Bolted joints analysis by CETIM-COBRA

Cobra
cetim

Cetim-Cobra

CETIM = Centre d'Etudes Techniques des Industries Mécaniques

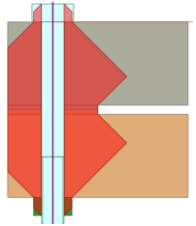
- Cetim is a French technical center dedicated to mechanical industries
  - One of its department is specialized in assembly engineering
    - COBRA is a software that has support with assembly experts

COBRA = Bolted joint calculation software

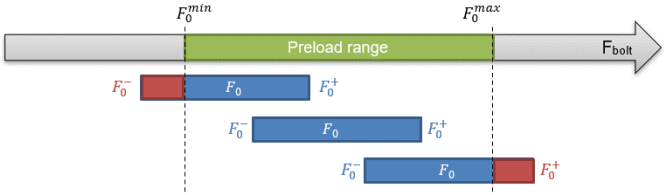
- Compliant with **VDI 2230** and **NF E 25-030-2**
  - **Analytical calculation** of a **single bolt joint** with **controlled tightening**
- Fastener and parts are modelled through an equivalent spring
  - Simple **linear model** built from geometric and mechanical properties of parts
- **Operational data is considered**
  - Tool accuracy, friction dispersion

Bolt calculation according to VDI2230 and NFE 25030-2

Calculation steps



- Spring model definition
  - Parts stiffness are calculated assuming a conical volume of uniform compression
- Preload range determination (F_0^{min}, F_0^{max})
  - Minimum preload to avoid opening or sliding
  - Maximum preload to avoid yielding
- Achieved preload calculation (F_0^-, F_0^+)
- Preload range and achieved preload comparison
  - Defines risks of opening/sliding or yielding
- Assembly checking under maximum load
  - Bolt stress, thread alternate stress, pressure at joint faces, thread strength …



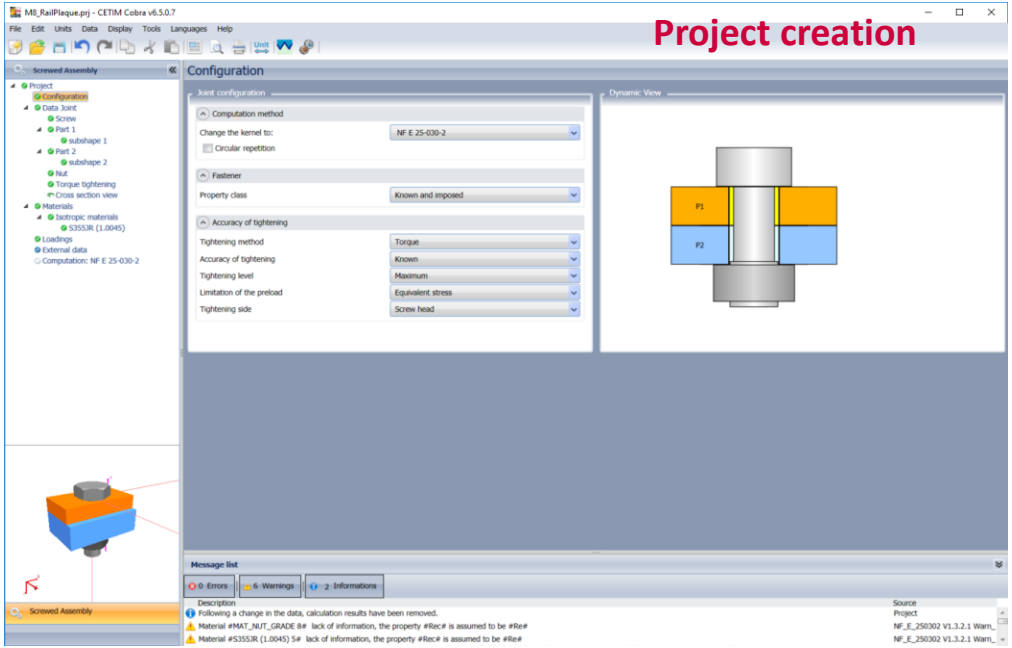
Cobra main features

Bolted joint calculations using COBRA

- Designing and verifying a single bolted joint according to VDI2230 and NFE 25-030-2 are performed in a few minutes with Cobra
- Enhanced calculations :
  - Cobra can handle non-cylindrical parts
  - Torque tightening but also hydraulic tensioning and angle tightening
- Many wizards will help the user to define the joint
  - Preselection of a bolt diameter, torque tightening, fatigue limit, …
- Cobra is provided with multi-standard databases
  - Material characteristics, thread definition, friction coefficient, …
- Custom catalogues can be defined
  - Standardized solution right from the beginning of studies

Use of Cobra

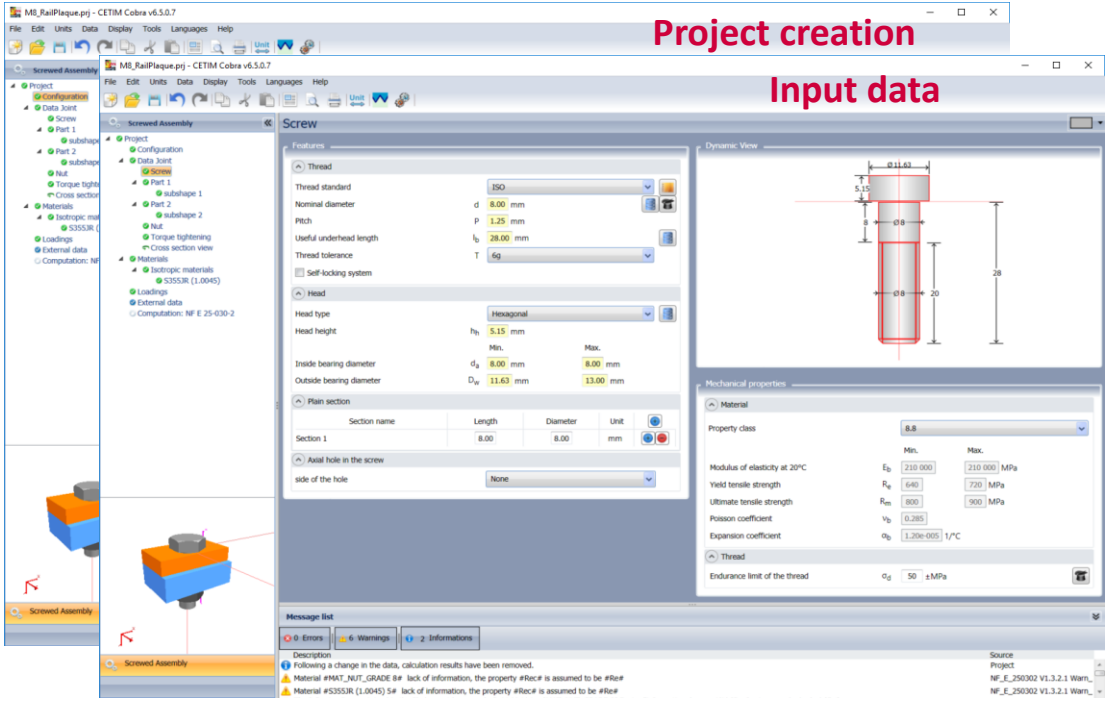
Main steps



- Project configuration
  - Fastener type (screw, stud, threaded rod)
  - Number of clamped parts
  - Tightening method (torque, tension, angle)
  - Check assembly only or also define tightening conditions
  - …

Use of Cobra

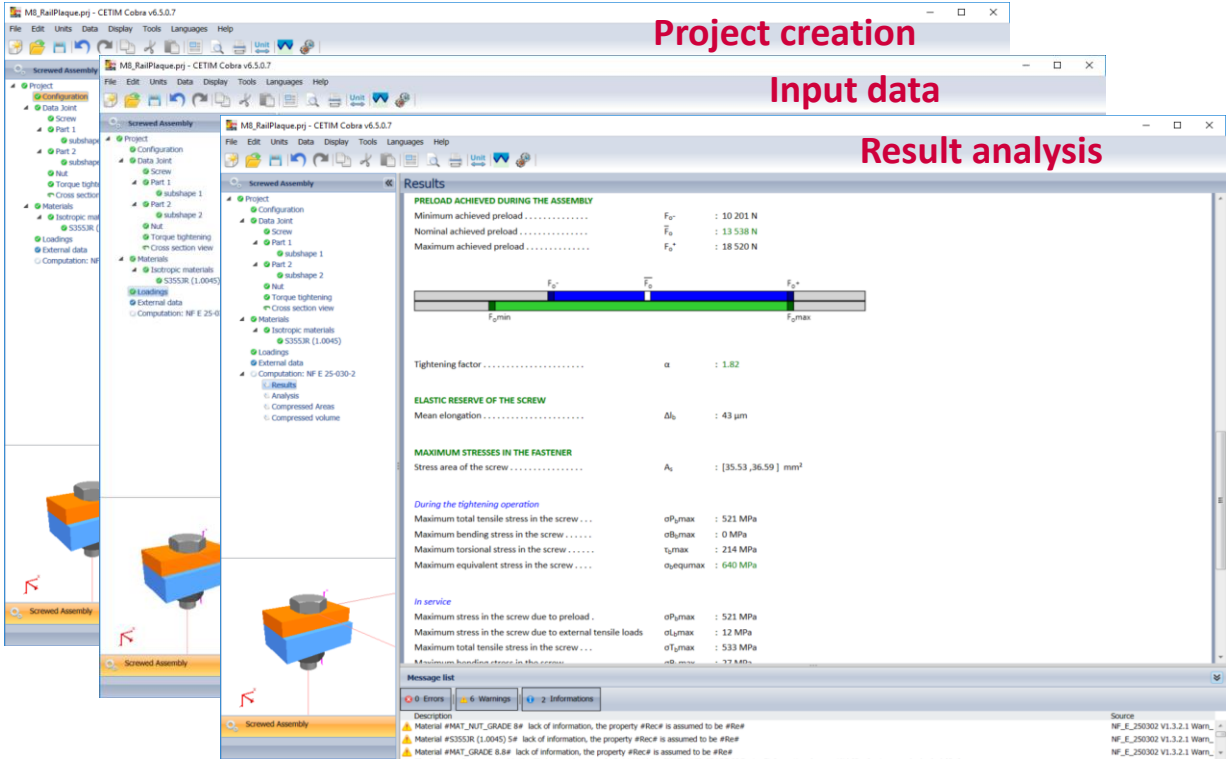
Main steps



- Input geometry of fastener and parts
- Set material properties (elastic characteristics)
- Define tightening parameters
- Define loadings

Use of Cobra

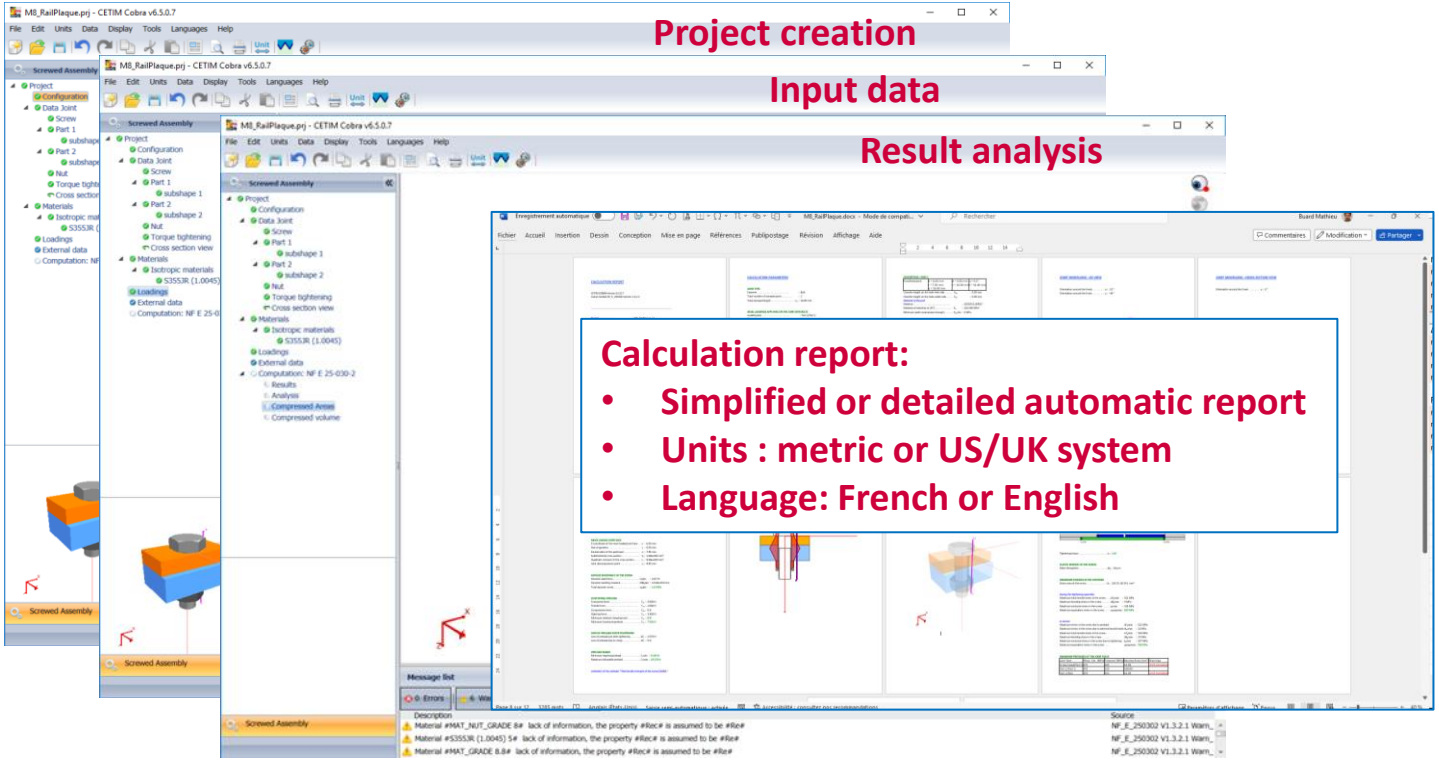
Main steps



- Detailed results
- Simple color code analysis
  - ✓ Acceptable
  - ➢ Acceptable but close to limits
  - ○ Caution : results over limits
- Compressed area and volume

Use of Cobra

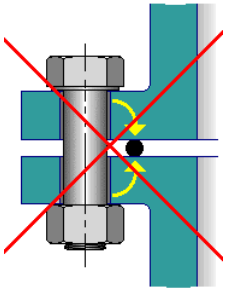
Main steps



Cobra limitations

Limitations of VDI2230 / NFE 25030-2

- Single bolt analysis
- Need of a continuous volume around the bolt
- Model validated in specific domain
  - standard sizes (M4 to M39)
  - High stress steel bolts (8.8 to 12.9 or A-70 A-80)
  - Metallic (steel) parts
    - *Cobra extends the model to any size and any isotropic material properties (use with caution and engineering judgement)*



Software limitations

- No link with other software (CAD, FEM, …)
  - Export to FEM is a new feature of the upcoming release (September 2023)

Cobra advantages

Advantages of using CETIM-COBRA

- No need of CAD-files
- Built-in wizards to ease model setup
- Fast analytical calculations dedicated to bolted joints according to VDI 2230 and NF E 25-030-2 standards
  - Ideal for solution iterations

Easier and faster than Finite Element Analysis

- FEM is complex and need more input data
- FEA doesn’t consider operational data easily
- FEA is time and cost consuming (especially for bolt analysis)

Typical use-case

Typical user profile

- Engineers (assembly design and dimensioning, tightening definition)
- Transportation industry, oil/gas, heavy machinery, …
  - Any industry where bolt assembly requires a precise preload

Typical use of Cobra

- Assembly definition: validating bolt size and material, clamped thickness, …
- Tightening definition: torque value considering dispersion
- Assembly validation: parts and bolt integrity, threads resistance in fatigue
- Sensitivity analysis: impact of friction dispersion, tool accuracy