

FOOT ANCHOR

SPHERICAL LIFTING SYSTEM

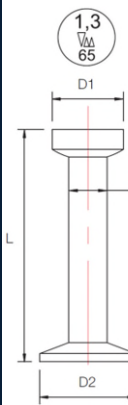


Updated 20/11/2024

Presentation

- The foot anchor is part of the Artéon product range: designed for lifting prefabricated elements in the factory or on construction site.
- All our foot anchors are CE-certified.
- In addition, our products are inspected for conformity and safety before being put on the market.
- Anchors are made from raw steel grade S355J0.
- They are available in raw, electro-galvanized, galvanized (please consult us) finish and, on request, in stainless steel.

Dimensions and working loads

Category	1.3 T	2.5 T	5 T	7,5 T	10 T	15 T	20 T	32 T	
D mm	10	14	20	24	28	34	38	50	
D1 mm	18	25	36	46	47	69	69	88	
D2 mm	25	35	50	60	70	85	98	135	
L mm	35	45	75	120	115	165	200	200	
	40	55	85	140	135	200	240	500	
	50	65	95	165	150	300	250	700	
	55	75	120	200	170	400	340		
	65	85	180	240	200		500		
	85	120	240	300	250				
	120	170	340		340				
	170	240							
		280							

Safety factors

- The safety factor is 3 with respect to anchor steel failure. The static test's load coefficient is 1.5 without deformation of the anchor. The recommended anchor safety factor against concrete cone breakout is 2.5 minimum.
- Anchors used more than 10 times must not be loaded more than 0.6 times their maximum working load.
- An anchor's maximum working load is engraved on its head.

Precautions to be taken when placing anchors and when lifting

- Always position the anchors according to the center of gravity of the part.
- Never weld the anchors or enlarge the imprint left in the concrete by the pocket.
- Always use the hemispherical formers provided for this purpose.
- The anchors must be slightly offset from the concrete surface (offset create by the former).
- At the time of lifting, refer to our instructions for use of the rings, which state the conditions ensuring correct and safe use.
- All assumptions taken into account in the dimensioning of the anchors must be strictly respected.

Determination of the forces applied to the anchorages

The following parameters must be taken into account in determining the forces applied to the anchorages:

- weight of the part
- adherence/bond to the mould
- lifting equipment introducing a dynamic coefficient
- sling angle
- number and positions of the lifting points (number of effective points).

1. Weight of the precast part

The weight to be used in the calculations is the true weight of the part plus the weight of the items that will be lifted with it (formwork, pre-assembled components, etc.).

2. Adherence to the formwork

The force of adherence q_{adh} acts when the part is stripped; it depends on the type of mould used and is indicated in table below:

- The area to be used in the calculations is the area of concrete still in contact with the mould at the time of stripping. - With imprinted concrete surfaces, the adherence will be greater than indicated by the table and must be calculated separately. - In some particular cases, the adherence to be counted may be zero: prestressed parts, parts poured in lost forms, etc...	Type of formwork	q_{adh}
	Oiled plastic or steel formwork	1 kN/m ²
	Oiled varnished wood formwork	2 kN/m ²
	Rough wood formwork	3 kN/m ²

3. Dynamic forces

During the lifting and shifting of the precast parts, the anchorages are subjected to dynamic forces. These forces depend on the type of lifting equipment used; a dynamic coefficient, defined in the table below, is used to allow for them:

<i>Lifting equipment</i>	<i>dynamic coefficient (ψ_{dyn})</i>
Crane, fixed or on rails, speed < 1m/s	1.15
Grue fixe ou sur rails, vitesse > 1m/s	1.30
Bridge crane, speed < 1m/s	1.15
Bridge crane, speed > 1m/s	1.60
Lifting and moving on flat ground	2
Lifting and moving on uneven ground	4

In other cases, the dynamic coefficient will be determined by a qualified individual.

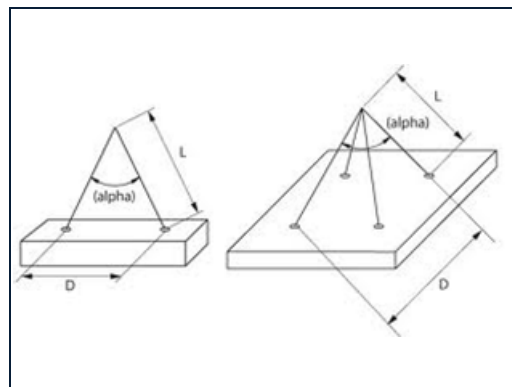
4. Sling angle

- If the slings are not vertical during the lifting, the force in the anchorages is weighted by the slinging coefficient from the table to the right.
- This coefficient depends on angle α , the angle at the apex of two diametrically opposed slings.
- With D = distance between the two diametrically opposed anchorages.

<i>Angle α</i>	<i>Sling length L</i>	<i>Slinging coefficient (ψ_e)</i>
0°	-	1
30°	2 D	1.04
45°	1.3 D	1.08
60°	D	1.16
90°	0.7 D	1.42
120°	0.6 D	2

5. Number of effective lifting points

- In a static system, the distribution of the loads in the slings depends on the positions of the anchorage points and on the tension in the slings; this is because, if the points are not perfectly symmetrical or if the slings are not all of the same length, some will not be taut. For this reason, when four-strand slings are used, only two effective lifting points are counted in the dimensioning.
- All of the lifting points placed are included in the calculation when a system that can distribute the loads over all of the anchorages is used (balancing lifting beam, slings with pulleys, etc.)



6. Determination of the forces applied to the anchorages

- The forces E_d , must be calculated using the following formula:

$$E_d = \frac{(G + q_{adh} \cdot A_f) \cdot \psi_{dyn} \cdot \psi_e}{N_{eff}}$$

Where :

- G : weight of the part (kN)
- Q_{adh} : adherence (kN/m²)
- A_f : shuttered area (m²)
- ψ_{dyn} : dynamic coefficient
- ψ_e : slinging coefficient
- N_{eff} : number of effective points

- It is sometimes necessary to calculate the forces applied to the anchorages in different stages of production in order to identify the worst case and choose the anchorages accordingly (handling in plant, lifting on site, tilting, etc.).

7. Conclusion

- The working load limit of the foot anchor and its break-out strength (see below) must always be greater than E_d .
- The strength of the concrete at the time of the different lifting steps (in plant and on site) must be taken into account when choosing the size and type of anchorage.
- A qualified individual must choose the anchorage and check its break-out strength in concrete.

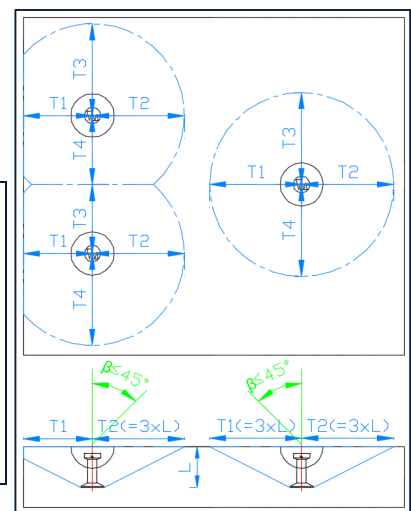
Pull-out strength of the anchors (tension)

When it is subjected to a tension ($\beta \leq 45^\circ$), a double head anchor exerts a pull-out load on a concrete compression cone: the larger the cone, the stronger the anchorage. It must systematically be checked that the pull-out strength in the concrete is greater than E_d , using Doctor Haeussler's third equation:

$$F_{max} = (0,217 \times \left(\frac{L}{10}\right)^2 \times \sqrt{\sin\left(\frac{30 \times T_1}{L}\right)} \times \sqrt{\sin\left(\frac{30 \times T_2}{L}\right)} \times \sqrt{\sin\left(\frac{30 \times T_3}{L}\right)} \times \sqrt{\sin\left(\frac{30 \times T_4}{L}\right)} \times (f_c/100)^{0,67}) / 2,5$$

Where:

- L : Length of anchor (mm)
- T_x : Radius of concrete cone breakout (mm)
- nota : T_x always $\leq 3 \times L$
- f_c : Strength of concrete at the time of use of the anchor (MPa)



Nota : For double head anchors, the minimum strength of the concrete is **10 MPa**.

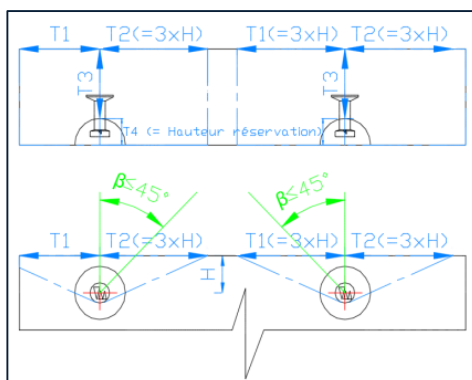
The table below indicates, for a given concrete, the tensile strength of the double head anchors **in the case of a complete concrete cone breakout ($T_1=T_2=T_3=T_4=3xL$)**:

Ancre		Admissible load (T) for a given strength of concrete (MPa)									
force (T)	L(mm)	10	12	14	16	18	20	25	30	35	40
1,3	35	0,23	0,26	0,28	0,31	0,34	0,36	0,42	0,47	0,53	0,58
	40	0,30	0,34	0,37	0,41	0,44	0,47	0,55	0,62	0,69	0,75
	50	0,46	0,52	0,58	0,64	0,69	0,74	0,86	0,97	1,07	1,17
	55	0,56	0,63	0,70	0,77	0,83	0,89	1,04	1,17	1,30	1,30
	65	0,78	0,89	0,98	1,07	1,16	1,25	1,30	1,30	1,30	1,30
	85	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30
	120	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30
	170	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30
2,5	45	0,38	0,42	0,47	0,51	0,56	0,60	0,69	0,78	0,87	0,95
	55	0,56	0,63	0,70	0,77	0,83	0,89	1,04	1,17	1,30	1,42
	65	0,78	0,89	0,98	1,07	1,16	1,25	1,45	1,64	1,81	1,98
	75	1,04	1,18	1,31	1,43	1,55	1,66	1,93	2,18	2,42	2,50
	85	1,34	1,51	1,68	1,84	1,99	2,13	2,48	2,50	2,50	2,50
	120	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50
	170	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50
	240	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50
5	280	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50	2,50
	75	1,04	1,18	1,31	1,43	1,55	1,66	1,93	2,18	2,42	2,64
	85	1,34	1,51	1,68	1,84	1,99	2,13	2,48	2,80	3,10	3,39
	95	1,67	1,89	2,10	2,29	2,48	2,66	3,09	3,50	3,88	4,24
	120	2,67	3,02	3,35	3,66	3,96	4,25	4,94	5,00	5,00	5,00
	180	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00
	240	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00
7,5	340	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00
	100	1,86	2,10	2,33	2,54	2,75	2,95	3,43	3,87	4,30	4,70
	120	2,67	3,02	3,35	3,66	3,96	4,25	4,94	5,58	6,19	6,76
	160	4,75	5,37	5,95	6,51	7,04	7,50	7,50	7,50	7,50	7,50
	165	5,05	5,71	6,33	6,92	7,49	7,50	7,50	7,50	7,50	7,50
	200	7,42	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50
	240	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50
7,5	300	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50

Ancre		Admissible load (T) for a given strength of concrete (MPa)									
force (T)	L(mm)	10	12	14	16	18	20	25	30	35	40
10	115	2,45	2,77	3,07	3,36	3,64	3,90	4,53	5,12	5,68	6,21
	135	3,38	3,82	4,24	4,63	5,01	5,38	6,25	7,06	7,83	8,56
	150	4,18	4,72	5,23	5,72	6,19	6,64	7,71	8,72	9,67	10,00
	170	5,36	6,06	6,72	7,35	7,95	8,53	9,91	10,00	10,00	10,00
	200	7,42	8,39	9,30	10,00	10,00	10,00	10,00	10,00	10,00	10,00
	250	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
	340	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
15	165	5,05	5,71	6,33	6,92	7,49	8,04	9,33	10,55	11,70	12,79
	200	7,42	8,39	9,30	10,17	11,01	11,81	13,72	15,00	15,00	15,00
	300	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00
	400	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00
20	200	7,42	8,39	9,30	10,17	11,01	11,81	13,72	15,50	17,18	18,79
	240	10,69	12,08	13,39	14,65	15,85	17,01	19,75	20,00	20,00	20,00
	250	11,60	13,11	14,53	15,89	17,20	18,45	20,00	20,00	20,00	20,00
	340	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
	500	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00	20,00
32	200	7,42	8,39	9,30	10,17	11,01	11,81	13,72	15,50	17,18	18,79
	500	32,00	32,00	32,00	32,00	32,00	32,00	32,00	32,00	32,00	32,00
	700	32,00	32,00	32,00	32,00	32,00	32,00	32,00	32,00	32,00	32,00

break-out strength of the anchors (shear)

When it is subjected to shear, a foot anchor again exerts a pull-out load on a concrete compression cone, which must always be checked using Doctor Haeussler's third equation: the formula remains the same but the parameters are modified (the length of the anchor is no longer included in the calculation)



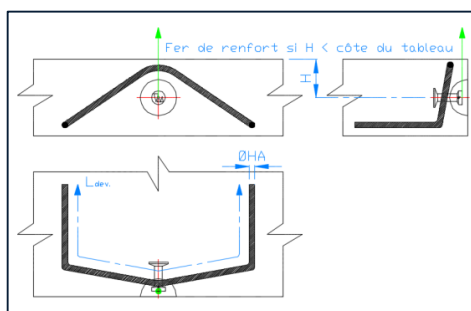
$$F_{max} = 0,217 \times \left(\frac{H}{10}\right)^2 \times \sqrt{\sin\left(\frac{30 \times T1}{H}\right) \times \sin\left(\frac{30 \times T2}{H}\right) \times \sin\left(\frac{30 \times T3}{H}\right) \times \sin\left(\frac{30 \times T4}{H}\right)} \times (f_c/100)^{0,67} / 2,5$$

Where:

- H : Distance from anchor axis to exposed upper surface of the concrete (mm)
- T_x: Radius of concrete breakout cone (mm)
- nota : T_x always ≤ 3xH
- f_c: Strength of the concrete at the time of use of the anchor (MPa)

Rebars

When the foot anchor is loaded in tension, no rebar is needed. For tilting, or use in shear, and if H is insufficient, a rebar must be placed (as indicated in the table below) to forestall cracking of the concrete :



Force (T)	H mini. (mm)	ØHA (mm)	L _{developed} (mm)
1.3	60	8	800
2.5	80	10	1120
5	100	14	1600
10	130	20	1750
20	180	32	2000

The information provided in this document is for guidance only and reflects our current knowledge. We shall not be responsible or liable for any improper or inappropriate use of our products.

Given the wide range of possible uses, our recommendations do not exempt users from carrying out their own tests. Our laboratory and technical department will be happy to provide you with any information you may require.

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