MAREFORGE

Temporary cable guide module

Load derivation and axle sizing for an illustrative deck handling concept

Technical note MF-TN-001 | Revision 1.0 | 12 September 2026

A temporary cable guide must carry the cable reaction while preserving a suitable cable path. This worked example connects those two requirements through a simple sheave and stationary axle concept for a deck handling operation.

The baseline produces a 5.112 kN screening load. A 40 mm solid axle meets the stated nominal bending and bending deflection targets over a 320 mm support span. A separate bend radius check rejects the initial 400 mm groove root diameter and carries a 600 mm alternative forward for further design.

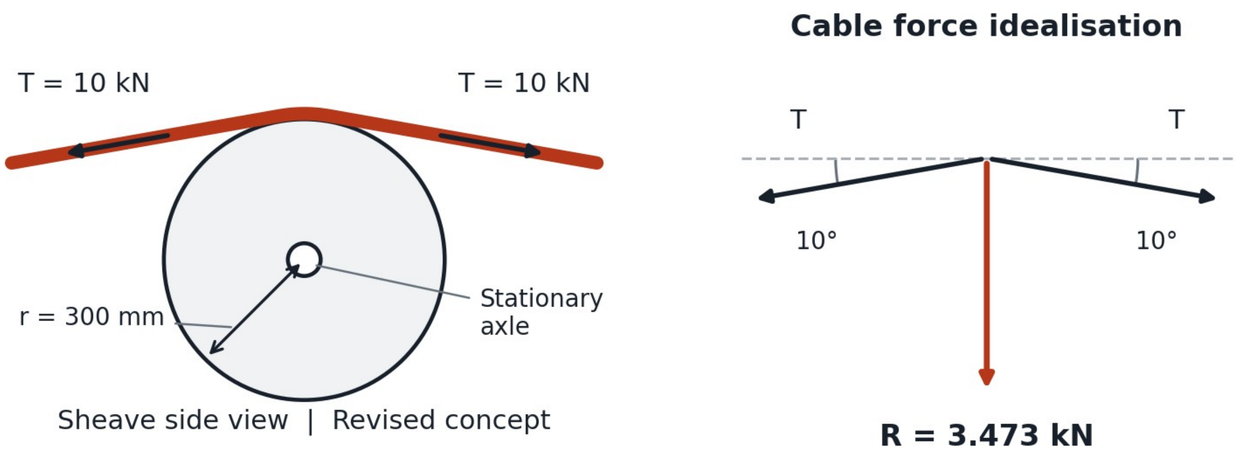

Figure 1. Original concept schematic and cable force idealisation. The cable changes direction by 20 degrees; the two outward tension vectors are 160 degrees apart. Sketch is not a fabrication drawing.

Scope of this example

This is an illustrative engineering example created for public explanation, with hypothetical inputs. It does not describe a delivered client project or a tested product. The calculations cover a planar cable reaction, a nominal axle beam model and a geometric bend radius screen. They do not establish an equipment rating or approval for manufacture or use.

1 Design basis and cable load

The cable passes over a freely rotating sheave on a stationary axle. Equal tension in both cable legs is assumed. The route is symmetric in a vertical plane, so the cable reaction and the dead load act downward. Out of plane lead, friction and acceleration require separate load cases.

Input	Value	Basis
Tension in each cable leg T	10 kN	Hypothetical operating input
Cable direction change θ	20 degrees	Deviation from a straight route
Cable load multiplier φ	1.40	Assumed screening multiplier
Dead load allowance W	0.250 kN	Assumed load carried by axle
Support span L	320 mm	Assumed support centre spacing
Elastic modulus E	200000 MPa	Assumed linear elastic value
Nominal bending target	100 MPa	Illustrative comparison criterion
Bending deflection target	0.20 mm	Illustrative stiffness criterion
Cable outside diameter	24 mm	Hypothetical geometry input
Minimum inside bend radius	250 mm	Assumed for this example only

Neither the multiplier nor the two axle targets is a code derived allowable or safety factor. No material grade, fatigue limit or manufacturer cable limit has been qualified. The 0.250 kN allowance must be replaced by the final sheave and axle mass and the load model updated if it is exceeded.

Resultant from the cable

The horizontal tension components cancel. Adding the two downward components gives the cable reaction R. The multiplier is applied to that reaction; W is then added as a central dead load allowance.

$$R = 2T \sin\left(\frac{\theta}{2}\right) = 2 \times 10 \times \sin\left(10°\right) = 3.473 \ kN$$

$$P = \varphi R + W = 1.40 \times 3.473 + 0.250 = 5.112 \ kN$$

The cable tension is not itself the transverse axle load. For unequal tensions, resolve the two cable force vectors directly and evaluate the associated sheave torque. The equal tension case used here does not bound a seized sheave or a snag.

2 Axle bending and deflection

The axle is idealised as a uniform solid circular beam with simple supports. The total load acts at midspan. This bounds the maximum beam moment for the same total downward load distributed within the support span, but does not assess local bearing contact, shoulders or grooves.

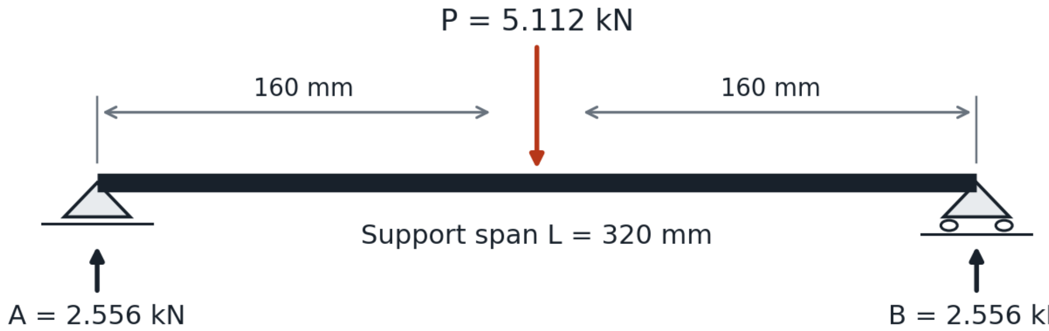

Figure 2. Axle beam model. Support flexibility and the actual load transfer through the sheave bearings are excluded. Dimensions refer to the idealised support centres.

$$A = B = \frac{P}{2} = 2.556 \ kN$$

$$M_{max} = \frac{PL}{4} = 0.409 \ kN \ m$$

$$I = \frac{\pi d^4}{64}$$

$$\sigma_b = \frac{M_{max} d}{2I} = \frac{32 M_{max}}{\pi d^3}$$

$$\delta_b = \frac{P L^3}{48 EI}$$

Use N, mm and MPa consistently. I is the second moment of area; d is axle diameter; σb is nominal outer fibre bending stress; δb is the maximum bending deflection. Beam model background: reference 1.

Axle d	Bending stress	Bending deflection	Target comparison
30 mm	154.3 MPa	0.439 mm	Both exceeded
35 mm	97.2 MPa	0.237 mm	Deflection exceeded
40 mm	65.1 MPa	0.139 mm	Both met in this model

The 35 mm option meets the stress target but exceeds the deflection target by about 18%. The 40 mm option reduces bending stress by 33% and bending deflection by 41% relative to 35 mm, because these responses scale with the inverse third and fourth powers of diameter respectively.

Carry the 40 mm uniform section into the next design iteration. This is a nominal sizing decision, not a final axle specification. With L/d = 8, shear deflection and local compliance should be checked when developing the detailed model; the tabulated deflection is the bending component only.

3 Cable geometry and sensitivity

A larger axle cannot resolve an incompatible cable bend. For this example the assumed minimum radius is explicitly measured to the inside of the bent cable. With the cable seated in the groove, that radius corresponds to the groove root radius. Manufacturer definitions and limits must be confirmed for the actual cable and tension.

Groove root diameter	Inside bend radius	Geometric result
400 mm initial concept	200 mm	Below assumed 250 mm minimum
600 mm revised concept	300 mm	Above assumed 250 mm minimum

For the revised concept the cable centreline radius is 300 + 24/2 = 312 mm. An ideal flexible cable under 10 kN tension has a distributed normal contact load $q = T/r = 32.1$ kN/m along this arc. This is a line load, not a contact pressure in MPa. Cable stiffness, groove contact width and allowable local compression remain unresolved.

The baseline is sensitive to the cable route

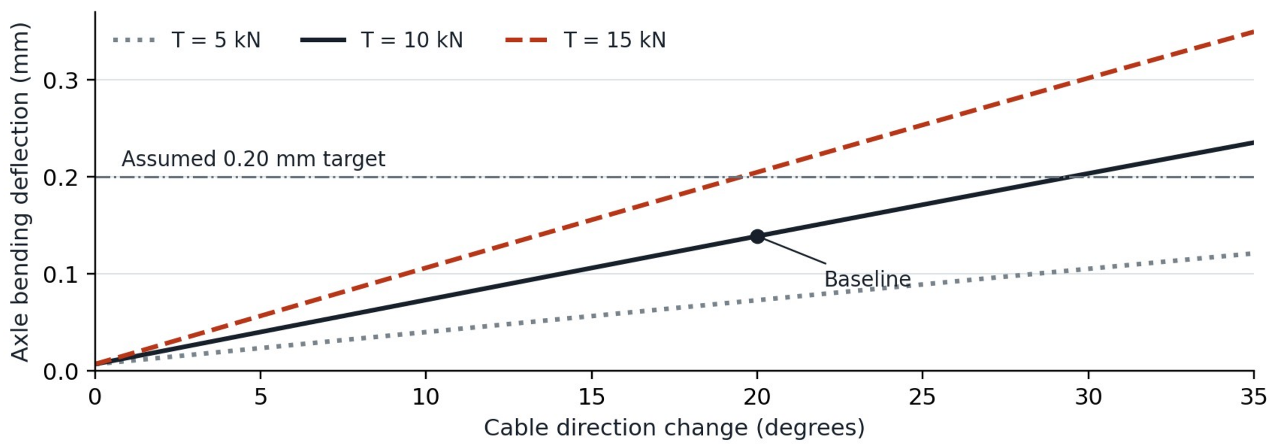

Figure 3. Bending deflection of the 40 mm axle at L = 320 mm. Each curve uses φ = 1.40 and W = 0.250 kN. The line at 0.20 mm is the assumed comparison target, not an operating limit.

At the same 10 kN tension, increasing the direction change from 20 to 30 degrees raises P from 5.112 to 7.497 kN. Bending stress remains below 100 MPa at 95.5 MPa, while bending deflection rises to 0.204 mm and exceeds the target. At 15 kN and 30 degrees, both targets are exceeded.

The algebraic load bound from the 0.20 mm bending target is 7.363 kN for this beam model. It is not a working load limit. Final route angles, tension transients, friction, material details and the supporting structure can impose more restrictive conditions.

4 From the concept to an engineering package

The next design iteration starts with a 600 mm groove root diameter and a 40 mm nominal axle section over a 320 mm support span. These dimensions remain conditional on the stated load and geometry assumptions. The larger sheave may change mass, inertia, space requirements and access; those effects must feed back into the design basis.

What remains to be established

- Confirm the cable data and operation. Obtain cable construction, bend radius definition and limits under tension, maximum handling tension, local compression limits, speed, tension history and permitted fleet angles. Confirm whether a single sheave is an acceptable handling interface.
- Resolve the complete load path. Model unequal tension, start and stop events, a seized sheave, snagging and out of plane loading as applicable. Check the sheave, hub, bearings, axle details, support cheeks, joints and deck attachment, including eccentricity and overturning.
- Develop the detailed mechanical checks. Select certified material properties and applicable acceptance criteria. Evaluate shear, local bearing stresses, stress concentrations, fatigue, retention, clearances and support compliance. Select bearings for the actual load, speed, environment and duty.
- Prepare drawings and verification requirements. Define the assembly, groove geometry, fits, tolerances, corrosion protection, bill of materials and inspection points. Address cable retention, access and pinch points in the risk review. Establish the required functional or load testing before any release.

Calculation traceability

The companion calculation file reproduces the inputs, results and sensitivity cases in N and mm. Arithmetic checks cover vector equilibrium, support equilibrium and a separate numerical integration of beam curvature. They verify the calculation implementation; they do not validate the physical assumptions. No finite element analysis, prototype test or independent design approval is claimed.

Technical reference

1. MIT OpenCourseWare, 1.050 Solid Mechanics, Fall 2004. Chapter 10 Deflections due to Bending, printed page 269, simply supported beam with a point load. Accessed 12 September 2026. Background for the beam idealisation; all example inputs, calculations and figures are original to this note.

Related engineering scope

Vessel routing and deck interfaces sit within Marine and Offshore Engineering.

A defined mechanical concept can progress through Equipment and Product Development into a detailed engineering package.

Where cable data or interface loads are incomplete, Technical Assessment and Concept Definition provides a starting scope. A useful initial enquiry includes the cable data sheet, route sketch, tension envelope and available installation space.