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The Onset of Ironing during Casing Expansion

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Abstract : Shell has developed a mono-diameter well concept for oil and gas wells as opposed to the traditional telescopic well design. A Mono-diameter well design allows well to have a single inner diameter from the surface all the way down to reservoir to increase production capacity, reduce material cost and reduce environmental footprint. This is achieved by expansion of liners (casing string) concerned using an expansion tool (e.g. a cone). Since the well is drilled in stages and liners are inserted to support the borehole, overlap sections between consecutive liners exist which should be expanded. At overlap, the previously inserted casing which can be expanded or unexpanded is called the host casing and the newly inserted casing is called the expandable casing. When the cone enters the overlap section, an expandable casing is expanded against a host casing, a cured cement layer and formation. In overlap expansion, ironing or lengthening may appear instead of shortening in the expandable casing when the pressure exerted by the host casing, cured cement layer and formation exceeds a certain limit. This pressure is related to cement strength, thickness of cement layer, host casing material mechanical properties, host casing thickness, formation type and formation strength. Ironing can cause implications that hinder the deployment of the technology. Therefore, the understanding of ironing becomes essential. A physical model is built in-house to calculate expansion forces, stresses, strains and post expansion casing dimensions under different conditions. In this study, only free casing and overlap expansion of two casings are addressed while the cement and formation will be incorporated in future study. Since the axial strain can be predicted by the physical model, the onset of ironing can be confirmed. In addition, this model helps in understanding ironing and the parameters influencing it. Finally, the physical model is validated with Finite Element (FE) simulations and small-scale experiments. The results of the study confirm that high pressure leads to ironing when the casing is expanded in tension mode.

Keywords : casing expansion, cement, formation, metal forming, plasticity, well design
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