

Warehouse Racking System Structural Capacity Calculation Template

(Compliant with FEM 10.2.02, ISO 21981:2021, ANSI MH16.1:2020)



1. Project Basic Parameters

1.1 Client Requirements

Parameter	Value	Unit	Notes
Warehouse Location		-	For seismic zone mapping
Operating	-20°C~50°C	°C	Material thermal expansion

Parameter	Value	Unit	Notes
Temperature			coefficient correction
Max Storage Height		m	Critical for column buckling analysis
Forklift Type (Class I/IV)		-	Impact force calculation

1.2 Rack Configuration

Component	Specification	Material Grade	Surface Treatment
Upright Columns	120×80×2.0mm C-channel	S355JR	Hot-dip galvanized (80μm)
Beams	100×50×1.5mm box section	Q235B	Powder coating (RAL 9010)
Decking (for shelving)	0.8mm perforated steel	DX51D+Z275	Anti-slip epoxy coating
Base Plates	200×200×15mm	SS400	Anchor bolt M16

Component	Specification	Material Grade	Surface Treatment
			(Grade 8.8)



2. Structural Analysis

2.1 Static Load Capacity Formula

2.1.1 Pallet Racking Beam Capacity (FEM Methodology)

$$P_{allow} = FS \times (L + 0.1 L_{def}) \sigma_y \times Z_x \times C_{imp} \times C_{fat}$$

σ_y : Yield strength of beam material (MPa)

Z_x : Section modulus of beam (mm³) $Z_x = 6b \cdot h^2 - 6(b - 2t)(h - 2t)^2$

(Box section)

C_{imp}: Impact factor (1.25 for reach trucks)

C_{fat}: Fatigue factor (0.9 for >10,000 cycles/year)

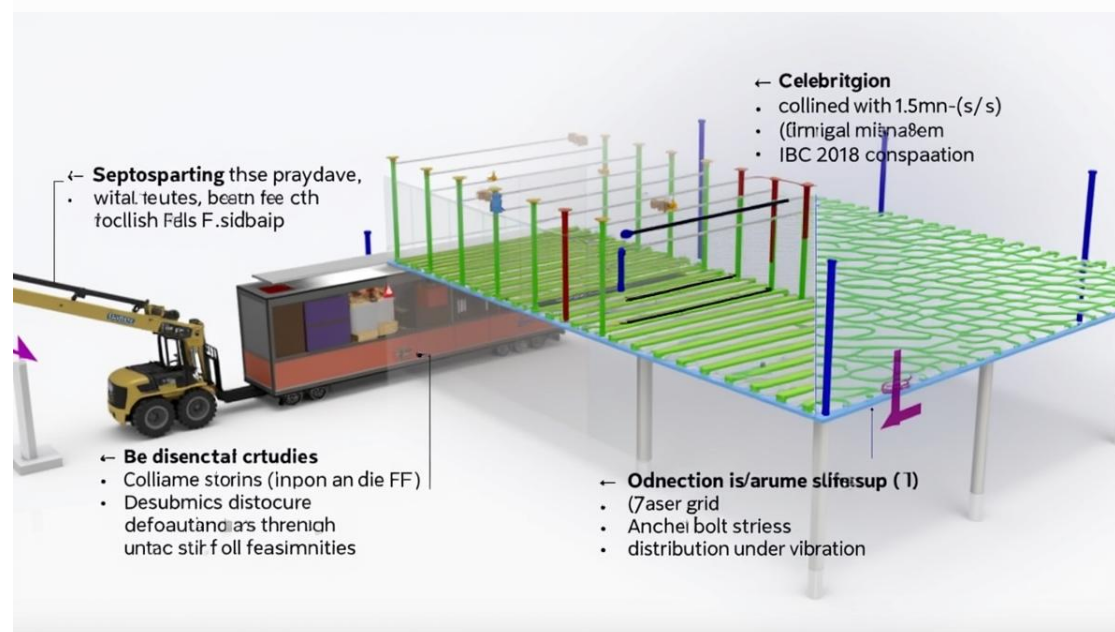
FS: Safety factor (1.5-2.0 per EN 15512)

L_{def}: Allowable deflection (L/200 max)

2.1.2 Column Buckling Analysis (Euler's Formula)

$$P_{cr} = (KL)^2 \pi^2 EI$$

- **E**: Elastic modulus (210 GPa for steel)
- **I**: Moment of inertia (mm⁴)
- **K**: Effective length factor (0.65 for fixed-base racks)
- **L**: Unbraced column height (mm)



3. Dynamic Load Simulation

3.1 Forklift Impact Force Calculation (ISO 22915-2)

$$F_{impact} = 2dm \cdot v^2 \times C_{angle}$$

- **m**: Forklift mass + load (kg)
- **v**: Impact velocity (m/s)
 - 0.5 m/s (low speed)
 - 1.0 m/s (standard)
 - 1.5 m/s (high traffic)
- **d**: Deformation distance (mm)
- **C_angle**: Angle coefficient (1.0 for frontal impact)

3.2 Seismic Load (IBC 2018)

$$F_p = 0.4 \cdot S_{DS} \cdot I_p \cdot W_p$$

- **S_DS**: Site spectral acceleration
 - **I_p**: Importance factor (1.5 for storage racks)
 - **W_p**: Operational weight (rack + stored goods)
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4. Material Property Database

4.1 Steel Mechanical Properties

Grade	Yield Strength (MPa)	Tensile Strength (MPa)	Elongation (%)
Q235B	235	370-500	26
S355JR	355	510-680	22
ASTM A36	250	400-550	23

4.2 Connection Strength

Fastener Type	Shear Capacity (kN)	Tension Capacity (kN)
M12 8.8 bolt	45	60
Rivet Ø10mm	25	-
Wedge anchor M16	70	90



5. Case Study: Automotive Parts Warehouse

5.1 Input Parameters

- **Rack Type:** Selective pallet racking (5 levels)
- **Beam Span:** 3,000mm
- **Material:** S355JR steel beams ($Z_x = 120,000 \text{ mm}^3$)

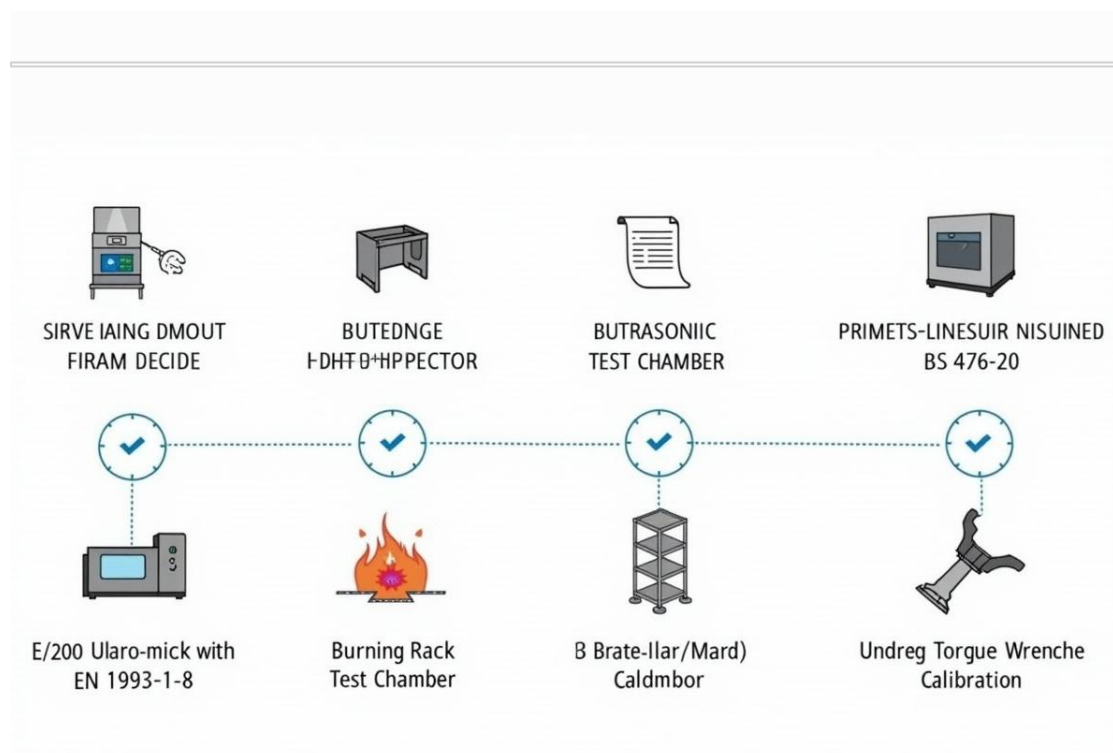
- **Load per pallet: 1,200kg**

5.2 Calculations

$$P_{allow} = 1.67 \times (3,000 + 0.1 \times 15) 355 \times 120,000 \times 1.25 \times 0.9 = 8,760 \text{ kg/level}$$

Safety Check

$$8,760 \text{ kg (allowable)} / 1,200 \text{ kg (actual)} = 0.137 \text{ (Safe)}$$



6. Compliance Checklist

Requirement	Verification Method	Standard
Beam deflection limit	Laser measurement	FEM 10.2.02 §5.3
Weld seam integrity	Ultrasonic testing	ISO 5817-B

Requirement	Verification Method	Standard
Anchor bolt preload force	Torque wrench calibration	EN 1993-1-8
Fire resistance rating	60-minute burn test	BS 476-20



7. Report Appendix

7.1 Reference Documents

- FEM 10.2.02: "The Design of Static Steel Pallet Racking"
- ISO 21981:2021: "Steel Storage Systems - Structural Design Principles"
- RMI (Rack Manufacturers Institute) Technical Bulletin #001

7.2 Software Validation

- Autodesk Robot Structural Analysis (FEA simulation)
- RackCAD Professional (DIN 15018 compliance check)
- SAP2000 (Seismic spectrum analysis)

7.3 Disclaimer

*This calculation assumes perfect installation alignment. Actual capacity may vary $\pm 5\%$ due to:

- Foundation unevenness ($> 3\text{mm/m}$ tolerance)
- Horizontal load from unbalanced storage
- Corrosion rate exceeding 0.1mm/year^*