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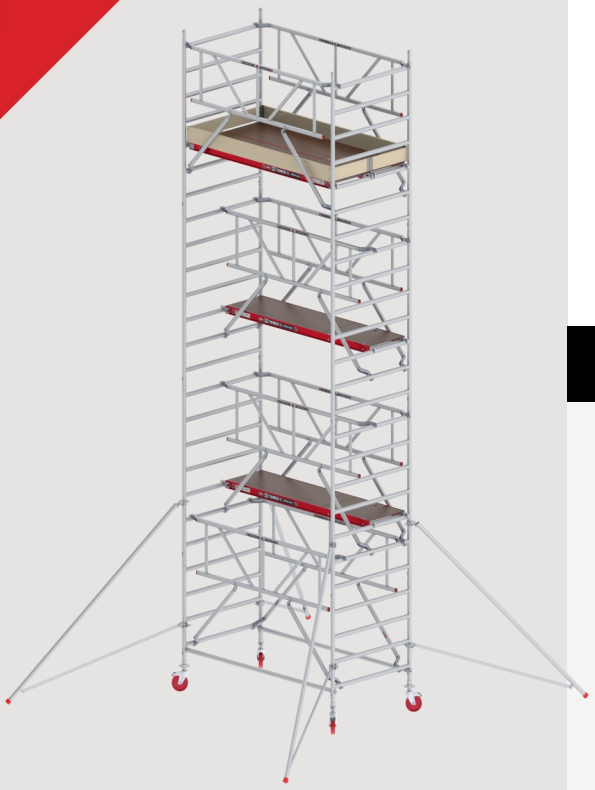
SUMMARY STRENGTH AND STABILITY CALCULATION

Rolling tower

RS TOWER 42-S



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Declaration

Calculated according to valid standard: EN 1004:2020

The European Directive “Working at Height” is compulsory within the countries of the European Committee. Based on this, when using rolling tower at work a strength- and stability calculation must be available and in accordance with the applicable standards (state of the art). For mobile access towers the current standard is EN 1004:2020 (Mobile access and working towers made of prefabricated elements - Materials, dimensions, design loads, safety and performance requirements). Upon purchase this declaration gives the guarantee of a liable working tool.

Scope of this summary

Altrex B.V. possesses the necessary specialist knowledge to produce and analyze a structural strength and/or stability calculation for standard configurations, Combination Configurations and custom-built products. The output of a calculation is very comprehensive. For that reason, a summary of the calculation has been opted for. If required, the Health and Safety Inspectorate can check the total calculation (results) at Altrex.

Method

The strength and stability calculations are made by means of the Finite Element Method (FEM). For the calculations FEMAP (v.10.1.0.) *pre-processor/post-processor and NX Nastran is used as solver*. Using these programmes enables you to make the obligatory second-order calculations by means of FEM.
Each rolling tower contains a line-model as basis for the geometry. A precise model consisting of various elements is obtained by adding the correct characteristics. To this end, different types of elements are used:

- Beam-elements Extruded profiles
- Plate-elements Platforms; wood or fiber
- Rigid-elements Connection components
- Mass-elements Correction of component mass

Wherever necessary, degrees of freedom are applied to simulate a proper connection.

Strength calculation

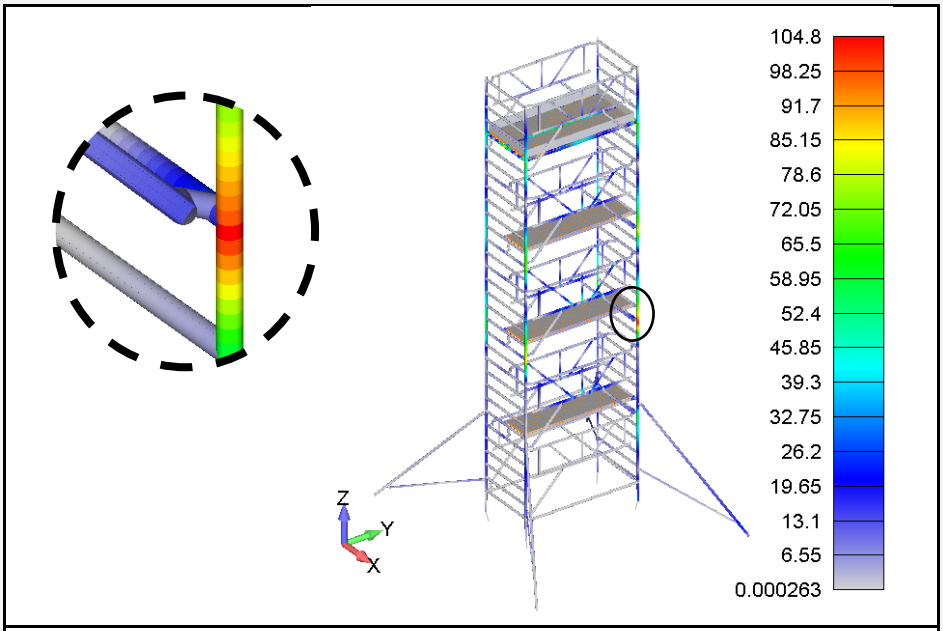
The European standard EN 1004 states that for strength a rolling tower should be able to resist a combination of loads. This includes the following loads:

A. Self-weight of the construction
B. Loads resulting from an inclination of 1%
C. Uniformly distributed load on topmost platform (class 3) q_{distr} = 2.0 kN/m^2
D. Minimum vertical service load $F_{ser.\ vert}$ = 5.0 kN/4 legs
E. Horizontal service loads (on the level of the platform) $F_{ser.\ hor}$ = 0.15 kN
F. Wind load q_{wind} = 0.1 kN/m^2

The above loads must be carried out in different combinations. In doing so, safety factors must also be taken into account. An overview of the different load combinations is shown below.

Loadcase	A	B	C	D	E	F
1	1.2	1.2	1.2	-	1.2	1.2
2	1.2	1.2	-	1.2	1.2	1.2

The above table is used in both the longitudinal direction and the transverse direction of the rolling tower. For all possible configurations (see configuration overview) all four load combinations are evaluated in the most unfavorable direction.



Critical stresses [N/mm^2] -Model D-010

Figure 1

Figure 1 shows the most critical occurring stresses of the relevant scaffold ranges. The stresses are evaluated with respect to their maximum allowable material values. These stresses depend on the base material used and therefore, can vary per element. Heat Affected Zones (HAZ) are also taken into account by allowing a reduced maximum value for these elements. Such stress evaluation are resumed in the following table:

Evaluated Material	Max. Stress [MPa]	Target [MPa]	Max. Stress HAZ [MPa]	Target HAZ [MPa]	Status
Al6063-T66	93.8	**181.8**	58.3	**68.2**	
Al6005-T6	104.8	**195.5**	100.8	**104.5**	

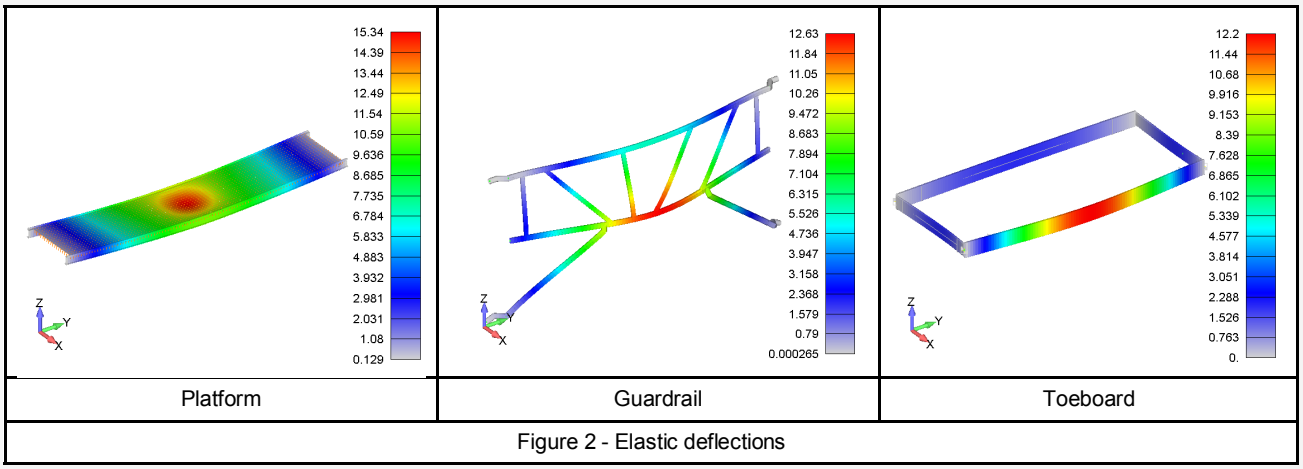
Table 1: Maximum stresses values on RS42-S Rolling tower

The stress values of all calculated configurations are within the permissible limits and therefore, these scaffolds comply with the stress criteria formulated in the European standard EN 1004.

Regarding displacements, EN1004 stipulates maximum elastic displacements at component levels. The loads must be applied at the most unfavourable position on each component. Such loads, with a safety factor of 1.2, are summarized in the following table:

Component	Load [N]
Platform	1500
Guardrail	300
Toeboard	150

And results are exposed below:



Platform	Guardrail	Toeboard

Figure 2 - Elastic deflections

Component	Deflection [mm]	Target [mm]	Status
Platform	15.4	**25**	
Guardrail	12.9	**35**	
Toeboard	12.2	**35**	

Table 2: Components deflection values on RS42-S Rolling tower

Thus, it can be confirmed that the scaffolds comply with the stress and displacements requirements in strength of the standard EN1004.

Stability calculation

The European standard EN 1004 states that for stability a rolling tower should be able to resist a combination of loads. This includes the following loads:

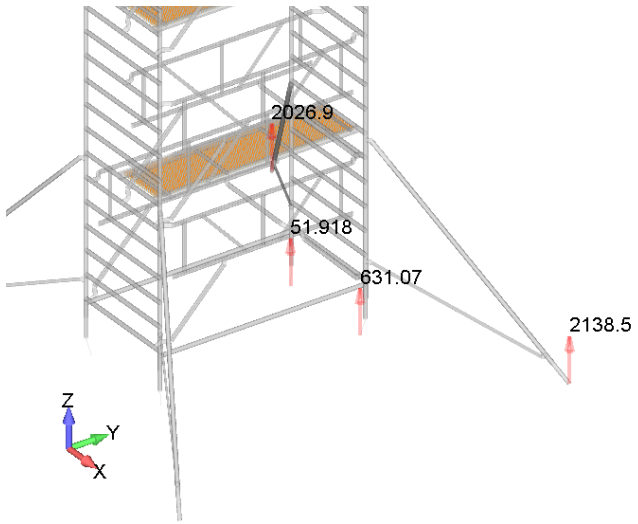
A. Self-weight of the construction
B. Loads resulting from an inclination of 1%
C. Vertical service load
D. Horizontal service loads (on the level of the platform)
E. Wind load

$F_{ser.\,vert}$ = 0.75 kN
$F_{ser.\,hor}$ = 0.3 kN
q_{wind} = 0.1 kN/m^2

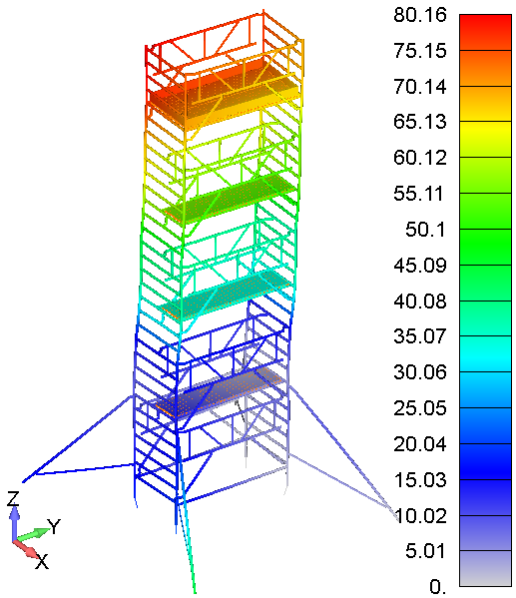
The above loads must be carried out in different combinations. In doing so, safety factors must also be taken into account. An overview of the different load combinations is shown below.

Loadcase	A	B	C	D	E
1	1.0	1.5	1.0	1.5	-
2	1.0	1.5	1.0	-	1.5
3	1.0	1.3	-	-	1.3

The above table is used in both the longitudinal direction and the transverse direction of the rolling tower. For all possible configurations (see configuration overview) all four load combinations are evaluated in the most unfavorable direction.



Reaction forces [N] - Model D-010



Displacements [mm] - Model D-010

Figure 3

Figure 3 shows the most critical reaction forces and displacements of the relevant rolling-tower range. The supports of the rolling tower can only absorb pressure forces. This means that a relevant support (boundary condition) will be removed from the model in case of a tensile force. This process is repeated up to a minimum of four supports (two supports of the rolling tower and two of the stabilizers). If this measure proves to be insufficient, then counterweight is added in steps of 5 kg to each leg of the construction. The purpose of this analysis is obtaining a situation in which there are only pressure forces on the scaffold construction.
A rolling tower is considered stable if all reaction forces are pressure forces.

Configuration overview

This summary of the strength and stability calculation applies to all rolling tower configurations of the type RS TOWER 42 as described in the table below. If the configuration is used outside (or location where wind may act), the potential ballast must be taken into account.

RS TOWER 42-S with Safe-Quick®2 Guardrail - Aluminium rolling tower double width 1.35 m													
Lenght (cm)		**185**		**245**									
Platform height (m)						2.20 m	3.20 m	4.20 m	5.20 m	6.20 m	7.20 m	8.20 m	9.20 m	10.20 m	11.20 m	12.20 m
Working height (m)						4.20 m	5.20 m	6.20 m	7.20 m	8.20 m	9.20 m	10.20 m	11.20 m	12.20 m	13.20 m	14.20 m
Description	**Art.no.**	**Kg**														
Frame double width 135-7 RS4	303370	9,0	303370,0	9,0		2	4	4	6	6	8	8	10	10	12	12
Frame double width 135-4 RS4	303340	5,4	303340,0	5,4		2	-	2	-	2	-	2	-	2	-	2
Wheelleg with wheel ø200 mm RS4	511216	3,3	511216,0	3,3		4	4	4	4	4	4	4	4	4	4	4
Wooden platform with trapdoor RS4	305010	14,0	305110,0	17,8		1	1	2	2	3	3	4	4	5	5	6
Wooden platform RS4	305020	14,1	305120,0	18,1		1	2	1	1	1	1	1	1	1	1	1
Safe-Quick® GuardRail 185 RS4	360275	7,1	360276,0	8,4		4	4	6	6	8	8	10	10	12	12	14
Horizontal brace RS4	304304	1,8	304306,0	2,1		2	2	2	2	2	2	2	2	2	2	2
Triangular stabiliser RS4 standard	513080	7,4	513080,0	7,4		-	-	-	-	-	4	4	4	4	4	4
Triangular stabiliser RS4 till 6.2m PH	513070	4,4	513070,0	4,4		4	4	4	4	4	-	-	-	-	-	-
Toeboard set Wood 135 RS4	305580	7,5	305585,0	14,4		1	1	1	1	1	1	1	1	1	1	1
Total weight excl. ballast (kg) - 185 cm lenght						127	149	174	181	220	239	278	285	324	332	371
Total weight excl. ballast (kg) - 245 cm lenght						148	173	201	208	254	273	318	325	371	378	424
Ballast for indoors use - Number of ballast weights (5kg) on each wheel leg																
185						0	0	0	0	0	0	0	0	0	0	0
245						0	0	0	0	0	0	0	0	0	0	0
Ballast for outdoors use - Number of ballast weights (5kg) on each wheel leg																
185						**0**	**0**	**0**	**2**	**4**	**6**	**9**	**-**	**-**	**-**	**-**
245						**0**	**0**	**0**	**0**	**1**	**3**	**5**	**-**	**-**	**-**	**-**

Table 2: Configuration table RS42-S Rolling tower

Conclusion

In this summary of the strength and stability calculation Altrex B.V. declares that the rolling tower RS TOWER 42-S meets the requirements of the European standard EN 1004:2020 (*Mobile access and working towers made of prefabricated elements - Materials, dimensions, design loads, safety and performance requirements)*, provided that the rolling tower is assembled and used in accordance with the manual.

The rolling tower RS TOWER 42-S meets the strength criteria: YES

The rolling tower RS TOWER 42-S meets the stability criteria: YES