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# Structural Simulation Applied to Industrial Port Components: Case Study of Metallic Gates at Port of Namibe

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## ABSTRACT

Structural simulation using the Finite Element Method (FEM) has become essential for validating industrial components prior to fabrication. This paper presents a case study of two metallic gates designed for Port of Namibe, demonstrating ICOS's technical capacity in advanced structural analysis, 3D modeling, and complete project management. The analysis included static stress evaluation, safety factor calculation, and fatigue life estimation for steel S275JR structures. Using SolidWorks with refined solid mesh, the study verified structural integrity under operational loads and repetitive cycles. Results confirmed that the design meets safety requirements and operational reliability standards for port infrastructure. This study confirms the structural integrity, operational reliability and fabrication readiness of the proposed gate assemblies, demonstrating ICOS's capability to execute high-complexity industrial engineering projects in Angola.

**Keywords:** structural simulation, finite element analysis, port infrastructure, industrial engineering, metallic gates, computational validation

## 1. INTRODUCTION

Structural simulation through Finite Element Method (FEM) has transformed industrial project development by enabling performance prediction before fabrication. This methodology allows engineers to:

- Predict internal stresses, deformations, and failure modes
- Optimize geometries and material thickness
- Ensure safety and compliance with international standards
- Reduce fabrication rework and operational failures

For port structures such as large-scale metallic gates, computational validation becomes critical due to environmental loads, repetitive stress cycles, and durability requirements. This paper presents the structural analysis of two metallic gates designed for Port of Namibe, demonstrating the practical application of simulation-driven engineering.

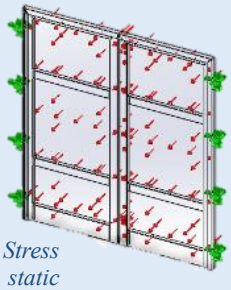

*Figure 2: Von Mises Stress distribution for static analysis*

## 2. SCOPE & DESIGN REQUIREMENTS

The project scope encompassed two metallic gates subjected to:

- Static structural analysis under normalized operational loads
- Safety factor (FOS) calculation for steel S275JR
- Fatigue life estimation under repetitive loading cycles
- Reaction force validation for support structures
- 3D modeling and computational mesh optimization as shown in figure 1 and 4
- Design specifications followed port infrastructure standards, with emphasis on:
  - ✓ Operational load capacity
  - ✓ Structural redundancy and safety margins
  - ✓ Environmental corrosion resistance
  - ✓ Long-term operational reliability

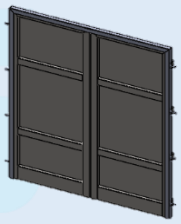

*Figure 1: Model of the metallic gate*

## 3. ENGINEERING METHODOLOGY

### 3.1 Modeling Approach:

3D parametric models were developed in SolidWorks with detailed geometric representation of all structural components. Solid mesh refinement was applied in regions with expected stress concentration to improve result accuracy.

### 3.2 Analysis Framework:

Static Analysis: Evaluation of von Mises stresses, deformations, and displacements under service loads.
Safety Factor: Calculation of structural margin relative to S275JR yield strength.
Fatigue Assessment: Life cycle estimation under alternating stress conditions with appropriate correction factors.
Boundary Conditions: Pressure loads and fixed constraints applied to 8 support faces representing actual installation conditions.

## 4. ANALYSIS & VALIDATION

### 4.1 Static Structural Performance:

Von Mises stress distribution was analyzed across all components, with maximum stresses occurring at connection

points and load transfer zones. Deformation patterns were evaluated to verify structural stiffness meets operational requirements.

### 4.2 Safety Factor Verification:

Safety factors were calculated for all critical regions, confirming adequate structural margins. Design optimization reduced unnecessary material while maintaining structural integrity.

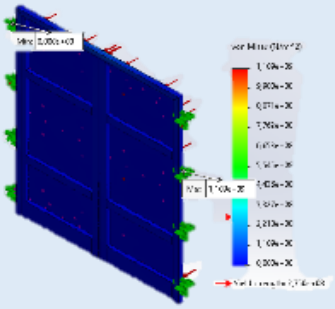

*Figure3: Graphical representation of Von Mises stress distribution*

### 4.3 Fatigue Life Estimation:

Fatigue analysis considered operational cycles typical of port equipment. Results indicated expected service life exceeds design requirements with appropriate maintenance protocols.

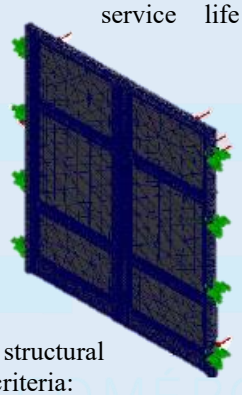

*Figure 4: Mesh distribution*

## 5. RESULTS & DISCUSSION

Computational analysis confirmed the structural design meets all safety and performance criteria:
Maximum stresses remain below material yield limits
Safety factors provide adequate margins
Fatigue life exceeds specified operational cycles
Support reactions fall within acceptable ranges
The simulation-driven approach enabled design optimization and validation before fabrication, reducing project risk and ensuring compliance with port infrastructure standards. The summary of stress, displacement, strain and factor of safety is presented in **Table 1** below:

| Results Summary | | | | |
|---|---|---|---|---|
| **Data** | **Stress** | **Displacement** | **Strain** | **F. of Safety** |
| Max | 2.278e+08 N/m^2 | 1.084e+01 mm | 5.191e-04 | 1.000e+16 |
| Min | 0.000e+00 N/m^2 | 0.000e+00 mm | 0.000e+00 | 1.207e+00 |
| Yield Strength | 2,75e+08 N/m^2 | | | |
| Status | Good | Good | Good | Good |

*Table 1*

## 6. CONCLUSION

The structural analysis of metallic gates for Port of Namibe demonstrates the effectiveness of FEM-based validation in complex industrial projects. The methodology confirms not only component viability but also validates ICOS's multidisciplinary capabilities in conducting projects from initial concept through fabrication and final operation.
By integrating advanced simulation, technical expertise, and manufacturing infrastructure, ICOS establishes itself as a strategic partner for companies seeking innovation, precision, and reliability in Angola's industrial sector.

## REFERENCES

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