COMPARATIVE THEORETICAL-EXPERIMENTAL EVALUATION OF CONROD LITTLE-EYE STRESS ANALYSIS

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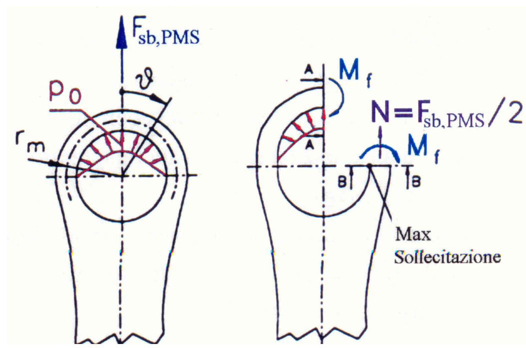
Introduction. In this paper we show the way to test conrod little-eye using a testing machine supported by theoretical and FEM calculations and results that confirm experimental values and position of stresses with thoretical ones and viceversa.

Theoretical studies.
Connecting rod little end is subjected to loads only in the extreme superior position in phase of intersection, when its body suffers of tensile stress caused by inertial forces.



The strength lines that solicit the conrod are those due to the mass of the piston complete of elastic bands, and pin and of a part of conrod little end difficult to measure. Such actions cause traction and bending solicitations.
For what concerning the more solicited section, considering the demieye of connecting rod like a hyperstatic curved beam inserted into the body, it is the perpendicular one to the inertial force; the more dangerous point is in iternal side where bending force puts the inside fibers in traction and in compression those external.
In the B-B section traction is:

$$N = \frac{F_{i,PMS}}{2} = \frac{m_a r(1+\lambda)\omega^2}{2}$$

Contact pressures are:

$$p_0 = \frac{2F_{i,PMS}}{l_p \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} d_p \cos^3 \theta d\theta} = \frac{3F_{i,PMS}}{2 l_p d_p}$$

This distribution of the pressures is realistic in phase of compression of the body, but not in phase of traction. In this case the empirical expression is more appropriate:

$$M_f = 0.08 F_{i,PMS} r_m$$

Total actions have been calculated in two cases:
1)conrod as a mass and an inertial moment

$$S_{p\to b,tot_x} = S_{p\to b,gas_x} + S_{p\to b,ip_x} + S_{p\to b,iG_x x} + S_{p\to b,iG_{y_x}} + S_{p\to b,M_x} = F_{gas} + F_{ip} + 0 + 0 + 0$$

$$S_{p\to b,tot_y} = S_{p\to b,gas_y} + S_{p\to b,ip_y} + S_{p\to b,iG_x y} + S_{p\to b,iG_{y_y}} + S_{p\to b,M_y} =$$

$$-F_{gas}\cdot\tan(\beta) - F_{ip}\cdot\tan(\beta) - F_{G_x}\cdot\frac{L-d_G}{L}\cdot\tan(\beta) - F_{G_y}\cdot\frac{L-d_G}{L} + \frac{M}{L\cdot\cos(\beta)}$$

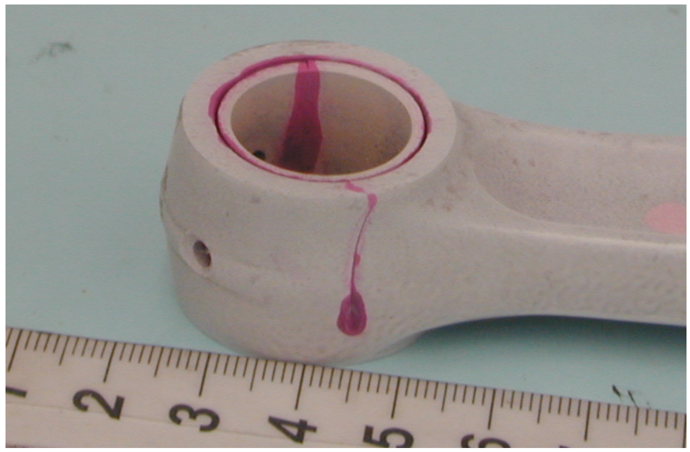
2)conrod as an alternate mass, a rotative mass and an inertial moment

$$S_{p\to b,tot_x} = S_{p\to b,gas_x} + S_{p\to b,ip_x} + S_{p\to b,iab_x} + S_{p\to b,irb_x} + S_{p\to b,M'_x} = F_{gas} + F_{ip} + 0 + 0 + 0$$

$$S_{p\to b,tot_y} = S_{p\to b,gas_y} + S_{p\to b,ip_y} + S_{p\to b,iab_y} + S_{p\to b,irb_y} + S_{p\to b,M'_y} =$$

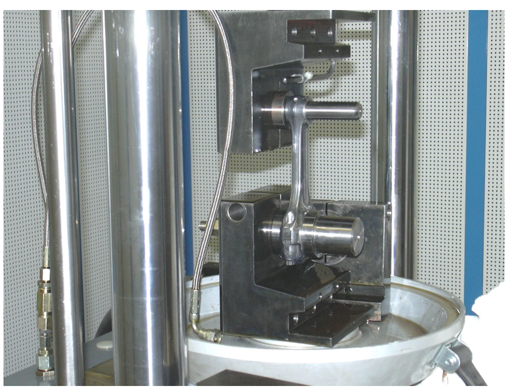
$$-F_{gas}\cdot\tan(\beta) - F_{ip}\cdot\tan(\beta) - F_{iab}\cdot\tan(\beta) + 0 + \frac{M'}{L\cdot\cos(\beta)}$$

Experimental tests.



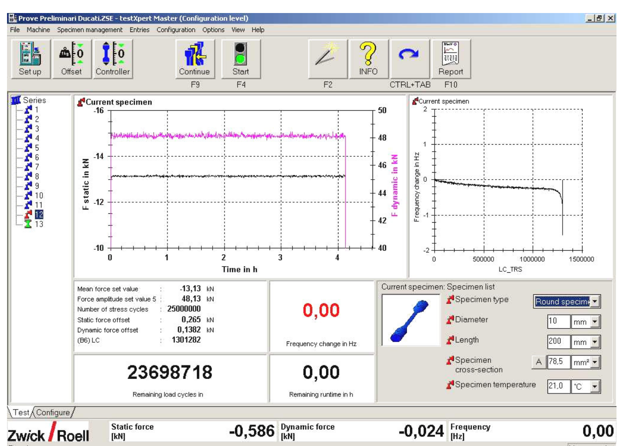
Testing machine is a vibrophore that work at a very high frequency. A large number of conrods has been tested and they all have presented the same kind of fracture. Breakups have been verified in the same zones also if with different number of cycles since stress ratio was different. Tests conducted with the same value of stress ratio have caused breakups with the same formality and for a number of cycles almost correspondent.

The specimen, has been fixed in correspondence of the eyes through two pins with a free joining between eyes of connecting rod and diameter of the pins; particularly in the zone of the small eye, where the breakups are compared, the tolerance is h6.



The cycle of load is imposed to the testing machine through an express interface program, that allows to fix the limit conditions to which the sample must be tested and to establish the number of cycles that compose the test.

The parameters to furnish are: the number of cycles, the middle value of the solicitation and the maximum and minimun values of solicitation. It is possible approach and hold under control only some type of information during testing operation. First of all the test starts with a preliminary phase of arrangement in which the machine tries to agree to the frequency that allows the attainment and

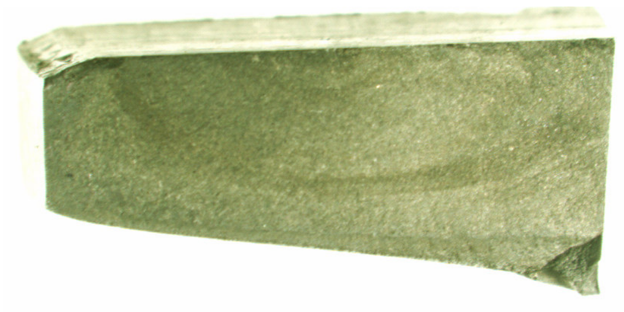


maintenance of the wanted strength; in the first phase the load linearly grows from time 0 to the value of with speed, for instance, equal around to 1KNw/ s. Subsequently, for an equal period to about 60 s, the load starts to oscillate around the value with an equal ampleness to 8KNw; the machine tries to stabilize the frequency for the value of the imposed load.

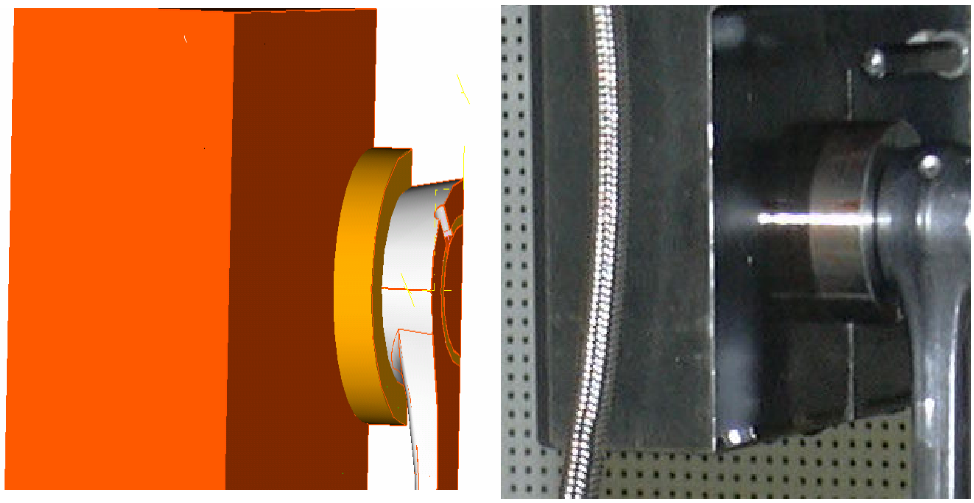
Tests stoppes when there is a frequency decrease higher than the planned one.

From the report of the analyses of the breakups it is observed that all these result equivalent,: they appear with the same formality in the same zone of the little eye which is coincident with the inside surface of the hole. Even if the connecting rods have had breakups for different values of load, the way of propagation of the crack has resulted always be the same and, particularly, fatigue lines are noticed on the share sections.

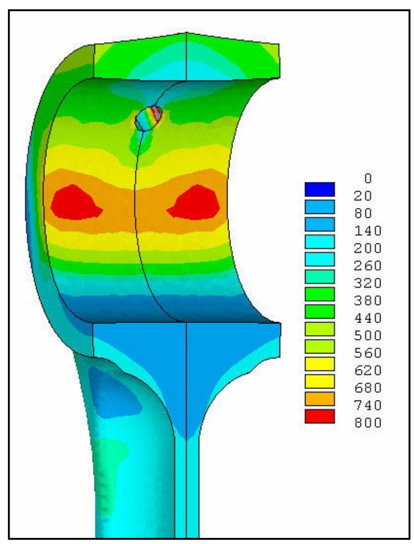
The crack crosses thickness of the small eye and propagates on radial direction describing an ellittic trajectory.



FEM analysis.
The model is composed by conrod, bush and constraints in a configuration similar to testing machine layout.



Stress caused by tensile loads, considering also the presence of the bush, is similar to that observed in tests. We find maximum Von Mises Stress in the same zone of experimental fracture.



Results.
The two parallel studies have permitted to trace a Goodman-Smith diagram for that part of the component and its Wohler curve.

Conclusions and discussion.
Here a summary of the work and of the most important results are given. A short discussion on the main result is welcome.

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