Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 12-14, 2021

Structure Analysis of the IV-CEDM Lower Support

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1. Introduction

In-Vessel CEDMs (IV-CEDMs)

- Benefits
- Elimination of rod ejection accident
- Minimization of penetration of the reactor vessel

In-Vessel CEDM Lower Support

- Connecting the IV-CEDM and the IV-CEDM installation structure
- Composition : Adapter, Gusset, Flow area with fillet, Bolt hole, Rib

Structural Analysis

- Background
- Stepping load occurs consistently in the magnetic jack type CEDM
- The maximum stress is likely to occur at the geometrically discontinued point
- Purpose
- Optimization of fillet radius to minimize the maximum stress while maintaining the flow area

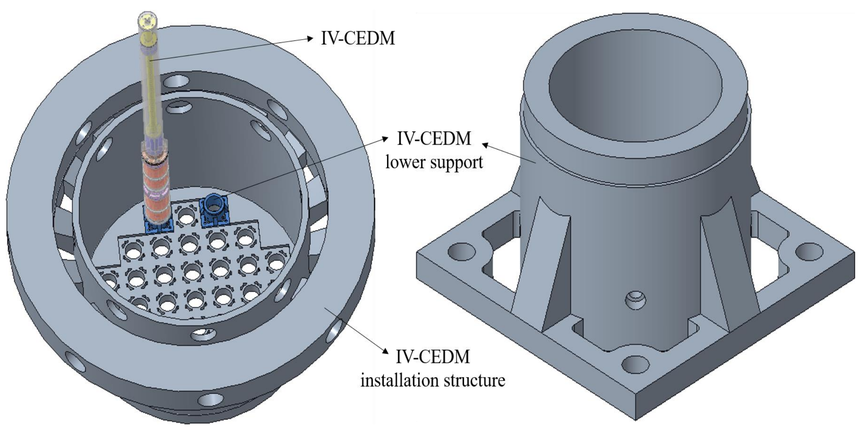

Fig. 1. IV-CEDM installation structure

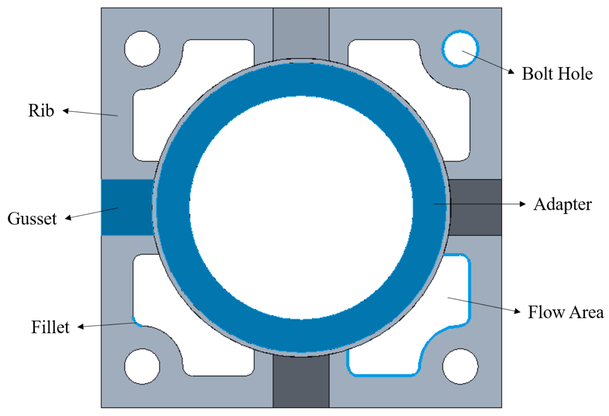

Fig. 2. IV-CEDM lower support

2. Modeling & Analysis

Modeling

- Only rib is modelled
- Rib is the weakest part of IV-CEDM lower support
- Adapter and gusset are even more stiffer than rib
- Only 1/4 finite element model is generated with SHELL 181
- Structure of the IV-CEDM lower support is symmetric
- Material : 300 series stainless steel

Analysis

- Tool : ANSYS Workbench
- Variables : Fillet radius, Width of the rib
  (to be adjusted to maintain the flow area same)
- Boundary conditions
- Edge of the bolt hole is fixed
- 1/8 of stepping load is applied on the two symmetric lines of 1/4 finite element model, respectively
- Mesh size
- Optimized so that the stress changes less than 1% as the number of the element increases

3. Results & Review

Stress Distribution

- Fillet radius increases → Stress concentration is relieved
- Rib width becomes thinner to maintain flow area size
  → Stress at rib increases

Fatigue Margin

- The ratio of the maximum stress to fatigue endurance limit given in ASME Boiler and Pressure Vessel Code Section Ⅲ
- Optimum case : Case C (Fillet radius of 25mm)
- Case C has significantly improved margin comparing to initial case, Case A

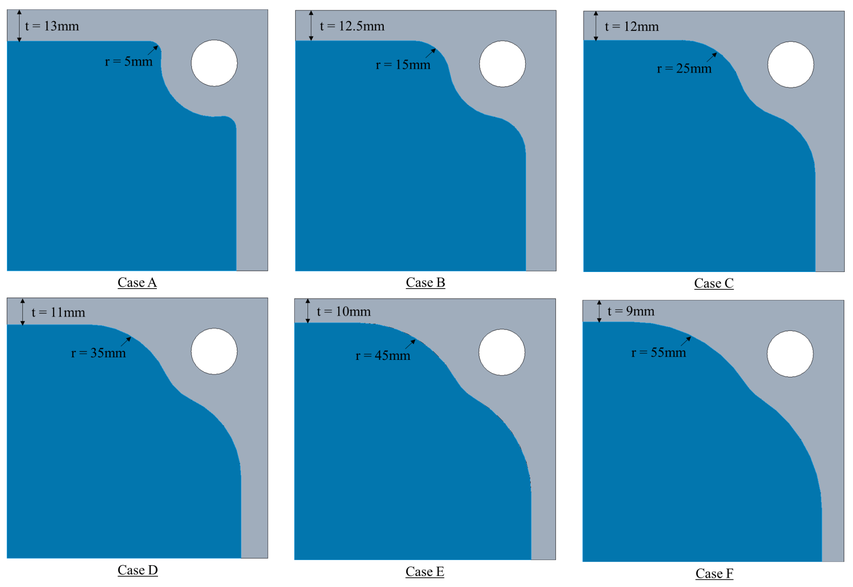

Fig. 3. Analysis cases

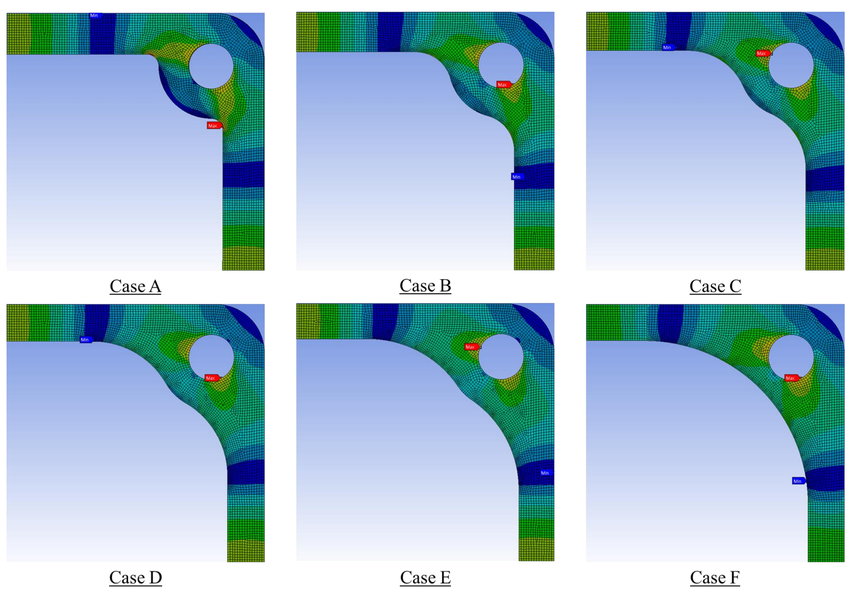

Fig. 4. Stress distribution

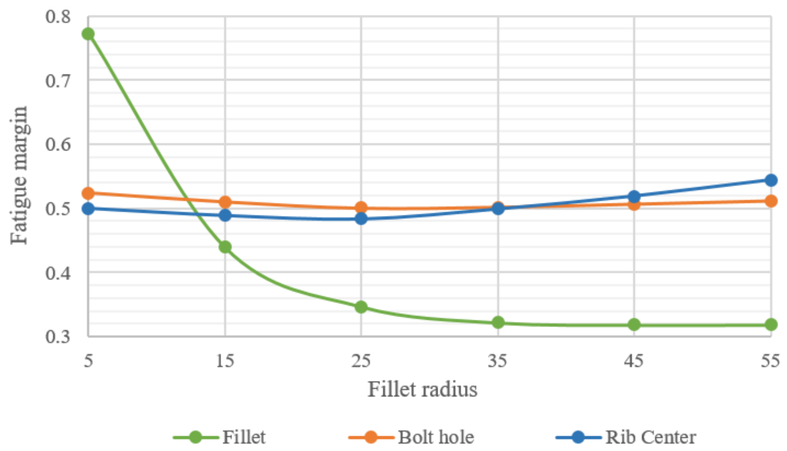

Fig. 5. Fatigue margin

4. Concluding Remarks

- Parametric analysis was carried out to minimize the maximum stress of the IV-CEDM lower support
- The best case was found to secure about 30% more margin than the initial case
- More realistic boundary condition will be needed for more accurate quantitative result
- More loadings will be considered as their directional loading characteristics can change the optimization result