Module 03 Step-by-Step Guide: Modeling Approach

Release 2023 R1

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Step-by-Step Guide 03: Modeling Approach

Use this guide as a summary of the modeling approach discussed in this module.

- The Preliminary Decisions that will lead us to a reasonable analysis approach are the following:
  - What components to include in the model and why?
  - How will I characterize those components from a geometry and material standpoint?
  - How will I model the interfaces among the components?
  - How will I characterize the operating environment?
  - How will I validate both my model and my design?

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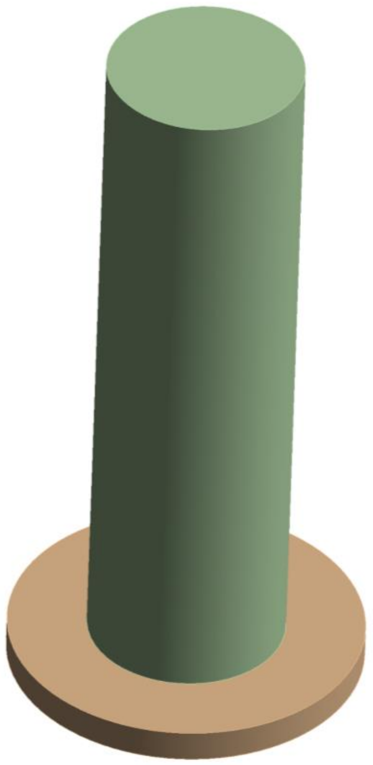
- Discussion point #1: What components do I model and why?
  - Valve body, required per the stated analysis objective
  - **Valve rod**
  - **Valve seal**
  - Flange
  - Nuts/Bolts



- *These components will be modeled as solid bodies*
  - *We're not concerned with their mass (no inertial loading)*
  - *Their stiffness is important as they distribute the internal pressure to the Flange part and are important to the load path*
  - *Later in the course we'll refine the interface condition between these parts along with the interface between the Valve Rod and Flange*

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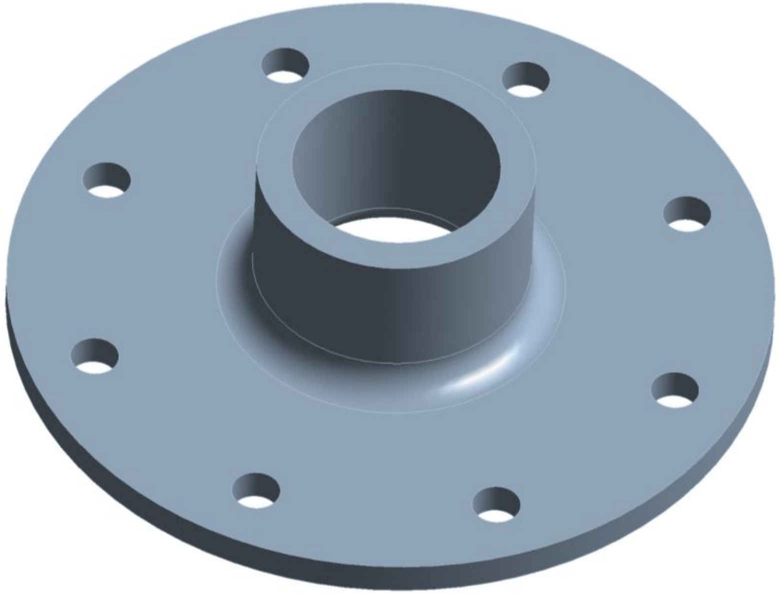
- Discussion point #1: What components do I model and why?
  - Valve body
  - Valve rod
  - Valve seal
  - **Flange**
  - Nuts/Bolts



- *This component will be modeled as a solid body*
  - *We're not concerned with its mass (no inertial loading)*
  - *Flange and Valve Seal interface is critical for proper load path for internal pressure*
  - *Gap between Flange and Valve body could be important; there's likely a gasket between these parts which we have no information about; that could influence the load path and also the stress results local to that interface*

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- Discussion point #1: What components do I model and why?
  - Valve body
  - Valve rod
  - Valve seal
  - Flange
  - **Nuts/Bolts**

- *These components will be modeled as solid bodies*
  - *We're not concerned with their mass (no inertial loading)*
  - *They contribute local stiffness between Valve body and Flange*
  - *Later in the course we'll consider the effect of their preload on the assembly as well as abstract them by replacing them with beams*

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- Discussion point #2: What material properties do we need?
  - Valve body (Type 40 Gray Cast Iron)
  - Valve rod (AISI 6150 Steel)
  - Valve seal (Type 302 Stainless Steel)
  - Flange (Type 40 Gray Cast Iron)
  - Nuts/Bolts (AISI 6150 Steel)

- *Required properties are Young's Modulus, Poisson's ratio, Strength*
  - *Strength is used for Safety Factor calculations*
  - *Density is only needed for inertial loading*
  - *CTE and Conductivity are only needed for thermal stress and thermal analysis*
  - *Fatigue strengths are only needed for fatigue analysis*
  - *Stress/strain data is only needed for plasticity or hyperelasticity*

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- Discussion point #3: How do I treat the interfaces among the components, along with interfaces to the rest of the world?
  - In the real world, what happens at the interface between components?
  - What are some ways that can be handled in FEA?
  - If we choose not to model a component, how and/or when do we account for its presence?

    - *Supports are needed at interfaces to rest of "world" to prevent rigid body motion (Sum of forces = 0)*
    - *Bonded contact or shared topology (mesh) can be used to enforce load transfer through part interfaces*
    - *Later in the course we'll investigate frictionless contact at some interfaces*
    - *Stress at supports may be approximate and/or inaccurate, much like the supports themselves*

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- Discussion point #4: What do I know about the operating environment and what simplifying assumptions will/must I make?
  - How will the pressure be modeled ?
  - What effect will the preload in the bolts have?
  - Based on what we know about the mating flanges at the inlet/outlet, how will we model that condition?

- *Pressure is likely transient and non-uniform, but we'll assume a worst-case static uniform pressure as it conforms to the scope of this approach*
- *Later in the course we'll implement preloads in the bolts using common engineering handbook guidelines*
- *Stress at supports may be approximate and/or inaccurate, much like the supports themselves*

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- Discussion point #5: How will I know if/when I’ve met the design objectives?
  - What stress are we going to use to validate the design criteria?
  - How will I know whether the stress value is accurate?
  - How else can we validate the model in order to determine whether we should believe the answers?

- *Under fault pressure of 7 MPa, Valve body stress must be < 0.5*Ultimate Strength*
- *Equivalent, Principal and Directional (Normal) stresses to validate the design*
- *Failure criteria for brittle material*
- *Ensure static equilibrium via reaction force balance*
- *Influence of mesh on the stress results*

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End of presentation