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Method for the examination of corrosion preventive compounds influence on the friction in riveted aircraft joints

The paper describes new approach to the investigation of probable harmful effects of Corrosion Preventive Compounds on the bearing capacity of aircraft riveted structures. It is shown, that Corrosion Preventive Compounds may influence the force of friction between the components of riveted joints, thus to prevent negative influence on bearing capacity the method for the measurement of friction between the components of the riveted joint is required. The principle concept of the new method and correspondent equipment are proposed.

Despite the development and implementation of new constructional materials, improvement of maintenance and methods for the protection against corrosion, the problem of the aircraft corrosion still one of the main concerns in aviation industry.

Among the plenty of the methods for protection against corrosion the special place take the Corrosion Preventive Compounds (CPC). These compounds are used when it is necessary in addition to the existing system of protection.

As an example the DINITROL family of protective materials, approved by the AIRBUS INDUSTRIE, BOEING, BOMBARDIER, ATR, LOCKHEED MARTIN CORPORATION, EMBRAER, etc. may be mentioned.

Widely used AV8 has following physical properties [1]: Flash point - 47^{o} C; Viscosity - 16 cSt; Type of solvent - Aliphatic hydrocarbon with 0.5% aromatics; Density - 880 kg/m3; Storage and application temperature – (15^{o} C), min; Colour - Transparent, slightly brown tinted; Specific film weight - 8 g/m^{2}; Approximate film thickness - 8μm; Drying time - 40 min tack – free.

For materials used for the manufacturing of aircraft skin protection system comprises cladding by pure aluminum, oxidizing, covering by the primer and painting.

The CPC reduce the rate of corrosion process as inhibitors, penetrate into the gaps, for example gaps between the components of riveted structures, displace moisture from the gaps, develop protective thin films (with thickness up to 100 μm).

It should be mentioned also, that CPC have low prices, easy to produce and to use.

To the moment, a great deal of CPC have been developed for use in different areas. Appearance of new materials can be expected, so their implementation requires attention.

The high level of the reliability requirement for aviation industry determines the special approach for the selection of the CPC.

It should be taking into account that the composition of CPC has surfactant components, thus the influence on this component on the fatigue requires investigations.

Also, as the CPC has properties of grease, the influence of compound on friction may take a place. This problem is actual one for riveted structures because the integrity of this kind of joints determined not only by rivet axial compressive force, but by the friction between the mating sheets as well. When the friction decreases the body of rivet carries all load exerted to the riveted unit.

Some relevant experiments and results are presented in the works [2,3], where the fact of negative side effects of CPC on riveted joints fatigue is shown.

The importance of the problem defines the direction of further research activity, which should be aimed on the development of the reliable and grounded method for the side effects control.

Riveted joints are widely used in aircraft structures to joint parts of wing, fuselage, tail unit, etc. Number of rivets in the construction of medium civil transport exceeds million. Each hole for rivet in fact is a trouble zone due to probability of fatigue crack nucleation and its further propagation. Increase of the fatigue crack probability due to the redistribution of loads on mating parts requires special attention.

For the simulation of riveted joint the analysis of joint used in civil aviation has been performed. As a result of the analysis the double zig-zag riveted lap joint as typical for skin assembly has been selected.

The multi times used model specimen looks like a fragment of lap joint of skin components.

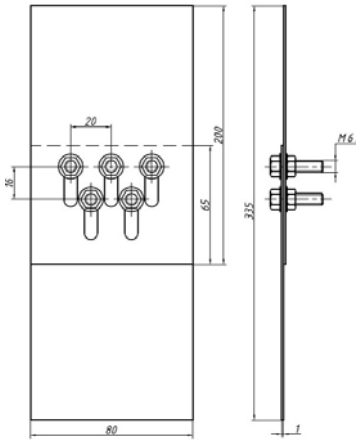

Fig. 1. Model specimen for the measurements of the friction between the sheets of skin in the presence of CPC and without CPC

To provide mutual displacement of the sheet components of developed simulating sliding joint the slots instead of holes where made.

The bolts of 6.0 mm diameter have been installed instead of rivets to provide multiple usage of the simulating structure.

For sheet components the D16AT alloy has been used. The thickness of sheets is typical for the aircraft skin manufacturing and is selected to be 2.0 mm.

The sketch of the model specimen for the measurements of the friction between the sheets of skin is shown in figure 1.

As the axial rivet force influences friction between the mating parts, this load is specified to be in the range typical for industrial process. Application of a torque wrench ensures stable value of the axial compression load for all tests.

The friction force is estimated as force created by test machine to start displacement of mating sheets. The servo hydraulic testing machine with digital control Bi-00-202V is used for the simulating specimen loading with registration of the load for beginning of sheets displacement and constant rate of displacement regulation.

The CPC liquid is introduced into the gap between the sheets by the covering of mating surfaces before the assembly of specimen.

The thickness of the covering is determined by the properties of the selected compound.

Conclusions.

The application of the Corrosion Preventive Compounds requires complex investigation of probable negative side effects on fatigue. One of the aspects that must be explored is influence of Corrosion Preventive Compounds on the lap riveted joints because the redistribution of loads on the joints components may lead to the fatigue life reduction. For the selection of appropriate Corrosion Preventive Compound the measurement of the friction force between the mating surfaces of lap riveted joint is able to answer the question whether or not the Corrosion Preventive Compound influences friction and fatigue life of riveted structural. Proposed method is easy to conduct, gives adequate output, reflects the phenomenon of Corrosion Protective Compounds effect on the mechanical properties of lap riveted joint.

References

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