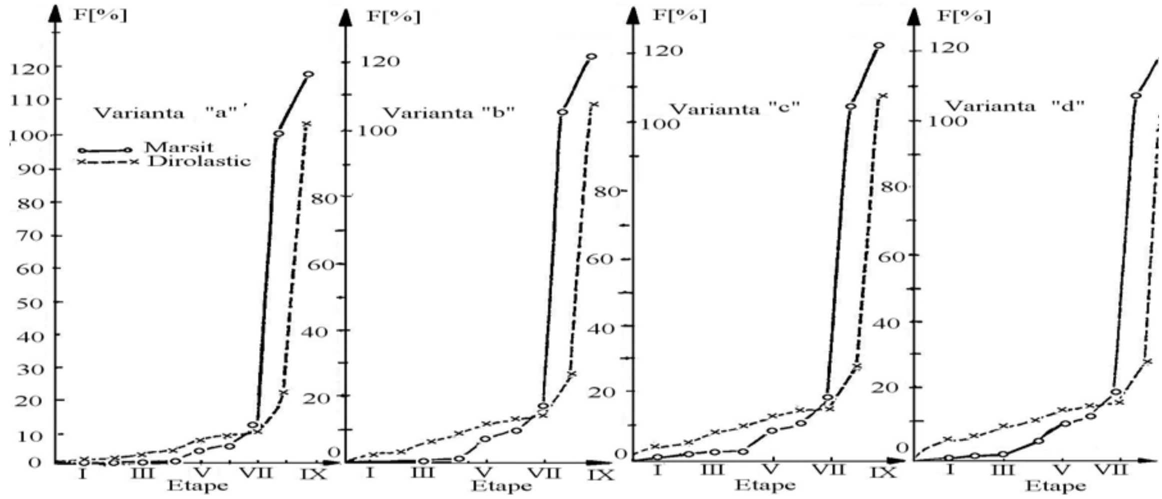

Fig.5. The taking over mechanism of the total pre-stressing force F

The steps of the tightening operation (marked by *I*, *II*,…*IX*) correspond to the sequences of each elastic element becoming operative in taking over of total pre-stressing force $F=14F_0$.

Figure 5 presents for the two seal materials the results of these computations, corresponding to the four variants.

4. Conclusions

By analyzing these diagrams, on can observe the following:

- the two kind of materials have totally different behaviors regarding to the taking over of the pre-stressing force;
- the DIROLASTIC material is not able to compress the all of characteristic elements, even the total pre-stressing force was consumed;
- by growing the value of ***s***, this difference will grows up;
- not the MARSIT will be adequate for higher values of *s*;
- can be put in evidence a good correspondence between the elastically properties of the seal materials and the admissible over heightening *s* of the sleeve collar;
- assessments could be produced on the adequacy of a material from the operational point of view (ensuring appropriate tightness of the combustion chamber during operation).

Further goals of the authors will be focused to other kind of seal materials used in Romanian car industry.

REFERENCES

[1]. I. Száva, Ph:D. thesis, Transilvania University of Brasov, 1993;
[2]. Fl.L.Sperchez, I. Száva, The 6th International Symposium on Tensometry, Craiova, Romania, (1992), p.234;
[3]. I. Száva, V. Ciofoaia, I. Curtu a.o.,The 17th Danubia-Adria Symposium on Experimental methods of Solid Mechanics, Prague, (2000), p.313;
[4]. L. Borbás, "Seminar and Workshop on Design for Quality, Bologna University, Training Centre, Bertinoro", (1996). p.61;
[5]. Fr. Thamm, L. Borbás, Gép, (1988), p.293.