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ENDURA

PIN ANCHOR LIFTING SYSTEM

TECHNICAL MANUAL

END/PAS/DC/001

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ENDURA

PIN ANCHOR SYSTEM

The Pin Anchor System is used for lifting and handling precast concrete elements safely during transportation and erection. This system comprises a high-strength cast steel anchor, a matching rubber recess former, and a lifting clutch. The pin anchor system is specially made of forged foot and head to give best results and reliability. These are manufactured from high-strength steel. Long anchors are installed to achieve reduced edge spacing.

The advantages of Pin anchor Lifting system as below:

- Easy installation and release.
- An economical and effective lifting method.
- Safe, Simple and very efficient system for lifting and transporting elements.
- Time-saving and cost-effective.
- Ideal for beam or wall elements.
- Huge range of anchors and accessories for all types of precast elements.
- Durable clutch is resistant to abrasion.

Table of Content

1. INTRODUCTION

EP Lifting Anchors are manufactured using for precast concrete elements. These anchors are made of round steel bars with forged foot and head. These anchors are designed for various precast elements such as columns, walls, slabs, beams, manhole and staircase. These are available wide range of safe working load from 13kN to 320kN. Lifting angle of these anchors upto 45° or 90°. EP anchors are available in various lengths. Disc shaped foot is provided at the bottom end and is embedded in concrete. The load of the anchor is transferred to the concrete through the foot.

The Lifting Eye Anchor (EEP) are generally used for thin precast element. The Lifting Eye Anchor (EEP) is designed to transfer the entire anchor load through the reinforcement into the concrete. The additional reinforcement must be passed through the hole with bent at an angle 30°. These anchors are available in various lengths with different capacity. Lifting eye anchor are available in various material stainless steel, Electro-zinced, Acid resistant steel. These are available wide range of safe working load from 13kN to 320kN.

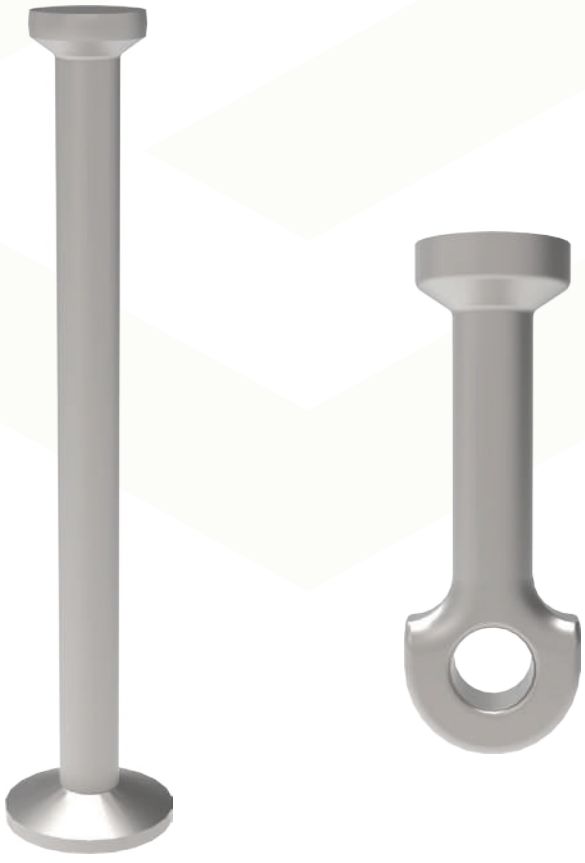


Figure: 1

The lifting clutch consists of a shackle and clutch head; the shackle is free to move in any direction. Once the lifting clutch head is placed into the recess and anchor head, the bolt prevents any movement of the lifting clutch head. Lifting clutches are used for lifting a wide range of precast concrete elements, such as walls, beams, columns, etc.

Figure 2. Pin Anchor lifting Devices

Figure 3. Pin Anchor lifting Accessories

Safety Features

The safety of the pin anchor lifting system has been verified through testing. Factor of safety for concrete is 2.1

2. PRODUCT SPECIFICATIONS

2.1. EP Lifting Insert Dimensions

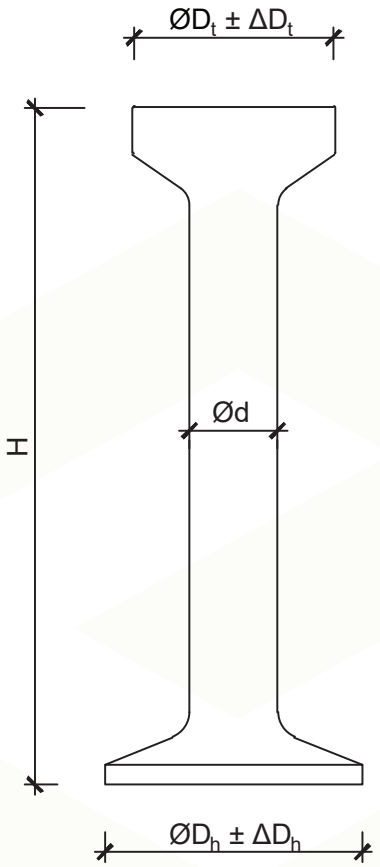


Figure 4. EP Lifting Insert

Table 2. EP Lifting Insert dimensions

Load Category	Size	H [mm]	ØDt [mm]	ΔØDt [mm]	ØDh mm]	ΔØDh [mm]	Ød [mm]	ΔØDh [mm]
1.3t	1.3-40	40	18	-0 /+0.8	25	-3/+2	10	-0.4/+0.5
	1.3-50	50	18		25		10	
	1.3-65	65	18		25		10	
	1.3-85	85	18		25		10	
	1.3-120	120	18		25		10	
	1.3-240	240	18		25		10	

Load Category	Size	H [mm]	ØDt [mm]	ΔØDt [mm]	ØDh mm]	ΔØDh [mm]	Ød [mm]	ΔØDh [mm]
2.5t	2.5-55	55	25	-0 /+0.8	35	-4/+2	14	-0.4/+0.8
	2.5-65	65	25		35		14	
	2.5-85	85	25		35		14	
	2.5-120	120	25		35		14	
	2.5-170	170	25		35		14	
	2.5-280	280	25		35		14	
4.0t	4.0-75	75	36	-1 /+0.8	45	-5 /+2	18	-0.4/+0.8
	4.0-100	100	36		45		18	
	4.0-120	120	36		45		18	
	4.0-170	170	36		45		18	
	4.0-210	210	36		45		18	
	4.0-340	340	36		45		18	
5.0t	5.0-85	85	36	-1 /+0.8	50	-5 /+2	20	-0.4/+0.8
	5.0-95	95	36		50		20	
	5.0-120	120	36		50		20	
	5.0-180	180	36		50		20	
	5.0-240	240	36		50		20	
	5.0-340	340	36		50		20	
	5.0-480	480	36		50		20	
7.5t	7.5-100	100	46	-0.5 /+1	60	-6 /+3	24	-0.4/+1
	7.5-120	120	46		60		24	
	7.5-140	140	46		60		24	
	7.5-165	165	46		60		24	
	7.5-200	200	46		60		24	
	7.5-300	300	46		60		24	
	7.5-540	540	46		60		24	
10.0t	10.0-115	115	46	-0.5 /+1	70	-6 /+3	28	-0.4/+1
	10.0-135	135	46		70		28	
	10.0-150	150	46		70		28	
	10.0-170	170	46		70		28	
	10.0-250	250	46		70		28	

Load Category	Size	H [mm]	ØDt [mm]	ΔØDt [mm]	ØDh mm]	ΔØDh [mm]	Ød [mm]	ΔØDh [mm]
10.0t	10.0-340	340	46	-0.5 /+1	25	-6 /+3	10	-0.4/+1
	10.0-680	680	46		25		10	
15.0t	15.0-140	140	69	-1 /+1	85	-8/+3.5	34	-0.4/+1
	15.0-165	165	69		85		34	
	15.0-200	200	69		85		34	
	15.0-300	300	69		85		34	
	15.0-400	400	69		85		34	
	15.0-840	840	69		85		34	
20.0t	20.0-200	200	69	-1 /+1	98	-9/+4	38	-0.5/+1.2
	20.0-240	240	69		98		38	
	20.0-250	250	69		98		38	
	20.0-340	340	69		98		38	
	20.0-500	500	69		98		38	
	20.0-1000	1000	69		98		38	
32.0t	32.0-320	320	88	-1.5/+0.5	135	-10/+5	50	-0.8/+1.2
	32.0-700	700	88		135		50	
	32.0-1200	1200	88		135		50	

2.2. EEP Lifting Insert Dimensions

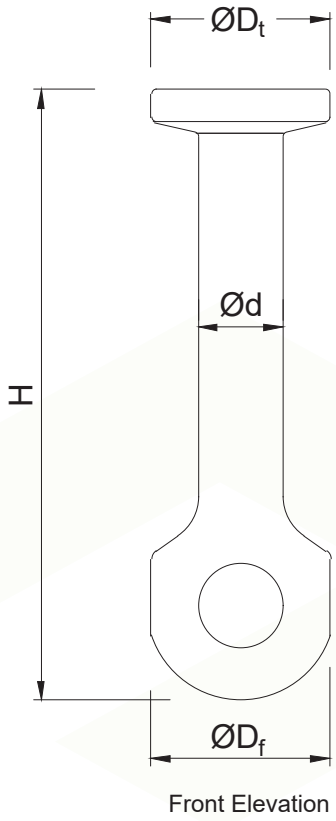


Figure 5. EEP Lifting Insert

Table 2. EP Lifting Insert dimensions

Load Category	H [mm]	ØDt [mm]	ØDf [mm]	Ød [mm]
EEP - 1.3 t	65	18	22	10
EEP - 2.5 t	90	25	32	14
EEP - 5.0 t	120	36	43	20
EEP - 10.0 t	180	46	57	28
EEP - 20.0 t	250	69	83	38
EEP - 32.0 t	300	88	100	50

2.3. Minimum concrete cover

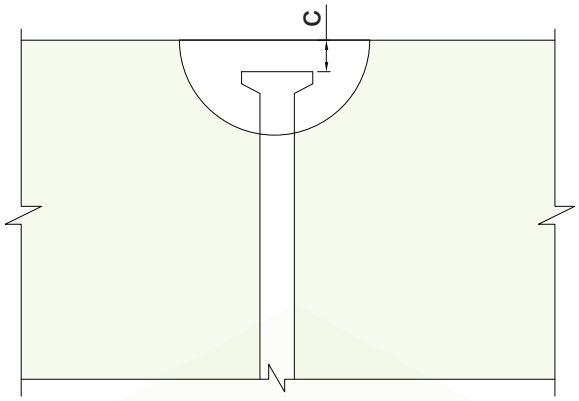


Table 3. Minimum concrete cover requirements for the pin anchor lifting system are specified in the following table :Load Category (t) | Minimum Concrete Cover (mm)

Load Category	c [mm]
1.3	10
2.5	11
4.0 - 20.0	15
32.0	23

2.4. Color classification scheme

The colour classification scheme simplifies the process of identifying each load category.

Table 1. Color classification for Pin anchor lifting system

Load Category	1.3	2.5	4.0	5.0	7.5	10.0	15.0	20.0	32.0
Colour	Canary Yellow	Ocean Blue	lemon chiffon	Light Salmon	Violet	Lawn Green	Rosy Brown	Aqua-marine	Forest Green

2.5. Product Markings

Usually, we mark the product to show information such as Load category , height of anchor, Product type and product manufacturing shown below figure :

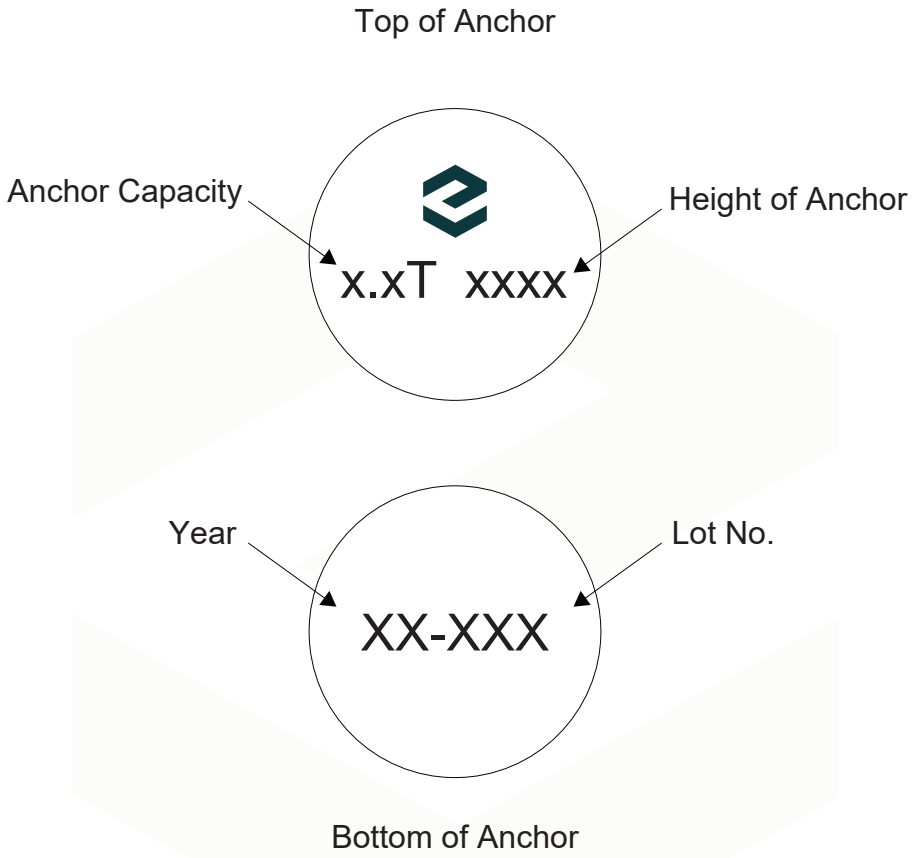


Figure. 6

2.6. Material

Table 5. Lifting Anchors are available in following materials.

Lifting	Material	Material Type	Standard
EP, EEP	S355J2	Electro Zinced	EN 10025
EPs, EEPs	1.4301	Stainless Steel	EN 10088
EPa, EEPa	1.4401	Acid Resistant Steel	EN 10088

3. DESIGN LOAD CAPACITY (SAFE WORKING LOADS)

The design of Lifting Anchors is according with European standards. Following European standards are - EN 1992, EN 1993, Machinery Directive 2006/42/EC, VDI/BV-BS 6205

Following Safety factors for failure are as below:

Steel Breakage of anchor	Concrete breakout (cone failure)
γs = 3.0	γc = 2.1

Safety factor 2.1 applies where the precast element is produced under plant-specific conditions. If a safety factor of 2.5 is to be used, then the design load capacity (safe working load) should be divided with factor of 2.1/2.5

The concrete is required to achieve a minimum compressive cube strength of 15 MPa prior to load application, and is treated as uncracked for the purposes of analysis.

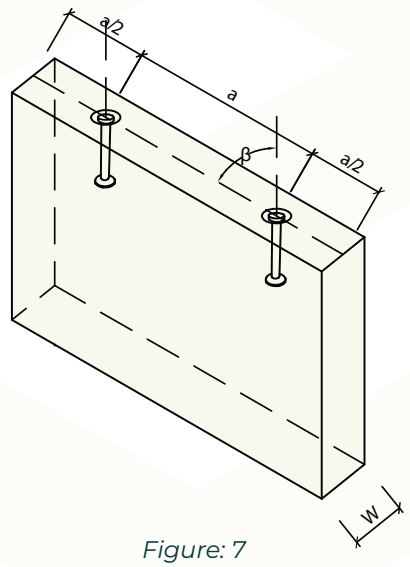


Figure: 7

Table 6: Safe Working Load (SWL) for EP Lifting Anchor in Wall Elements

Load Category	Lifting Anchor	Wall Thickness, W [mm]	Design Load Capacity (Safe Working Loads) β = 0° - 45°				γ = 0° - 90°			
			C12/15	C16/20	C20/25	C28/35	C12/15	C16/20	C20/25	C28/35
1.3t	1.3-85	60	10.33	11.94	13.00	13.00	5.16	5.97	6.50	6.50
		80	10.93	13.00	13.00	13.00	5.47	6.50	6.50	6.50
		100	11.54	13.00	13.00	13.00	5.77	6.50	6.50	6.50
	1.3-120	60	10.18	11.94	13.00	13.00	5.09	5.97	6.50	6.50
		80	10.64	13.00	13.00	13.00	5.32	6.50	6.50	6.50
		100	11.10	13.00	13.00	13.00	5.55	6.50	6.50	6.50

Load Category	Lifting Anchor	Wall Thickness, W [mm]	Design Load Capacity (Safe Working Loads)							
			β = 0° - 45°				γ = 0° - 90°			
			C12/15	C16/20	C20/25	C28/35	C12/15	C16/20	C20/25	C28/35
1.3t	1.3-240	60	9.52	11.94	13.00	13.00	4.76	5.97	6.50	6.50
		80	9.75	13.00	13.00	13.00	4.88	6.50	6.50	6.50
		100	9.99	13.00	13.00	13.00	4.99	6.50	6.50	6.50
2.5t	2.5-120	80	18.33	21.16	23.66	25.00	9.16	10.58	11.83	12.50
		100	19.12	22.08	24.68	25.00	9.56	11.04	12.34	12.50
		120	19.91	22.99	25.00	25.00	9.95	11.49	12.50	12.50
	2.5-170	80	19.43	22.44	25.00	25.00	9.72	11.22	12.50	12.50
		100	20.76	25.00	25.00	25.00	10.38	12.50	12.50	12.50
		120	21.41	25.00	25.00	25.00	10.71	12.50	12.50	12.50
	2.5-280	80	19.10	22.44	25.00	25.00	9.55	11.22	12.50	12.50
		100	19.51	25.00	25.00	25.00	9.75	12.50	12.50	12.50
		120	19.91	25.00	25.00	25.00	9.96	12.50	12.50	12.50
4.0t	4.0-170	120	31.37	36.22	40.00	40.00	15.69	18.11	20.00	20.00
		140	32.31	37.31	40.00	40.00	16.16	18.66	20.00	20.00
		160	33.26	38.40	40.00	40.00	16.63	19.20	20.00	20.00
	4.0-210	120	34.66	40.00	40.00	40.00	17.33	20.00	20.00	20.00
		140	35.55	40.00	40.00	40.00	17.77	20.00	20.00	20.00
		160	36.43	40.00	40.00	40.00	18.21	20.00	20.00	20.00
	4.0-340	100	31.48	36.36	40.00	40.00	15.74	18.18	20.00	20.00
		120	32.71	40.00	40.00	40.00	16.35	20.00	20.00	20.00
		140	33.27	40.00	40.00	40.00	16.63	20.00	20.00	20.00
5.0t	5.0-240	160	45.46	50.00	50.00	50.00	22.73	25.00	25.00	25.00
		180	46.45	50.00	50.00	50.00	23.23	25.00	25.00	25.00
		200	47.44	50.00	50.00	50.00	23.72	25.00	25.00	25.00
	5.0-340	120	41.78	49.31	50.00	50.00	20.89	24.65	25.00	25.00
		140	42.49	50.00	50.00	50.00	21.25	25.00	25.00	25.00
		160	43.20	50.00	50.00	50.00	21.60	25.00	25.00	25.00
	5.0-480	100	35.58	41.09	45.94	50.00	17.79	20.54	22.97	25.00
		120	40.57	49.31	50.00	50.00	20.28	24.65	25.00	25.00
		140	41.08	50.00	50.00	50.00	20.54	25.00	25.00	25.00

Load Category	Lifting Anchor	Wall Thickness, W [mm]	Design Load Capacity (Safe Working Loads)							
			β = 0° - 45°				γ = 0° - 90°			
			C12/15	C16/20	C20/25	C28/35	C12/15	C16/20	C20/25	C28/35
7.5t	7.5-200	160	39.97	46.16	51.60	61.06	19.99	23.08	25.80	30.53
		180	40.98	47.32	52.91	62.60	20.49	23.66	26.46	31.30
		200	42.00	48.49	54.22	64.15	21.00	24.25	27.11	32.08
	7.5-300	160	63.27	75.00	75.00	75.00	31.63	37.50	37.50	37.50
		180	64.43	75.00	75.00	75.00	32.21	37.50	37.50	37.50
		200	65.59	75.00	75.00	75.00	32.79	37.50	37.50	37.50
	7.5-540	140	58.56	69.00	75.00	75.00	29.28	34.50	37.50	37.50
		160	59.21	75.00	75.00	75.00	29.61	37.50	37.50	37.50
		180	59.87	75.00	75.00	75.00	29.93	37.50	37.50	37.50
10.0t	7.5-200	200	34.67	40.03	44.75	52.95	17.33	20.01	22.38	26.48
		240	36.54	42.19	47.17	55.81	18.27	21.10	23.59	27.91
		280	38.41	44.36	49.59	58.68	19.21	22.18	24.80	29.34
	7.5-200	200	55.17	63.71	71.23	84.28	27.59	31.85	35.61	42.14
		240	57.43	66.31	74.14	87.72	28.71	33.16	37.07	43.86
		280	59.68	68.91	77.04	91.16	29.84	34.46	38.52	45.58
	4.0-210	200	81.65	94.28	100.00	100.00	40.83	47.14	50.00	50.00
		240	84.27	97.30	100.00	100.00	42.13	48.65	50.00	50.00
		280	86.88	100.00	100.00	100.00	43.44	50.00	50.00	50.00
	4.0-340	160	81.40	94.00	100.00	100.00	40.70	47.00	50.00	50.00
		180	83.36	100.00	100.00	100.00	41.68	50.00	50.00	50.00
		200	84.10	100.00	100.00	100.00	42.05	50.00	50.00	50.00
15.0t	5.0-240	300	75.16	86.78	97.03	114.80	37.58	43.39	48.51	57.40
		400	81.29	93.86	104.94	124.17	40.64	46.93	52.47	62.09
		500	87.42	100.95	112.86	133.54	43.71	50.47	56.43	66.77
	5.0-340	300	107.65	124.31	138.98	150.00	53.83	62.15	69.49	75.00
		400	114.71	132.46	148.09	150.00	57.36	66.23	74.05	75.00
		500	121.77	140.61	150.00	150.00	60.88	70.30	75.00	75.00
	5.0-480	200	96.98	127.22	142.23	150.00	48.49	63.61	71.12	75.00
		220	97.68	130.24	150.00	150.00	48.84	65.12	75.00	75.00
		240	98.39	131.19	150.00	150.00	49.19	65.59	75.00	75.00

Load Category	Lifting Anchor	Wall Thickness, W [mm]	Design Load Capacity (Safe Working Loads)							
			β = 0° - 45°				γ = 0° - 90°			
			C12/15	C16/20	C20/25	C28/35	C12/15	C16/20	C20/25	C28/35
20.0t	20.0-340	400	93.72	108.22	121.00	143.17	46.86	54.11	60.50	71.58
		500	100.23	115.73	129.39	153.10	50.11	57.87	64.70	76.55
		600	106.73	123.24	137.79	163.04	53.37	61.62	68.90	81.52
	20.0-500	400	151.03	174.39	194.98	200.00	75.51	87.20	97.49	100.00
		500	158.89	183.47	200.00	200.00	79.44	91.73	100.00	100.00
		600	166.75	192.55	200.00	200.00	83.38	96.27	100.00	100.00
	20.0-1000	240	162.38	197.46	200.00	200.00	81.19	98.73	100.00	100.00
		260	163.37	200.00	200.00	200.00	81.69	100.00	100.00	100.00
		280	164.37	200.00	200.00	200.00	82.19	100.00	100.00	100.00
32.0t	32.0-320	450	92.32	106.61	119.19	141.03	46.16	53.30	59.59	70.51
		550	98.70	113.96	127.42	150.76	49.35	56.98	63.71	75.38
		650	105.07	121.32	135.64	160.49	52.53	60.66	67.82	80.25
	32.0-700	450	241.38	278.72	311.62	320.00	120.69	139.36	155.81	160.00
		550	250.70	289.49	320.00	320.00	125.35	144.74	160.00	160.00
		650	260.03	300.25	320.00	320.00	130.01	150.13	160.00	160.00
	32.0-1200	300	305.07	320.00	320.00	320.00	152.53	160.00	160.00	160.00
		350	320.00	320.00	320.00	320.00	160.00	160.00	160.00	160.00
		400	320.00	320.00	320.00	320.00	160.00	160.00	160.00	160.00

Capacities given in table above should be read in conjunction with information given in Clause 4 & 5.

Table 7. Safe Working Load (SWL) for EEP Lifting Insert in Wall Elements

Lifting Anchor	Safe Working Load, kN
	β = 0° – 30°
EEP - 1.3 t	13.0
EEP - 2.5 t	25.0
EEP - 5.0 t	50.0
EEP - 10.0 t	100.0
EEP - 20.0 t	200.0
EEP - 32.0 t	320.0

3.2 Slabs

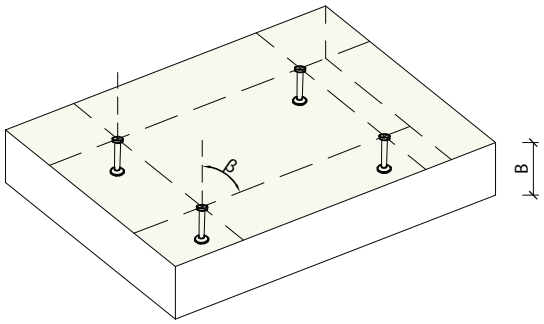


Figure: 8

Table 8: Safe Working Load (SWL) for EP Lifting Anchor in Slab Elements

Load Category	Lifting Anchor	Wall Thickness, W [mm]	Design Load Capacity (Safe Working Loads)			
			β = 0° - 45°			
			C12/15	C16/20	C20/25	C28/35
1.3t	1.3-40	70	6.97	8.04	8.99	10.64
	1.3-50	80	9.25	10.69	11.95	13.00
	1.3-65	95	13.00	13.00	13.00	13.00
	1.3-85	115	13.00	13.00	13.00	13.00
	1.3-120	150	13.00	13.00	13.00	13.00
	1.3-240	270	13.00	13.00	13.00	13.00
2.5t	2.5-55	86	10.48	12.10	13.52	16.00
	2.5-65	96	13.07	15.09	16.87	19.96
	2.5-85	116	18.79	21.70	24.26	25.00
	2.5-120	151	25.00	25.00	25.00	25.00
	2.5-170	201	25.00	25.00	25.00	25.00
	2.5-280	311	25.00	25.00	25.00	25.00
4.0t	4.0-75	110	17.00	19.63	21.95	25.97
	4.0-100	135	24.83	28.67	32.06	37.93
	4.0-120	155	31.77	36.69	40.00	40.00
	4.0-170	205	40.00	40.00	40.00	40.00
	4.0-210	245	40.00	40.00	40.00	40.00
	4.0-340	375	40.00	40.00	40.00	40.00
5.0t	5.0-85	120	20.01	23.11	25.84	30.57
	5.0-95	130	23.19	26.77	29.93	35.42
	5.0-120	155	31.77	36.69	41.02	48.53

Load Category	Lifting Anchor	Wall Thickness, W [mm]	Design Load Capacity (Safe Working Loads)			
			β = 0° - 45°			
			C12/15	C16/20	C20/25	C28/35
5.0t	5.0-180	215	50.00	50.00	50.00	50.00
	5.0-240	275	50.00	50.00	50.00	50.00
	5.0-340	375	50.00	50.00	50.00	50.00
	5.0-480	515	50.00	50.00	50.00	50.00
7.5t	7.5-100	135	24.17	27.91	31.20	36.92
	7.5-120	155	31.05	35.86	40.09	47.43
	7.5-140	175	38.49	44.44	49.69	58.79
	7.5-165	200	48.50	56.00	62.61	74.08
	7.5-200	235	63.75	73.62	75.00	75.00
	7.5-300	335	75.00	75.00	75.00	75.00
	7.5-540	575	75.00	75.00	75.00	75.00
10.0t	10.0-115	150	29.28	33.81	37.80	44.72
	10.0-135	170	36.58	42.24	47.22	55.87
	10.0-150	185	42.40	48.96	54.74	64.77
	10.0-170	205	50.59	58.42	65.31	77.28
	10.0-250	285	87.83	100.00	100.00	100.00
	10.0-340	375	100.00	100.00	100.00	100.00
	10.0-680	715	100.00	100.00	100.00	100.00
15.0t	15.0-140	175	37.91	43.78	48.94	57.91
	15.0-165	200	47.88	55.28	61.81	73.13
	15.0-200	235	63.07	72.83	81.43	96.34
	15.0-300	335	113.52	131.08	146.55	150.00
	15.0-400	435	150.00	150.00	150.00	150.00
	15.0-840	875	150.00	150.00	150.00	150.00
20.0t	20.0-200	235	62.39	72.04	80.55	95.31
	20.0-240	275	81.32	93.91	104.99	124.22
	20.0-250	285	86.31	99.67	111.43	131.84
	20.0-340	375	135.42	156.36	174.82	200.00
	20.0-500	535	200.00	200.00	200.00	200.00
32.0t	32.0-320	363	127.30	147.00	164.35	194.46

Capacities given in table above should be read in conjunction with information given in Clause 4 & 5.

4. MINIMUM ELEMENT THICKNESS AND SPACING OF ANCHORS

4.1 Walls

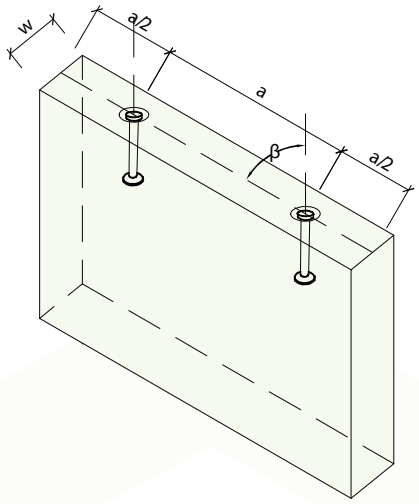


Figure: 9

Table 8: Safe Working Load (SWL) for EP Lifting Anchor in Slab Elements

Load Category	Lifting Anchor	Wall Thickness, W [mm]	Minimum Edge Distance, a/2 [mm]	Minimum Centre to Centre Distance, a [mm]
1.3t	1.3-85	60	140	280
	1.3-120	60	195	390
	1.3-240	60	375	750
2.5t	2.5-120	80	195	390
	2.5-170	80	270	540
	2.5-280	80	435	870
4.0t	4.0-170	120	275	550
	4.0-210	120	335	670
	4.0-340	100	530	1060
5.0t	5.0-240	160	380	760
	5.0-340	120	530	1060
	5.0-480	100	740	1480
7.5t	7.5-200	160	315	630
	7.5-300	160	465	930
	7.5-540	140	825	1650

Load Category	Lifting Anchor	Wall Thickness, W [mm]	Minimum Edge Distance, a/2 [mm]	Minimum Centre to Centre Distance, a [mm]
10.0t	10.0-170	200	270	540
	10.0-250	200	390	780
	10.0-340	200	525	1050
	10.0-680	160	1035	2070
15.0t	15.0-300	300	465	930
	15.0-400	300	615	1230
	15.0-840	200	1275	2550
20.0t	20.0-340	400	525	1050
	20.0-500	400	765	1530
	20.0-1000	240	1515	3030
32.0t	32.0-320	450	500	1000
	32.0-700	450	1070	2140
	32.0-1200	300	1820	3640

Table 10: Minimum Thickness & Spacing of Anchors for EEP Lifting for Wall

Load Category	Wall Thickness, W [mm]	Minimum Edge Distance, a/2 [mm]	Minimum Centre to Centre Distance, a [mm]
EEP - 1.3 t	80	195	390
EEP - 2.5 t	100	265	530
EEP - 5.0 t	120	380	760
EEP - 10.0 t	150	525	1050
EEP - 20.0 t	180	775	1550
EEP - 32.0 t	180	775	1550

4.2 Slabs

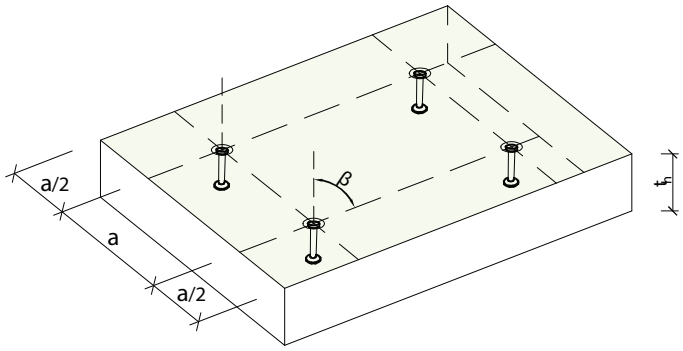


Figure: 10

Table 11: Minimum Thickness & Spacing of Anchors for EP Lifting for Slab

Load Category	Lifting Anchor	Slab Thickness, t_h [mm]	Minimum Edge Distance, a/2 [mm]	Minimum Centre to Centre Distance, a [mm]
1.3t	1.3-40	70	75	150
	1.3-50	80	90	180
	1.3-65	95	110	220
	1.3-85	115	140	280
	1.3-120	150	195	390
	1.3-240	270	375	750
2.5t	2.5-55	86	95	190
	2.5-65	96	110	220
	2.5-85	116	140	280
	2.5-120	151	195	390
	2.5-170	201	270	540
	2.5-280	311	435	870
4.0t	4.0-75	110	135	270
	4.0-100	135	170	340
	4.0-120	155	200	400
	4.0-170	205	275	550
	4.0-210	245	335	670
	4.0-340	375	530	1060
5.0t	5.0-85	120	150	300
	5.0-95	130	165	330
	5.0-120	155	200	400

Load Category	Lifting Anchor	Slab Thickness, t_h [mm]	Minimum Edge Distance, a/2 [mm]	Minimum Centre to Centre Distance, a [mm]
5.0t	5.0-180	215	290	580
	5.0-240	275	380	760
	5.0-340	375	530	1060
	5.0-480	515	740	1480
7.5t	7.5-100	135	165	330
	7.5-120	155	195	390
	7.5-140	175	225	450
	7.5-165	200	265	530
	7.5-200	235	315	630
	7.5-300	335	465	930
	7.5-540	575	825	1650
10.0t	10.0-115	150	190	380
	10.0-135	170	220	440
	10.0-150	185	240	480
	10.0-170	205	270	540
	10.0-250	285	390	780
	10.0-340	375	525	1050
	10.0-680	715	1035	2070
15.0t	15.0-140	175	225	450
	15.0-165	200	265	530
	15.0-200	235	315	630
	15.0-300	335	465	930
	15.0-400	435	615	1230
	15.0-840	875	1275	2550
20.0t	20.0-200	235	315	630
	20.0-240	275	375	750
	20.0-250	285	390	780
	20.0-340	375	525	1050
	20.0-500	535	765	1530
32.0t	32.0-320	363	500	1000

5. REINFORCEMENT

Reinforcement for Lifting Anchors is based on the assumption that the angle of lifting (β) lies between 0° – 45°. Angles greater than 45° are not allowed.

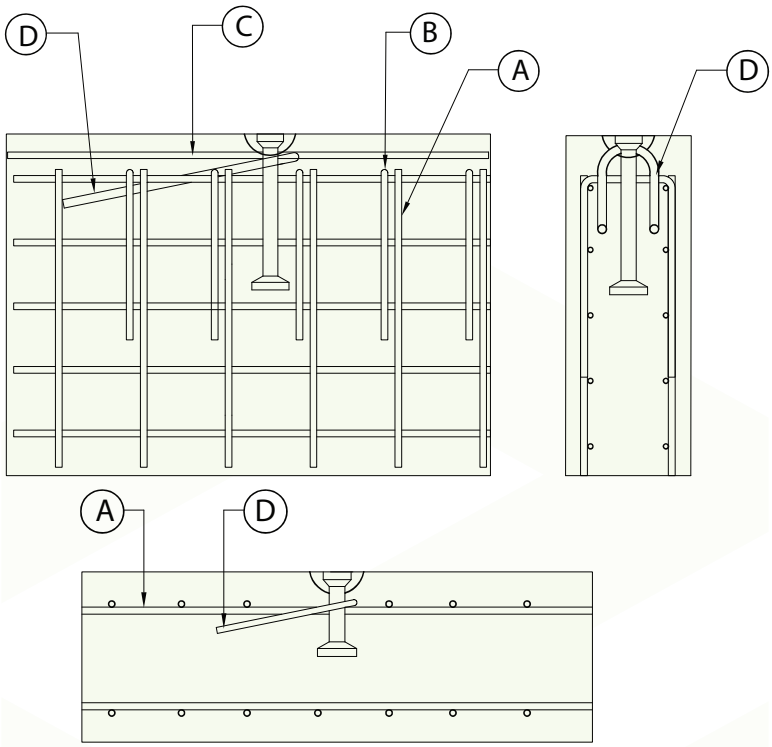


Figure: 11 Diagonal Reinforcement for EP lifting Anchor :

Table 12: Diagonal Reinforcement for EP lifting Anchor :

Load Category	Mesh Reinforcement, A [mm²/m]	Stirrup Reinforcement, B			Edge Reinforcement (both sides), C	Angle Pull Reinforcement, D (Ø - L)
		Pcs.	Diameter [mm]	Length [mm]		
1.3	2 x 80	2	6	400	10	8 – 895
2.5	2 x 100	2	8	500	10	10 – 1120
4.0	2 x 130	2	8	600	10	12 – 1350
5.0	2 x 140	2	10	700	12	16 – 1450
7.5	2 x 180	4	10	700	12	16 – 1590
10.0	2 x 200	4	10	700	12	20 – 1990
15.0	2 x 240	4	12	800	16	25 – 2255
20.0	2 x 350	6	12	1000	16	25 – 2655
32.0-700	2 x 500	8	12	1200	16	28 – 3425
32.0-1200				1700		

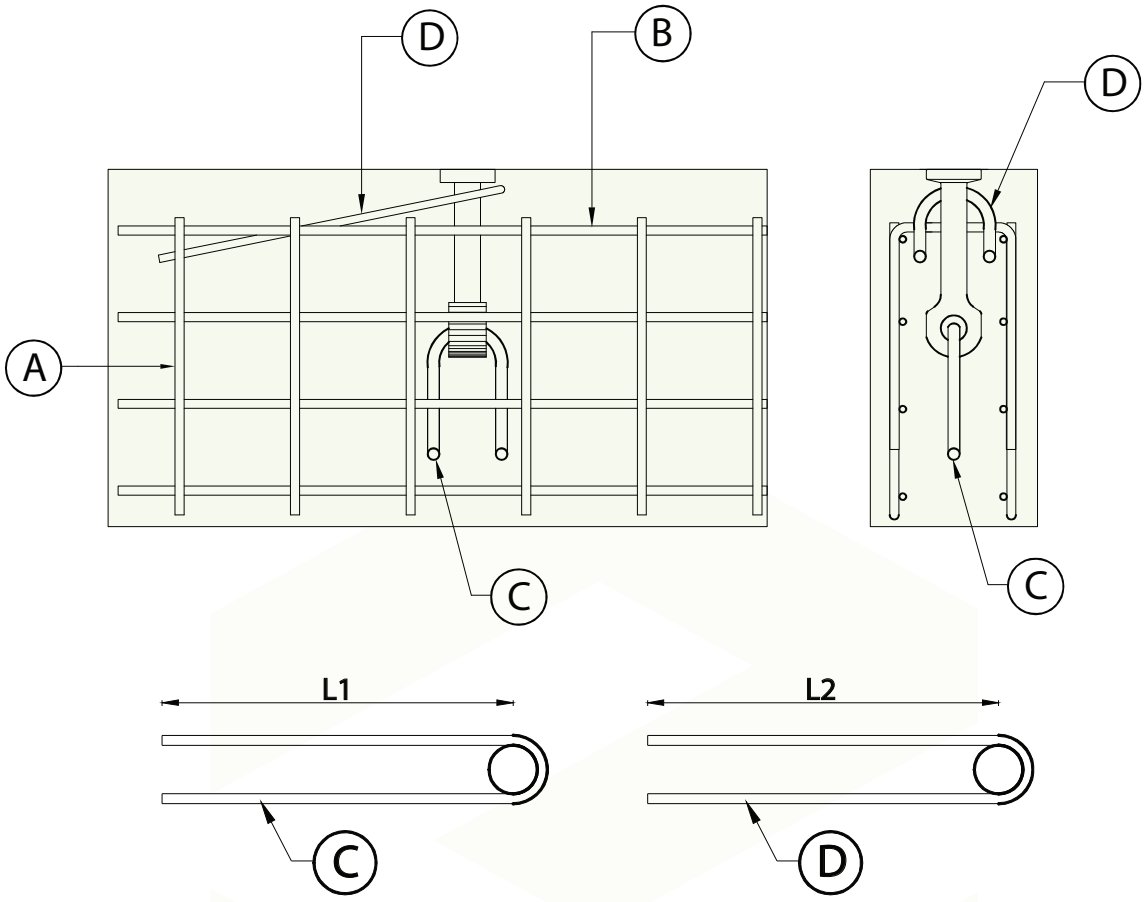


Figure: 12 Diagonal Reinforcement for EEP lifting Anchor :

Table 13: Diagonal Reinforcement for EEP lifting Anchor :

Lifting Anchor	Mesh Reinforcement A [mm2/m]	Edge Reinforcement (both sides) B	Diagonal pull Reinforcement, C (Ø – L1)	Diagonal pull Reinforcement, D (Ø – L2)
EEP -1.3	2 x 131	Ø8	Ø8 - 350	Ø8 - 375
EEP -2.5	2 x 188	Ø8	Ø12 - 550	Ø10 - 580
EEP - 2.5	2 x 188	Ø8	Ø12 - 550	Ø10 - 580
EEP -5.0	2 x 188	Ø10	Ø16 - 800	Ø16 - 780
EEP - 5.0	2 x 188	Ø10	Ø16 - 800	Ø16 - 780
EEP - 10.0	2 x 188	Ø10	Ø20 - 1000	Ø20 - 1220
EEP - 10.0	2 x 188	Ø12	Ø20 - 1000	Ø20 - 1220
EEP - 20.0	2 x 188	Ø12	Ø32 - 1500	Ø32 - 1750
EEP - 32.0	2 x 188	Ø14	Ø40 - 1900	Ø40 - 2440

Lateral pull reinforcement

Lateral pull reinforcement is a supplementary reinforcement arrangement installed around a lifting insert to resist forces that act at an oblique angle to the insert axis. These bars must be placed in direct contact with the recess former of the lifting insert, as any gap between the reinforcement and the former reduces the effectiveness of the load transfer. The lateral pull reinforcement specified in the table represents

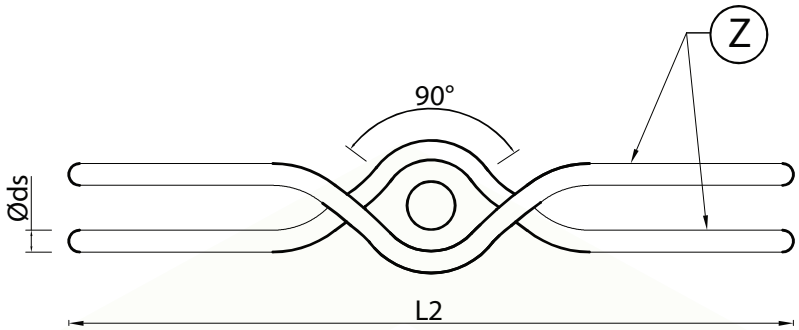


Figure: 13 Lateral Pull Reinforcement for Lifting Anchor :

Table 14: Lateral Pull Reinforcement for EP lifting Anchor :

Load Category	Diameter, Ø [mm]	Length, L [mm]
1.3	10	720
2.5	14	820
4.0	14	920
5.0	20	1020
7.5	20	1220
10.0	25	1520
15.0	25	1520
20.0	28	1820
32.0	28	1820

6. ACTIONS ON LIFTING ANCHOR

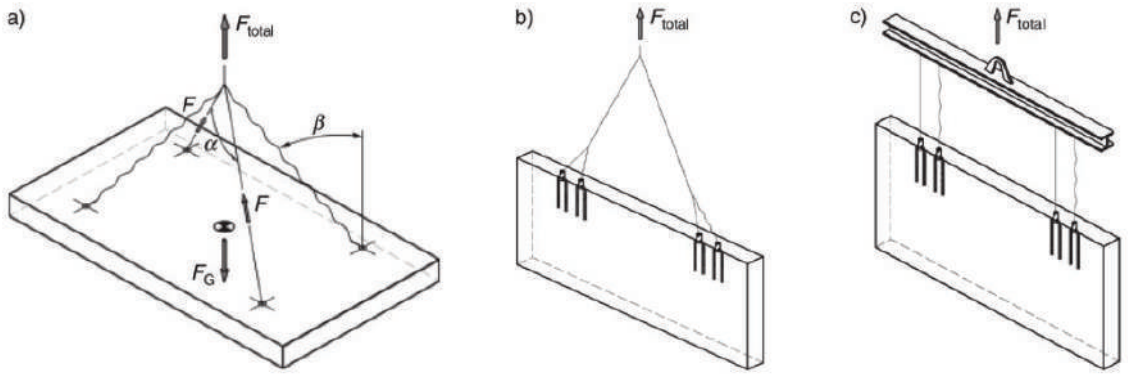
6.1 General

The loads acting on a lifting insert shall be determined considering the following factors:

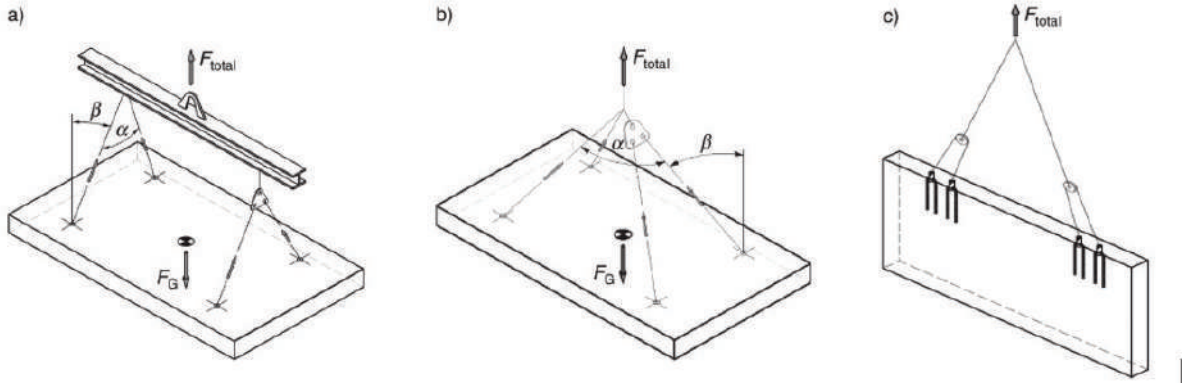
- Statical system
- Element self-weight
- Adhesion and form friction
- Dynamic effects
- Position and number of lifting inserts and type of lifting equipment

6.2 Statical System

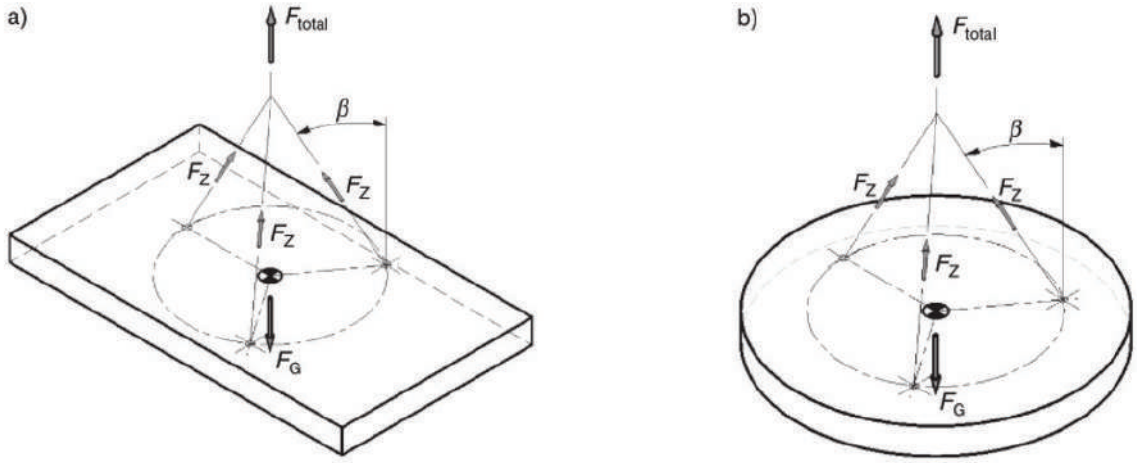
The lifting equipment shall allow a statically determinate load distribution to all present lifting inserts and lifting insert systems. Figures below give examples of statically indeterminate systems where only two lifting inserts carry the load. The load distribution is not clearly defined in these applications. Therefore, statically indeterminate systems shall be avoided.



To ensure a statically determinate system and that all lifting inserts carry their required part of the load in case of applications with more than two lifting inserts transport aids such as sliding or rolling couplings or balancing beams shall be used. In below figure, more transportation aids for slabs and wall elements are illustrated.



In case of inclined lifting slings the lifting inserts are loaded by combined tension and shear loads. The inclination β according to figure above (on previous page) governs the level of combined tension and shear loads to be taken into account in the design.
In the special case of three lifting inserts located in a slab located and situated in a star pattern with the same distance to the centre of gravity with equal inclinations of 120° it is ensured that all three lifting inserts experience the same load.



6.3 Self-Weight

The weight FG of precast elements shall be determined as given by equation below

$F_G = V \cdot \rho_G$

where,

F_G Weight of the precast element, in kN
V Volume of the precast element, in m3
ρ_G Density of the concrete, in kN/m3

6.4 Adhesion and Form Friction

Adhesion and form friction are assumed to act simultaneously during the lifting of the precast element from the formwork. The actions for demoulding situations shall be determined from equation below

$F_{adh} = q_{adh} \cdot A_f$

where,

F_{adh} Action due to adhesion and form friction, in kN
q_{adh} Basic value of combined adhesion and form friction as per Table below, in kN/m^2
A_f Contact area between concrete and formwork, in m^2

Formwork and Condition [a]	q_{adh} [b] kN/m²
Oiled steel mould, oiled plastic-coated plywood	≥ 1.0
Varnished wooden mould with panel boards	≥ 2.0
Rough wooden mould	≥ 3.0

[a] Structured surfaces should be considered separately.

[b] The area to be used in the calculations is the total contact area between the concrete and the form.

Note: The minimum values of Table above are valid only if suitable measures to reduce adhesion and form friction are taken e. g. casting on tilting or vibrating the formwork during the demoulding process.

6.5 Dynamic Actions

During lifting and handling of the precast elements, the lifting devices are subjected to dynamic actions. The magnitude of the dynamic actions depends on the type of lifting machinery. Dynamic effects shall be taken into account by the dynamic factor ψ_{dyn}. For further guidance values of ψ_{dyn} depending on the lifting machinery and characteristics of the terrain are given in table below.

Condition	Dynamic Factor ψ_{dyn}
Tower crane, portal crane, mobile crane	1.3
Lifting and moving on flat terrain	2.5
Lifting and moving on rough terrain	≥ 4

Note: Other values of ψdyn than given in Table above based on reproducible tests or verified experience can be used in the design. In case of other lifting and handling conditions than reported in Table above the factor ψdyn shall be determined on the base of tests or engineering judgement.

6.6 Distribution of Load for Asymmetrical Elements

For non-symmetrical installation of lifting anchors (using spreader beam only), the load distribution is as in the equations below.

FA = FG . b / (a + b)

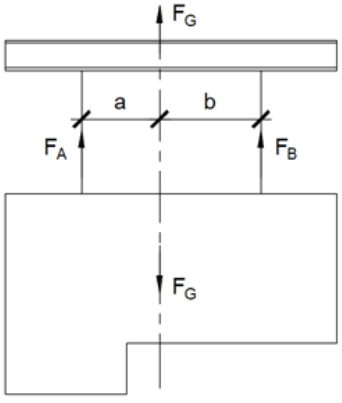
FB = FG . a / (a + b)

where,

FG Weight of the pre-cast element, in kN

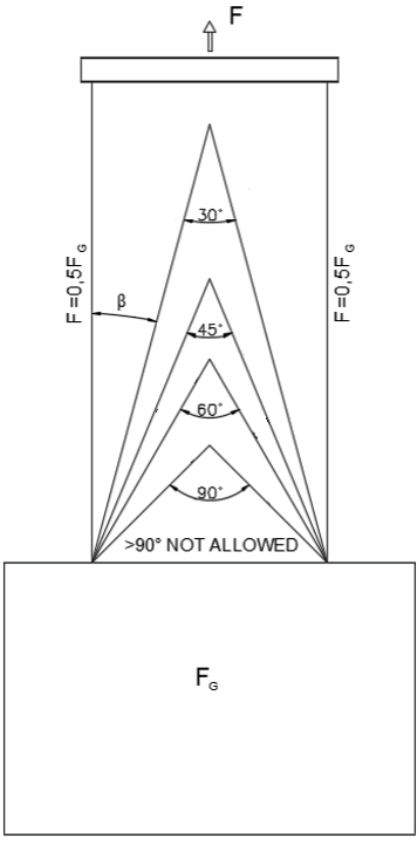
a Distance from insert A to centre of gravity, in m

b Distance from insert B to centre of gravity, in m



6.7 Spread Angle

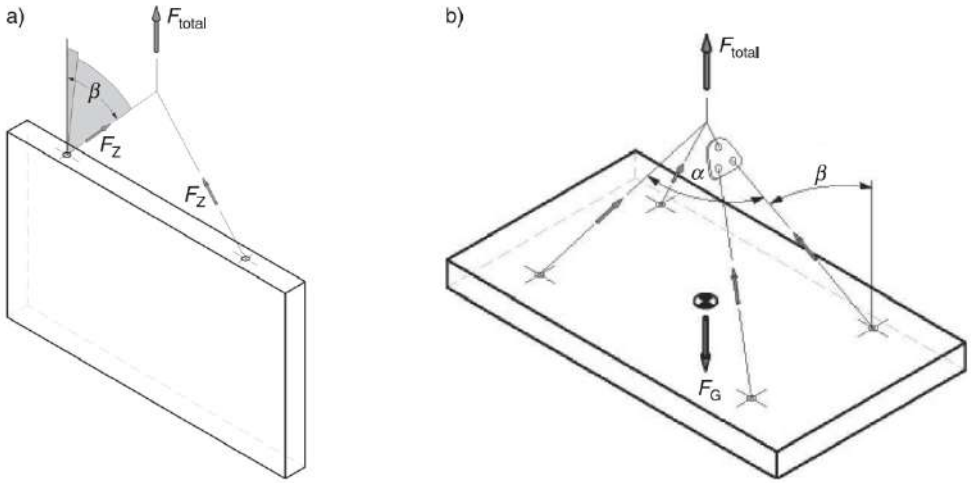
Cable Angle β	Spread Angle α	Load Factor z
0°	-	1.00
7.5°	15°	1.01
15°	30°	1.04
22.5°	45°	1.08
30°	60°	1.15
37.5°	75°	1.26
45°	90°	1.41



6.8 Number and Actions of Lifting Anchors

The number of and the load acting on the lifting insert shall be determined corresponding with the individual lifting situations in accordance with Equations given in the different situations below. The most unfavorable relation from action to resistance resulting from these equations governs the design.

6.8.1 Load condition “erection in combination with adhesion & form friction”



It is assumed that the precast element does not rest one-sided on the form. Then the action FQ is:

$F_Q = (F_G + F_{adh}) \cdot z/n$

where,

F_Q Load acting on the lifting insert, in kN

F_G Weight of the precast element

F_{adh} Action due to adhesion and form friction

z Factor for combined tension and shear, $z = 1/\cos \beta$

In case of tension: z = 1.

n Number of load carrying lifting inserts

6.8.2 Load condition “erection”

It is assumed that the precast element rests one-sided on the form. Then the action FQ is:

$F_Q = (F_G/2) \cdot \psi_{dyn} /n$

where,

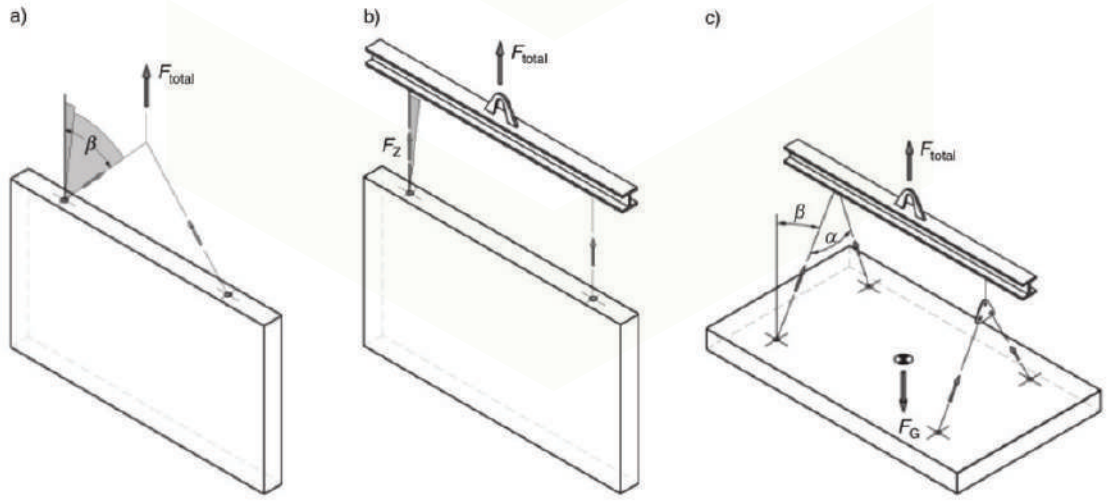
F_Q Shear load acting on the lifting insert (shear) directed perpendicular to the longitudinal axis of the concrete component

F_G Weight of the precast element

ψ_{dyn} Dynamic factor

n Number of load carrying lifting inserts

6.8.3 Load condition “lifting and handling under combined tension & shear”



The load condition is shown in the figure below. The action FZ is:

$F_Z = F_G \cdot \psi_{dyn} \cdot z/n$

where,

F_Z Load acting on the lifting insert in direction of the sling axis, in kN

F_G Weight of the precast element

ψ_{dyn} Dynamic factor as per Dynamic Actions table (Section 7.5)

z Factor for combined tension and shear, $z = 1/\cos \beta$

In case of tension: z = 1.

n Number of load carrying lifting inserts

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