Speech Title：Cold expansion technology of connection holes

in aircraft structures: A review and prospect

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正文：

Hi, everyone,

Today, I would like to talk to you about a fascinating topic in the field of aircraft structures - the cold expansion technology of connection holes. This technology has gained significant attention in recent years due to its ability to enhance the fatigue life of aircraft structures, while also satisfying the increasing demands for lightweight and durability.

"Next, I will discuss these four parts: Fatigue Failure in Aircraft Structures, Cold Expansion Technology of Connection Holes, Application and Benefits of Cold Expansion Technology, and Conclusion and Future Research."

The first is Fatigue Failure in Aircraft Structures.

Fatigue failure is a significant concern in aircraft structures, as it refers to the material's fracture due to long-term cyclic loading. In aging aircraft, fatigue failures of fastener holes account for a substantial portion of structure fractures. This highlights the need to address fatigue failure to ensure aircraft safety and performance.

Fatigue failure can have detrimental effects on aircraft safety and performance. Therefore, it is crucial to focus on enhancing the fatigue life of aircraft structures. This requires the development and utilization of advanced materials and manufacturing processes.

The second is Cold Expansion Technology of Connection Holes.

Cold expansion technology enhances the fatigue life of non-ferrous alloys by introducing compressive residual stress around fastener holes. This technique involves enlarging the hole diameter using a ball or mandrel, resulting in plastic deformation and residual stress in the surrounding material. The strength improvement achieved through cold expansion is influenced by the size and distribution of these residual stresses.

Look at the following three pictures. The first is Hole edge expansion process, expanding by applying downward force F. The following two principles are similar to the first one.

This is Typical tangential residual stress distribution around an expanded hole.It is divided into four stages: Reverse yielding zone, Zone of tangential compressive residual stress, Maximum compressive residual stress and Zone of tensile residual stress. And this one is Split sleeve expansion process.

The third part is Application and Benefits of Cold Expansion Technology.

Cold expansion technology has revolutionized the manufacturing processes of fighter and commercial aircraft. By introducing compressive residual stress around fastener holes, this technique enhances the fatigue life of aircraft components without adding extra weight. It is widely used in key fastening holes of various aircraft structures, such as connection holes in wings and fuselages. The compressive residual stress reduces stress concentration and inhibits the initiation and propagation of fatigue cracks, resulting in improved fatigue performance and extended component life. This technology has been successfully applied in the assembly and repair of different aircraft types, making it an essential technique in the aviation industry.

Experiments and simulations have examined the anti-fatigue properties of cold expansion technology. They analyze how cold expansion and bolt clamping affect fatigue life and failure modes, as well as the influence of different tolerances and strengthening parameters on fatigue life distributions. These studies provide valuable insights into the effectiveness of cold expansion for enhancing aircraft component fatigue life and optimizing performance.This picture is Research directions of cold expansion technology.And this one is Synthesis finite element simulation for fatigue life estimation of cold expanded specimens.

Finally, there is conclusion and future research section.

In future research, there should be a focus on strengthening composite holes, analyzing the impact of environmental factors on fatigue life, and improving the fatigue life of multi-plate structures and assembly units. Additionally, exploring new process methods and advanced materials will address the demand for lightweight and durable aircraft designs.

Overall, cold expansion technology is a valuable tool in aircraft manufacturing, and further research and development will continue to enhance its effectiveness and application in the industry.

Thank you for listening.