CT2M
Center for Mechanical and Materials Technologies

Scientific Interaction Meetings

Meeting nº 5

2008.01.09 – 14-15h

Room: B1.13

Agenda:

14h **– Nuno Costa, Analysis of the influence of manufacture parameters on the fatigue life of piston rings**
14h30 **– Filipe Silva, Dynamic modeling and analysis of the knee joint**

On behalf of SIM, new year 2008 wishes to everyone. All are welcome to the 5th SIM session on 9th January 2008. The more details of the presentations are as follows

1. Analysis of the influence of manufacture parameters on the fatigue life of piston rings, by Nuno Costa (nuno@dem.uminho.pt)

Abstract: The piston ring is a coated steel or cast iron part that, when is inside of the engine cylinder, becomes circular and auto expansible, allowing a movable barrier between combustion chamber and oil pan of the crankcase. The piston rings fill the gap between the cylinder wall and the piston. They maintain the combustion pressure and prevent the gas escaping from the cylinder. In this study only the compression piston rings will be studied. The bulk material is a martensitic nodular cast iron with an electroplated chromium-ceramics coating. The piston rings have not changed so much in the last years, but they are still very important on the engine working. The piston rings development has been made on the development of the coatings that allow a decrease in the friction coefficient and wear between piston ring and cylinder wall. The coatings are very important to improve wear resistance and scuffing resistance, but they should retain some oil when the engine stops, because when the engine starts working (especially when the engine is cold) with this oil the friction coefficient is lower.

It is known that the damage on piston rings occur with some frequency due to fatigue. The fatigue on piston rings occurs because the piston rings are subject to a mean stress (when is assembled in the engine) and to alternated stresses (when the engine is working). The damage on piston rings can occur due to fracture of the coating and/or bulk material. For piston rings fatigue test study, the bulk material and the coatings are very important, as well as the processing parameters. The deposition parameters, of the coating are very important on the introduction of residual stresses, as well as the defect in the bulk material, because both can decrease the piston ring fatigue life. It is also very important to analyse the residual stress introduction of the different process stages, because if a process stage introduces tensile residual stress the fatigue life decreases, but if a process stage introduces compressive residual stress the fatigue life increases. The crack initiation and propagation are dependent on the residual stress and the defects. The real stress on the piston ring is dependent on the applied stress, the residual stress, and the defects. Some different process stages, as bending, machining, deposition are necessary to manufacture a piston ring, and each of different

process stage introducing residual stress, and can introduce defects, and both have a great influence on the piston ring life.

The aim of this work is to study the influence of the processing parameters on the fatigue life of piston rings. Fatigue tests under alternating stress conditions were carried out on cast iron piston rings after different process stages. Also has been doing an analysis of the processing parameters influence on the fatigue life of the piston ring. The goal of this work is to achieve the optimized processing parameters in terms of fatigue life.

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2. Dynamic modeling and analysis of the knee joint, Filipe Silva, (josefilipe.silva@gmail.com)

Abstract: The purpose of this work is to present a dynamic model for the intact human knee joint. The model is formulated under the framework of multibody system methodologies, being the system modeled by two rigid bodies, the femur and tibia. The femur is fixed, while the tibia is considered to move relative to the femur. These two bones are modeled as rigid due to higher stiffness when compared to stiffness of the articular cartilages.

The femur and tibia cartilages are considered to be deformable, which are characterized by Young's modulus and Poisson's ratio. Based on medical imaging techniques, the femur and tibia profiles in the sagittal plane are obtained and used to define the geometric conditions, to check if the femur and tibia surfaces are in contact or not. When the contact is detected, a continuous contact force law is applied to evaluate the contact forces developed in that contact. The four basic ligaments present in the knee are also taken into account in the proposed knee joint model. The ligaments are modelled as nonlinear elastic springs.

Thus, the forces produced in the ligaments together with the contact forces are introduced into the equations of motion of the system as external applied forces. In addition, an external force is applied on the centre of mass of the tibia in order to actuate the system. Numerical results obtained from some computational simulations are used to discuss the assumptions and procedures adopted in this study.