HOW TO MODEL STRECON PRESTRESSED CONTAINERS IN THE FEM ANALYSIS OF HPS TOOLING SYSTEMS

1 Introduction

STRECON stripwound containers have proven to be a superior prestressing system for a large number of high-pressure synthesis applications. The increased prestressing pressure on the die, compared to conventional stress rings, results in the reduction of unbeneficial tensile stresses and a lower degree of plastification. These effects have a significant effect on the service life of the die. This report provides information on how to model STRECON containers in an FEM analysis of high-pressure synthesis dies.

2 The pressure on the die

The pressure magnitude and distribution on the inside of the die is normally based on an estimate. The pressure can be set to 5500 MPa on the straight bore of the die with a linear decrease to 0 at approximately half the length of the large chamfer (see Fig. 1).

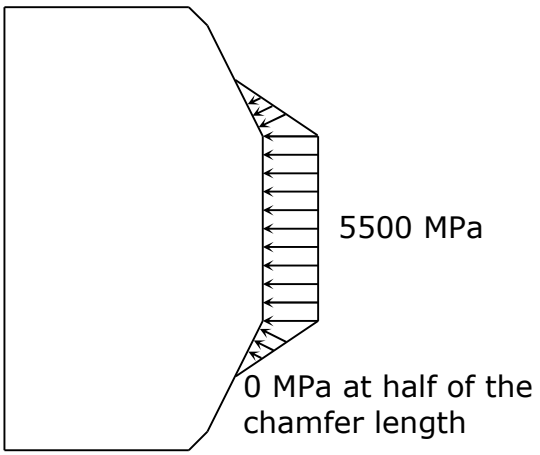

Fig. 1 *Assumed pressure distribution on the die*

3 Modelling a STRECON stripwound container

The design of a typical STRECON system for production of superabrasive products is shown in Fig. 2b. The container consists of the wear ring, the winding core, the stripwinding and the casing. Fig. 2a shows the FE meshes that represent the die, the sleeve and the container.

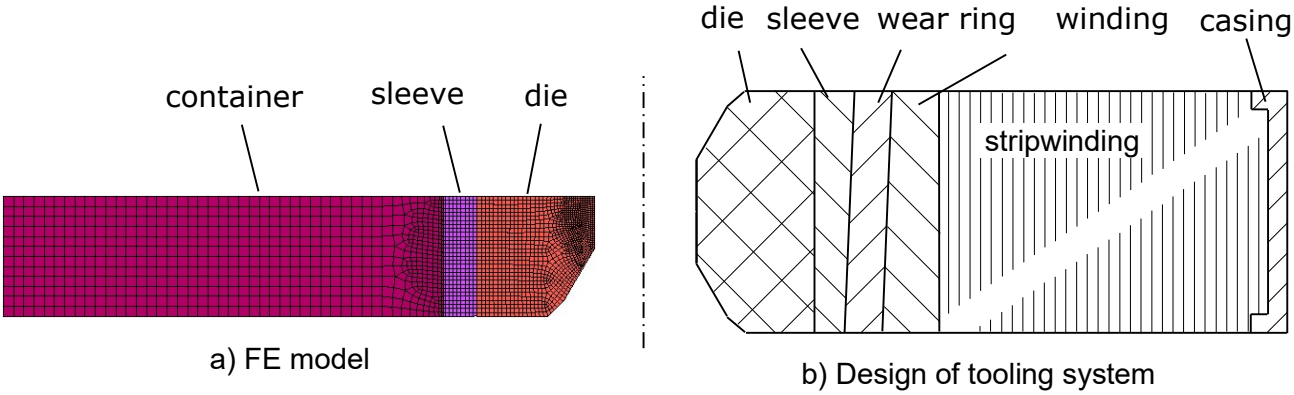

Fig. 2 *HPS tooling system prestressed by a STRECON® prestressed container*

When meshing the die and the container in the FE system, it is recommended to take the following into account:

- Use axisymmetric elements.
- Simplify the system by omitting the tapering. A symmetry line can then be utilized, and it is only necessary to model half of the system.
- Omit the radii, as they do not influence the overall stress-stain values. They should only be included in special cases, where the stresses are to be analysed in the radii.
- The STRECON container can be modelled as a single body. For modelling its effects on the die behaviour only, there is no need to model the winding core, the stripwinding and the casing separately.
- If the wear ring is to be modelled elastic-plastic, or if the stress distribution in the wear ring is of special interest, the wear ring has to be modelled as a separate body. For modelling the wear ring's effects on the die behaviour only, there is no need to model the wear ring separately.

Due to the simplification of the stripwound container in the model, the FE analysis will not provide the exact stress and strain distribution in the container elements. The loadability of the STRECON prestressed container can be checked by STRECON A/S only.

4 Interference fit

The modelling of the STRECON stripwound container described in chapter 3 shows that there is no significant difference compared to the modelling of a simple shrink ring. The main benefit of the STRECON stripwound container is exploited by its ability to withstand higher interference values without yielding, and thus behaving elastically. This is possible thanks to the high strength of the stripwinding material and the large number of windings. Typical values of interference are in the range of 1.2 % to 1.4 %.

The optimum interference must be chosen with regard to

- The best performance of the die.
- The allowable load on the container.

The interference for STRECON containers should be chosen in close cooperation with STRECON A/S in order to assure the optimum performance of the prestressing system.

The meshes of the sleeve and the container must overlap corresponding to the interference between the sleeve and the container, see Fig. 3. The overlap must be closed in the first step of the analysis. This feature is dependent on the FE code used.

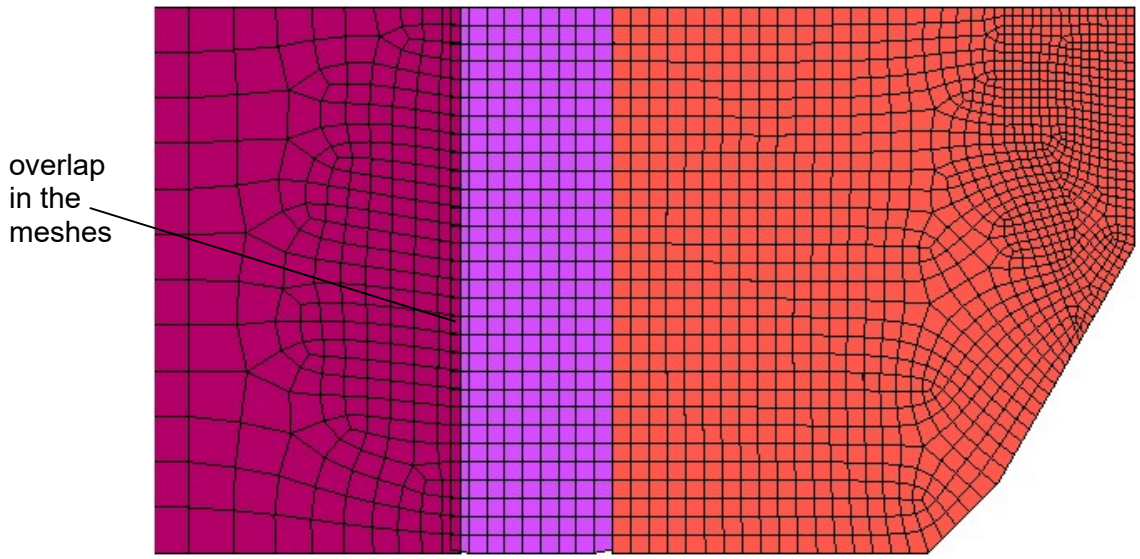

Fig. 3 *Enlargement of the mesh shown in figure 2a*

It is recommended to have a matching mesh on the surfaces where the sleeve and the container are in contact, i.e. the number of nodes and elements should be identical. That way, contact algorithms to close the interference and transfer the pressure between sleeve and container usually run more stable and precise.

5 Material modelling

For the sleeve material, an elastic material model is usually sufficient. It is recommended first to use an elastic material model for the sleeve. The effective stresses can then be checked, and if they do not exceed the yield strength of the sleeve material, the elastic material model for the sleeve is sufficient. Otherwise, an elastic-plastic material model should be used. Typical values to model the elastic behaviour of the steel sleeve material are E = 210 GPa and ν = 0.3.

For the die material, an elastic-plastic material model should be used. Typical values to model the behaviour of tungsten carbide die materials are E = 550 GPa and ν = 0.22.

For the material of the STRECON container, an elastic behaviour can be used as long as the interference pressure on the inside of the STRECON container is below the allowable interference pressure. This limit depends on the size of the STRECON container but is usually in the range of 1400 to 1600 MPa.

In order to make sure that the load on the STRECON prestressed container does not exceed the loadability of the STRECON prestressed container, please contact STRECON A/S for advice. Whenever we design a STRECON container for our customers, we make sure that it will behave elastically for the given process application and interference.

Typical values to model the elastic behaviour of a STRECON prestressed container are E = 210 GPa and ν = 0.3.

6 Technical Support

The recommendations and instructions given in this report should support our customers and business partners in properly analysing the behaviour of STRECON containers and their effects on the die behaviour.

In case of any questions, please contact:

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