FASTEINING PLATE SYSTEM
TECHNICAL MANUAL

EXM-FP-DC-1003 R0 - 12.12.2021

TABLE OF CONTENTS

1. Introduction
2. Product Specification
    2.1. Dimensions
        2.1.1. EFPR Lifting Insert Dimensions
    2.2. Materials
3. Resistances
    3.1. Design Resistances (without supplementary reinforcement)
    3.2. Resistance for combined load effects
    3.3. Fastening area
    3.4. Effect of edge and center distance on resistances
4. Minimum Dimension Requirements
    4.1. Minimum allowable edge and center distance
    4.2. Minimum thickness of base concrete
5. ADDITIONAL REINFORCEMENT REQUIREMENTS
    5.1. Additional reinforcement for tensile and bending resistance
    5.2. Additional reinforcement for shear and torsion resistance

1. Introduction

Fastening plate are used for connection between steel and concrete members through welding. There are two parts, one is steel plate, and another is steel stud welded on the plate, which is then cast into the concrete. They transfer the load from plate to the concrete structure through welded studs.

2. Product Specification

2.1.1. EFPR Lifting Insert Dimensions

Figure 1.

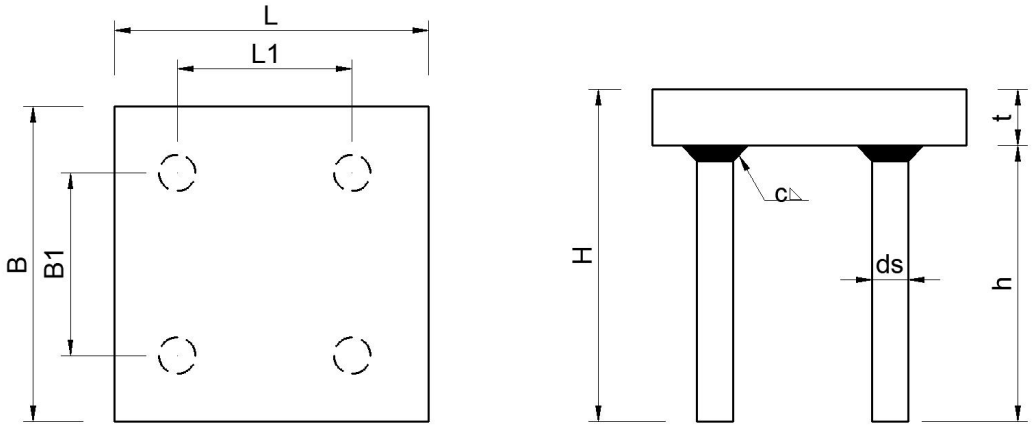

Table 1. Dimensions of EFPR fastening plates

L x B	H	B1	L1	t	ds	h	c
[mm] x [mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
EFPR 100x50	218	0	60	8	12	210	5
EFPR 100x100	218	60	60	8	12	210	5
EFPR 150x100	220	60	90	10	12	210	5
EFPR 150x150	222	90	90	12	16	210	7
EFPR 200x100	222	60	120	12	16	210	7
EFPR 200x200	312	120	120	12	20	300	8
EFPR 250x250	315	150	150	15	20	300	8
EFPR 300x100	315	60	180	15	20	300	8
EFPR 300x200	315	120	180	15	20	300	8
EFPR 300x300	315	180	180	15	20	300	8

2.2. Materials

Fastening plate are available in following materials.

Table 2. Materials of EFPR fastening plate

Type	Component	Material	Standard
EFPR	Steel plate	S355J2+N	SFS-EN 10025
	Anchor	B500B	SFS-1300
		BSt 500 S	DIN 488
EFPRs	Steel plate	1.4301	SFS-EN 10088
	Anchor	B500B	SFS-1300
		BSt 500 S	DIN 488
EFPRa	Steel plate	1.4401	SFS-EN 10088
	Anchor	B500B	SFS-1300
		BSt 500 S	DIN 488

3. Resistances

3.1. Design Resistances (without supplementary reinforcement)

The resistances of EFPR fastening plate have been calculated according to the following guidelines:

- SFS-EN 1992-4:2018 (Design of fastenings for use in concrete)
- SFS-EN 1992 (Eurocode 2 Design of concrete structures)
- SFS-EN 1993 (Eurocode 3 Design of steel structures)

The resistances have been calculated for concrete strength of C25/30 with respect to static loads. The design takes into consideration a tolerance of ± 15 mm for the location where load is max.

Figure 2.

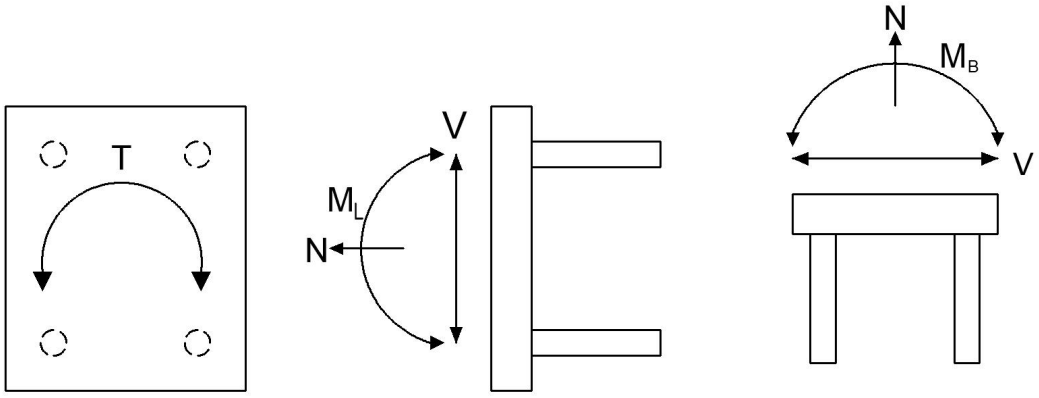

Table 3. Resistances of EFPR fastening plates without additional reinforcement

LxB	H	N	V	M_B	M_L	T
[mm] x [mm]	[mm]	[kN]	[kN]	[kNm]	[kNm]	[kNm]
EFPR 100x50	218	15.0	17.2	0.5	1.2	0.5
EFPR 100x100	218	39.2	35.0	2.5	2.5	2.0
EFPR 150x100	220	45.0	35.0	2.7	4.4	2.5
EFPR 150x150	222	73.0	71.0	6.4	6.4	5.5
EFPR 200x100	222	58.5	62.2	3.4	7.4	5.9
EFPR 200x200	312	158	119.3	16.4	16.4	12.0
EFPR 250x250	315	195.6	124.5	24.5	24.5	15.1
EFPR 300x100	315	110.0	97.3	6.1	19.5	13.5
EFPR 300x200	315	170.0	119.3	17.4	26.5	15.5
EFPR 300x300	315	207.5	128.4	31.0	31.0	18.4

The values in table 1 are maximum resistances of EFPR fastening plates for individual load effects. The maximum resistances given are values for concrete structures with minimum reinforcement and fastening plate locations according to tables 5 without additional reinforcement.

3.2. Resistance for combined load effects

If multiple load effects act simultaneously on EFPR fastening plate the resistance of the fastening plate shall be checked according to the following formula.

$$\left(\frac{N_{Ed}}{N_{Rd}}+\frac{M_{EdB}}{N_{RdB}}+\frac{M_{EdL}}{N_{RdL}}\right)^{\frac{4}{3}}+\left(\frac{V_{EdB}}{V_{Rd}}+\frac{V_{EdL}}{V_{Rd}}+\frac{T_{Ed}}{T_{Rd}}\right)^{\frac{4}{3}} \leq 1{,}0 \qquad (2)$$

Where subscript Ed means the ultimate limit state value for the dimensioning value of the load effect and Rd the corresponding resistance of the fastening plate.

3.3. Fastening area

When using resistances given in table 3, the fastening areas of the steel components to be attached on the EFPR fastening plates shall have minimum values according to table 4.

Table 4. Minimum fastening areas of EFPR fastening plates

EFPR		Minimum Fastening Area			
		EFPR		EFPRs, EFPRa	
L x B	H	L	B	L	B
[mm] x [mm]	[mm]	[mm]	[mm]	[mm]	[mm]
EFPR 100x50	218	65	20	60	20
EFPR 100x100	218	70	70	75	75
EFPR 150x100	220	85	45	95	60
EFPR 150x150	222	75	75	95	60
EFPR 200x100	222	110	45	130	65
EFPR 200x200	312	120	120	130	130
EFPR 250x250	315	130	130	150	150
EFPR 300x100	315	180	40	190	60
EFPR 300x200	315	160	80	180	110
EFPR 300x300	315	150	150	175	175

If the fastening area of the component to be mounted on the fastening plate is smaller than value given in table 3, the resistances of RJKL fastening plate need to be reduced according to formula as below

$$N_{Red.} = N \times \frac{(c-a_0)}{(c-a_1)}$$

where,

$N_{Red.}$= Reduced value of resistance

N - Actual value of resistance as per table 3

C - Center-to-center distance between anchor studs

a_0 - Length of minimum fastening area (table 3)

a_1 - Length of actual fastening area ($a_0 > a_1$)

4. Minimum dimension requirements

4.1. Minimum allowable edge and center distance

Minimum edge distance of fastening plates in concrete element for resistances given in table 6 are mentioned in the tables below.

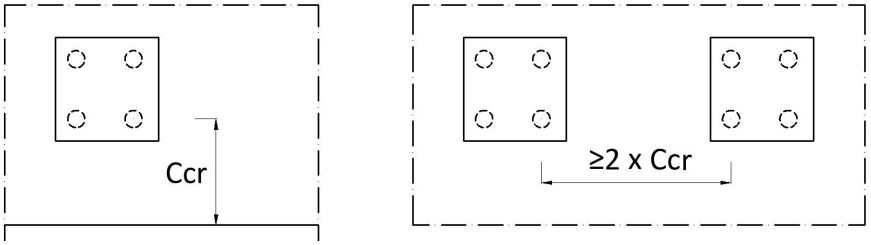

Figure 3. The edge distance c_{cr} of EFPR fastening plate from the edge of the concrete structure and the center distance between adjacent fastening plates.

Table 5. Min. edge distances of EFPR fastening plates for reduction factors as per table 5

Fastening Plate						Minimum edge distances for reduction factors of N, M_L and M_B	Minimum edge distances for reduction factors of V and T
EFPR	L	x	B	-	H	$c_{cr.min}$ [mm]	$c_{cr.min}$ [mm]
EFPR	100	x	50	-	218	45	105
EFPR	100	x	100	-	218	45	105
EFPR	150	x	100	-	220	45	105
EFPR	150	x	150	-	222	60	140
EFPR	200	x	100	-	222	60	140
EFPR	200	x	200	-	312	75	175
EFPR	250	x	250	-	315	75	175
EFPR	300	x	100	-	315	75	175
EFPR	300	x	200	-	315	75	175
EFPR	300	x	300	-	315	75	175

4.2. Minimum thickness of base concrete

Minimum thickness of concrete element for resistances are mentioned in the tables below. With smaller thicknesses of the base, the resistances of EFPR fastening plates need to be reduced.

4.3. Resistance for combined load effects

If multiple load effects act simultaneously on EFPR fastening plate the resistance of the fastening plate shall be checked according to the following formula.

$$\left(\frac{N_{Ed}}{N_{Rd}} + \frac{M_{EdB}}{N_{RdB}} + \frac{M_{EdL}}{N_{RdL}}\right)^{\frac{4}{3}} + \left(\frac{V_{EdB}}{V_{Rd}} + \frac{V_{EdL}}{V_{Rd}} + \frac{T_{Ed}}{T_{Rd}}\right)^{\frac{4}{3}} \leq 1{,}0 \qquad (2)$$

Where subscript Ed means the ultimate limit state value for the dimensioning value of the load effect and Rd the corresponding resistance of the fastening plate.

4.4. Effects of edge and center distances to resistance

If the center or edge distances are smaller than the values , the resistance values of the fastening plates according to section 4.2 need to be reduced. With smaller edge distances, the dimensioning values of shear and torsional moment resistances need to be reduced such that when the edge distance is 1,5 x anchor diameter, the resistance is 0 kN / kNm. Intermediate values can be interpolated linearly.

4.5. Effects of additional reinforcement on edge distances

In positioning a KL fastening plate with additional reinforcement edge distances according to table 5 and reduction factors according to section 4.4 must be used.

4.6. Effects of additional reinforcement on resistances

Additional reinforcement does not increase resistances of KL fastening plates. In location of a KL fastening plate additional reinforcement must always be installed to guarantee ductile action of the structure in ultimate limit state. Amount of reinforcement needed to make the structure ductile can be calculated according to the formula

As = additonal reinf. $= \frac{fck}{fu}$

Fck = characteristic value of the corresponding dimensioning load effect fu = characteristic strength of additional reinforcement

Additional reinforcement is installed in direction of the corresponding force and as close as possible to the anchors and steel plate of EFPR fastening plate. The additional reinforcement is anchored according to SFS-EN 1992