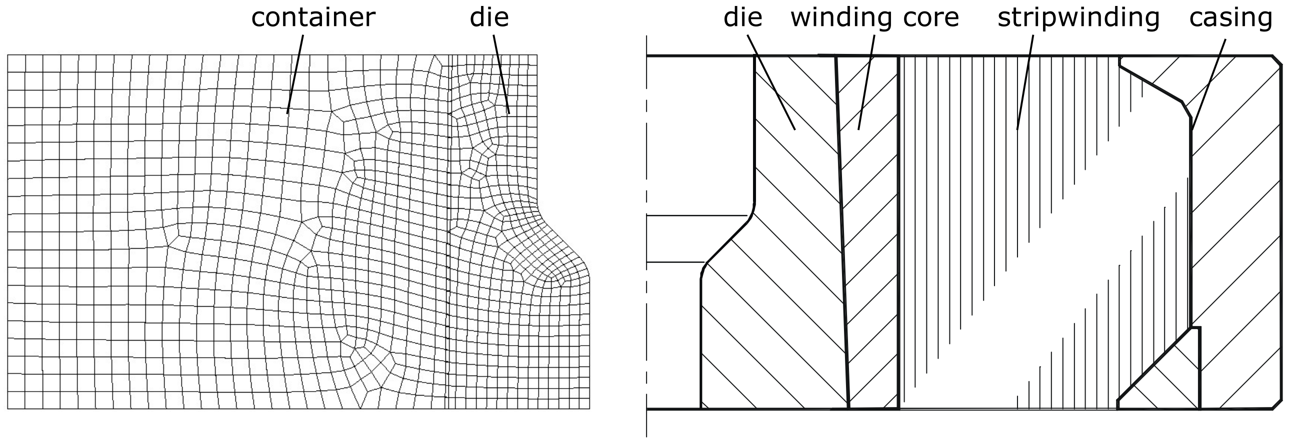
HOW TO MODEL STRECON STRIPWOUND CONTAINERS IN THE FEM ANALYSIS OF FORGING DIES

1 Modelling a STRECON stripwound container

In principle, STRECON containers and their effect on die stresses can be simulated the same way as conventional reinforcement rings. The STRECON container is modelled as one part as described below with the respective interference fit (see section 2) and material properties (see section 3).

The design of a typical forward extrusion die prestressed by a STRECON stripwound container is shown in Fig. 1b. The container consists of the winding core, the stripwinding and the casing. The inner bore of the winding core and the outer surface of the die are tapered in order to provide easy assembly. Fig. 1a shows FEM meshes that represent the die and the container in a 2D-example.



a) FE meshes of the container and die b) Design of the prestressed die

Fig. 1 *Forward extrusion die prestressed by a STRECON stripwound container*

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. This is the case both for SC200 containers with a steel winding core and $SC200^{+}$ containers with a carbide winding core.

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

When meshing the die and the container in the FEM system, it is recommended to simplify the FE model by utilizing symmetry features of the tool. In case of axially symmetrical dies, the meshing can be done in 2D. In case of cyclically symmetrical dies (e.g. gears) a section (e.g. a single gear tooth) should be analysed only.

2 Interference fit

The modelling of the STRECON stripwound container described in chapter 1 shows that there is no significant difference compared to the modelling of a simple shrink ring. The main benefit of the stripwound container is provided by its ability to withstand higher interference values thanks to the strip winding technology. Typical values of interference are in the range of 8 - 10 ‰ (i.e. 0.8 - 1.0 %).

In case of STRECON E^+ containers, the interference is in the range of simple shrink rings, typically about 4 - 6 ‰ (i.e. 0.4 - 0.6 %). The main benefit of the STRECON E^+ container is provided by the carbide winding core, which leads to a higher effective prestressing compared to a steel ring. Furthermore, its increased stiffness provides a lower expansion of the die and minimizes cyclic strains in the die, so that the risk of fatigue cracks is reduced significantly.

Regarding the modelling of the interference closure, the meshes of the die and the container should overlap corresponding to the interference. This overlap must be closed in the first step of the analysis. This feature is dependent on the FE code used. 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.

The interference for STRECON Basic and STRECON E^+ containers should be chosen in close cooperation with STRECON A/S only in order to assure the optimum performance of the prestressing system!

3 Material modelling

3.1 Die Material

For the die material, elastic or elastic-plastic material models can be used, depending on the capabilities and features of the FE code. Typical values to model the elastic behaviour of die material are E = 225 GPa, ν = 0.3 for dies made of steel and E = 500 GPa, ν = 0.22 for dies made of carbide.

3.2 STRECON stripwound container Material

For the material of the STRECON container, an elastic behaviour can be considered as long as the interference pressure on the inside of the STRECON container during the forging process is below the allowable interference pressure. This limit depends on the size of the STRECON container but is usually in the range of 1200 to 1600 N/mm^2.

In order to make sure that the load on the STRECON container does not exceed any limits, 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.

Typical values to model the elastic behaviour of a STRECON Basic container are $E = 210$ GPa and $\nu = 0.3$. STRECON E^+ containers with a winding core made of cemented carbide can still be modelled as one body as shown in section 1. The material values should then be set to a Pseudo Young's modulus that considers the combined effect of the carbide winding core, and the steel components of stripwinding and casing. Typical values to model the elastic behaviour of a STRECON E^+ container are $E = 400$ GPa and $\nu = 0.24$.

The exact value of the Pseudo Young's modulus depends on the dimensions of the winding core and the rest of the tooling. To get a precise value for a specific container, please contact STRECON A/S.

4 Technical Support

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

In case of any questions, please contact:

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