

MULTI-PHYSICS ANALYSIS OF GLOBE VALVE

Comparative Study: Stainless Steel vs. Brass vs. Bronze

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1. Executive Summary

This report summarizes the Finite Element Analysis (FEA) performed on a Globe Valve design. The study investigates the structural integrity, vibrational characteristics, and thermal performance of three distinct materials: Stainless Steel, Brass, and Bronze. The goal is to determine the optimal material for high-pressure and thermal operating conditions.

2. Modal Analysis (Natural Frequency)

A modal analysis was conducted to determine the natural frequencies of the valve body. Avoiding resonance is critical for safety in high-vibration environments.

Material	Mode 1 Frequency (Hz)	Performance
Stainless Steel	4084	Excellent (Safest)
Bronze	~3500	Good
Brass	2766	Poor (Risk of Resonance)

Conclusion: Stainless Steel exhibits the highest stiffness and natural frequency, making it the safest choice for environments with high mechanical vibration.

3. Static Structural Analysis

The valve was subjected to an internal pressure of 10 MPa and a downward force of 500 N. The equivalent (Von-Mises) stress and safety factors were evaluated.

Material	Minimum Safety Factor	Conclusion
Bronze	11.4	Highly Safe
Brass	1.5	Acceptable
Stainless Steel	1.04	Critical / Near Failure

Conclusion: Bronze significantly outperforms the other materials in structural safety, handling the high pressure with a large safety margin.

4. Thermal Analysis

Steady-state thermal analysis was performed for a temperature range of -35°C to 450°C. The total heat flux depends heavily on the thermal conductivity of the material.

Material	Thermal Conductivity (W/m°C)	Heat Transfer Behavior
Bronze	208	High Heat Dissipation

Brass	115	Moderate
Stainless Steel	15.1	High Insulation (Low Flux)

Conclusion: Bronze is ideal if heat needs to be removed quickly, while Stainless Steel is preferred when thermal insulation is required.

5. Final Conclusion & Recommendation

Based on the multi-physics simulation results, the following recommendations are made:

- **For Structural Safety:** Bronze is the superior choice due to its high safety factor.
- **For Vibration Resistance:** Stainless Steel is preferred because of its high stiffness and natural frequency.
- **For Thermal Applications:** Select Bronze for heat dissipation or Stainless Steel for thermal insulation.