DEVICES WITH CE MARKING

ELASTOFIP BEARINGS

FIP INDUSTRIALE
leading technologies

• UK -- KINGSTON BRIDGE

INTRODUCTION

CERTIFICATIONS

FIP Industriale is proud to be the first Italian manufacturer of structural bearings, anti-seismic devices and expansion joints boasting a Quality Assurance System certified at the highest level – from design to customer service assistance. Certification has been achieved via rigorous evaluation by an internationally recognized Third Party Organisation, thus internationally validating the quality assurance system. **FIP Industriale** designs and manufactures its devices in accordance with the most widely adopted and stringent international specifications: EN, AASHTO, CNR, British Standards, DIN, NF. Moreover, **FIP Industriale** meets the most recent requirements by supplying bearings and anti-seismic devices with CE marking.

OHS 618800

The certification ISO 9001, obtained in 1992, guarantees that the same quality level is kept from the design stage through manufacture to installation, while the Certificate OHS 618800 guarantees that **FIP Industriale** operates an Occupational Health and Safety Management System which complies with the requirements of BS OHSAS 18001:2007. **FIP Industriale**'s quality system is also certified to perform welding activities in accordance with EN ISO 3834-2 and DIN 18800-7.

PRODUCT

Fixed Elastofip type **EF** are structural bearings of reinforced elastomer, fixed on the upper and lower structure by means of mechanical anchors. They are made up of an elastomer core into which one or more steel sheets are inserted, these are united to the rubber through vulcanization.

The steel sheets produce a vertical stiffening effect (axial) and simultaneously reduce the bulging rubber. The vulcanization has the dual purpose of transmitting the tangential actions from the rubber to the sheet and of ensuring the steel's protection from corrosion.

Fixed Elastofip bearings (**EF**) create a type of intermedial bond between the fixed-type devices and those of the mobile type, allowing deformations in any direction horizontally, but at the same time generating elastic reactions of an intensity proportional to the deformations.

Also part of the same **Elastofip** series, though not dealt with here, are the **EM** (**Multidirectional Elastofip**) movable type bearings and **EU/EU*** (**longitudinal/transversal Unidirectional Elastofip**), in which the required movements are obtained through the mutual sliding of flat surfaces in contact with each other; one surface is made of stainless steel, the other of PTFE.

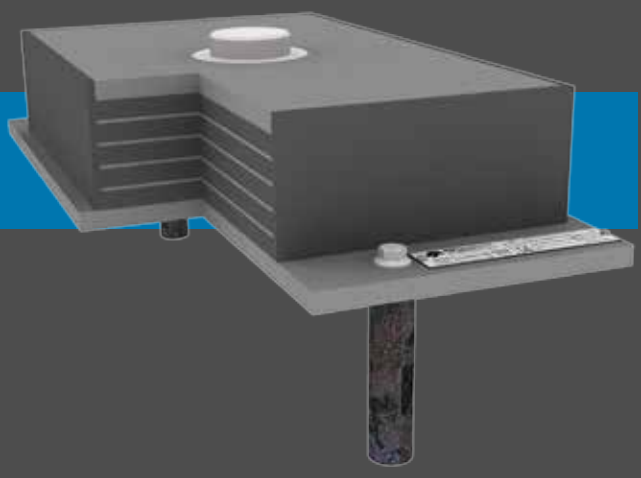
CLASSIFICATION

Fixed Elastofip bearings are classified with the abbreviation **EF** followed by two groups of figures that indicate respectively:

- vertical load in kN/10 (tons)
- horizontal load in kN/10 (tons)

The loads and forces are the Ultimate Limit State (ULS). Example:

EF 600-30 **Fixed Elastofip** bearing with a 6000 kN vertical load, that withstands a horizontal load of 300kN.



DESCRIPTION

Fixed Elastofip bearings consist of:

- a central core of reinforced elastomer, comprising at the top a steel plate which acts as a support for a central anchor pin;
- a vulcanized steel plate below the core, acting as a support for two or more lower anchor bars.

ANCHORING SYSTEMS

"In the case of dynamically stressed structures where extreme load fluctuations can occur, e.g. railway bridges and earthquakes, the horizontal forces shall not be resisted by friction." (EN 1337-1)

This means that only in a non-seismic area can one try to avoid the mechanical anchoring, entrusting the anchoring of the bearing to the super- or sub-structure to friction alone, since the relationship between the horizontal forces and the concomitant vertical loads prove sufficiently low. The various types of upper mechanical anchoring indicated below represent the majority of the cases that occur.

STEEL STRUCTURE

1. Shear pin in counterplate

The bearing will have a constant thickness because possible slopes of the deck are taken up by the counter plate.

PRECAST CONCRETE STRUCTURE

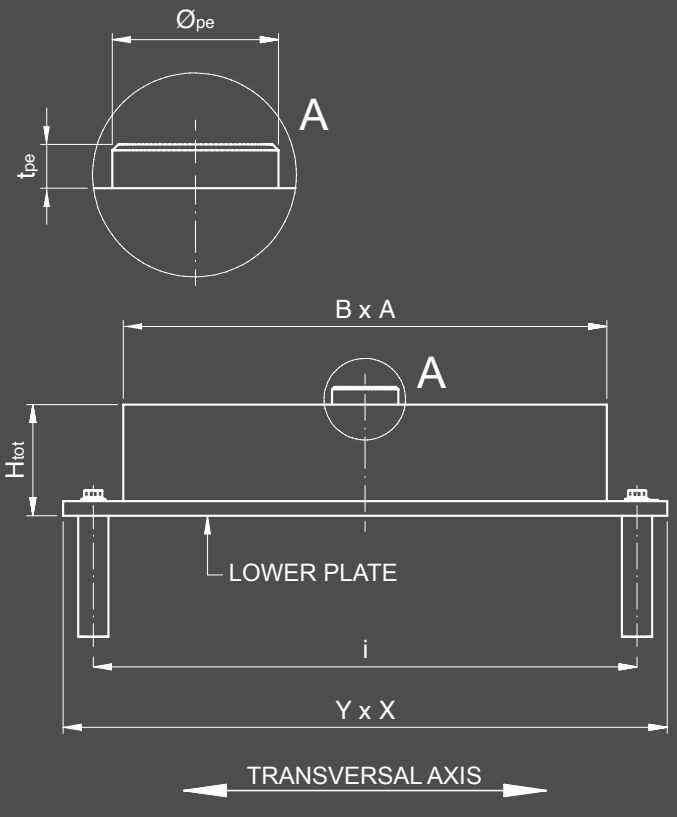
1. Shear pin in counterplate

In the case of longitudinal and/or transverse slopes of the lower deck, usually the upper element of the bearing is in a wedge-shaped, so that the sliding surfaces inside the support are perfectly horizontal.

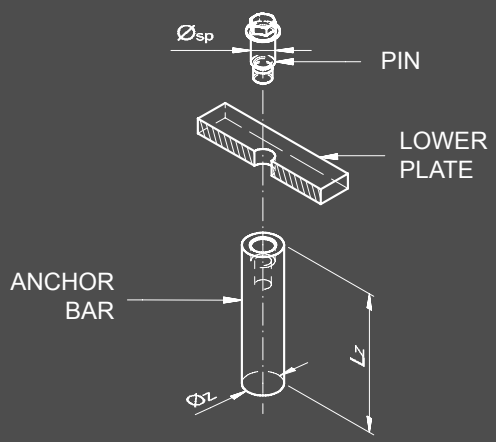
CAST *IN-SITU* STRUCTURE

1. Shear pin in counterplate

The bearing will have a constant thickness because possible slopes of the deck are taken up by the upper casting.



TYPICAL ANCHOR BAR	$Ø_{sp}$ (mm)	$Ø_z$ (mm)	L_z (mm)
1	14	25	100
2	20	35	140
3	30	55	220
4	54	100	400

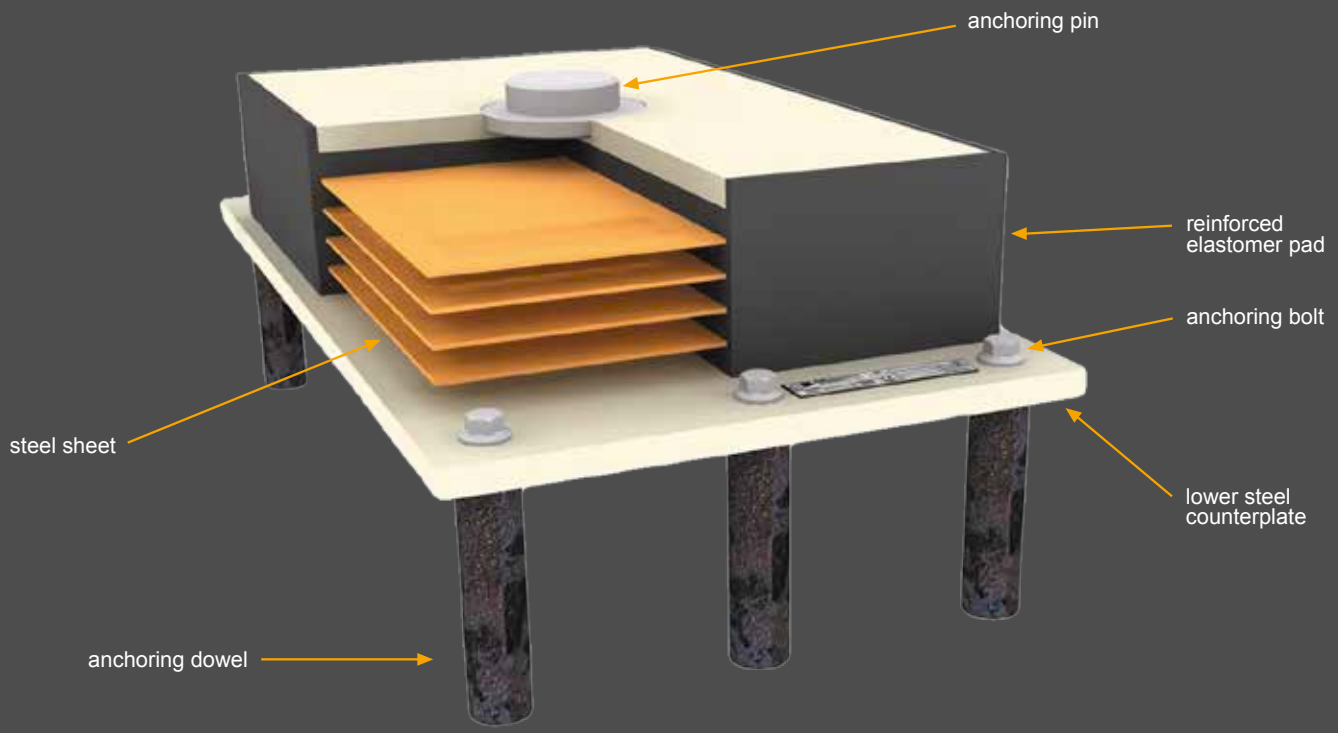


Lower, mechanical anchoring is carried out by means of steel anchor bars embedded in concrete.

More rarely metal counterplates are necessary, in which case the connecting pins or screws will be provided together with them.

BEARING COMPONENTS

ELEMENTS



Referring to the illustrative sketch, it is suggested that, in the case of a bearing with two anchoring dowels, these be placed on the transversal axis of the bearing; where there are four, they should be placed at the corners; in the case of six they should be placed as they are shown in the sketch.

If there are more than six dowels, we nevertheless recommend arranging them symmetrically with respect to the axes.

MATERIALS

The bearings in the catalogue are designed according to European standard EN 1337-3, in which they are classified as type C bearings.

The elastomer which forms the core is made of natural rubber (NR) or chloroprene rubber (CR), with a hardness of 60±5 Sh/A.

On the inside, reinforcing plates class S355 or higher steel, with a minimum thickness of 2 mm. The anchoring counterplates are made of class S275 or higher steel.

ACCESSORIES

Each bearing is equipped with an identification label which shows the main information about the device.

INDICATIONS

"Although elastomeric bearings are designed to accomodate shear movements, they shall not be used to provide permanent resistence to a constantly applied external shear force" (EN1337-3).

This means, for example, that in the classic types of bridges elastomeric bearings must be placed horizontally on the plane, even if the deck is sloped.

CORROSION PROTECTION

The corrosion protection follows the guidelines set out in EN 1337-9. Excepting special requests, the final coat of the bearings is light gray (RAL 7035).

HANDLING

The bearing is delivered assembled. To move the bearings when they are packed, use pallets, properly sling them and lift them using suitable mechanical equipment (cranes, forklifts).

STORAGE

Bearings are delivered assembled and ready for installation. In the event that they are not installed immediately, it is the responsibility of the Customer to arrange for their proper storage so as to avoid mechanical damage and deleterious effects caused by dust, dirt, moisture, heat, contaminants, and other harmful elements.

INSTALLATION

Bearings are supplied complete with drawings and instructions for installation. The Technical Department of **FIP Industriale** is always available to assist the customer and the designer in defining the most suitable installation procedure depending on the type of structure and the construction stages of the work.

DESIGN AND DIMESIONING CRITERIA

Based on the sizing of the standard supports shown in the tables of this catalogue, the following initial assumptions were hypothesized:

- absence of longitudinal and transverse slopes
- zero steel-concrete friction coefficient
- maximum total rotation, around the horizontal transverse axis (longer side of the core) = 0.01 rad.
- upper anchor pin (prestressed concrete or steel beam)
- lower anchor bars

BEHAVIOUR OF ELASTOMERIC BEARINGS

The elastomeric bearings allow for deformation in any direction of the plane. There is a displacement for every horizontal force, and vice versa at each deformation there is an elastic reaction in the elastomer in the opposite direction and of an intensity proportional to the deformation.

Therefore, imposing a deformation "u" on the bearing is the same as imposing a force equal to the elastic reaction associated with it, or "K_o x u" where K_o is the horizontal stiffness of the bearing.

CONSULTING THE TABLES

In order to facilitate finding the most appropriate bearings, it is possible to refer to the following tables, in which the **Fixed Elastofip** "standard" bearings are listed, with their technical and geometrical characteristics.

In order to cover the largest possible number of cases, two series are presented, the **Normal** and the **High**, which differ according to their lesser or greater horizontal forces borne, with the vertical loads being equal.

To offer the most general series of cases possible, since it is not realistic to expect standard strain levels, each displacement imposed, be it of a thermal or of some other nature, it has been computed in terms of the associated elastic reaction which, added to the horizontal force of the project, constitutes the effective horizontal stress to which the rubber is subjected.

To consult the tables properly then, it is necessary to transform the project deformations in terms of associated elastic reaction, and add the latter to the horizontal load in the same direction. The value obtained shall be considered as the overall horizontal force acting on the device.

The tables also show the displacement (horizontal deformation) of the bearing subjected to the maximum horizontal force (total). This value is of particular interest in evaluating the expansion joint to insert onto the deck.

BEARING CHOICE

Main characteristics regarding maximum vertical load at ULS, maximum rotation, the movements not due to horizontal loads (of a thermal or some other nature, like those due to shrinkage and creep) and the maximum horizontal forces at ULS being known, the most suitable bearing is searched in one of the two following tables.

After having identified a possible bearing, extrapolate its horizontal stiffness K_o and multiply it by the maximum displacement mentioned above. A horizontal force is obtained to be added to the maximum force in the same direction, to obtain an overall value that must be able to be borne by the bearing.

Example:

F_{zd}	= 900 kN	maximum vertical load at ULS
F_x	= 95 kN	maximum horizontal longitudinal force at ULS
v	= 4 mm	horizontal deformation not due to horizontal forces
α_{max}	≤ 0.01 rad	total maximum rotation

- choose the Normal or High series in function of the ratio between the horizontal and vertical load: up to 5% the Normal series, beyond that, the High series. In this case one uses the High series.
- the bearing is dimensioned in function of the maximum vertical load: EF 100-10.
- the horizontal stiffness is read (K_o = 2,25 kN/mm) and consequently calculated the elastic reaction associated with the maximum required displacement: FEL = $K_o \cdot v = 2{,}25 \cdot 4 = 9$ kN
- the total horizontal resistance required of the device is calculated and compared with the horizontal load supported by the bearing indicated in the catalogue (F_{xy} = 100 kN):

  $F_{x\,tot} = F_x + F_{EL} = 95 + 9 = 104$ kN > F_{xy} → **the bearing will NOT work**

  Looking at the next one in the same table, the EF 125-13 (con K_o = 3.22 kN/mm), it is obtained:

  $F_{x\,tot} = F_x + F_{EL} = 95 + 3{,}22 \cdot 4 = 95 + 12{,}88$ kN = 107,88 kN < F_{xy} = 130 kN → **the bearing is acceptable**

  The displacement corresponding to $F_{x\,tot}$ is $v_{eq} = F_{x\,tot} / K_o = 107{,}88 / 3{,}22 = 33{,}5$ mm.

FIP Industriale designs and builds out of standard bearings upon request, always with CE marking.

Furthermore, where the upper and lower surfaces are not parallel, that is, where the prestressed concrete beam has any slope at all, be it longitudinal or transverse or both, this can be resumed (counterbalanced) by giving the top plate of the bearing a wedge shape. In this case, too, the bearing cannot be considered "standard".

EF NORMAL TABLE

EF
NORMAL

CODE	NOMINAL VERTICAL LOAD F_{zd} kN	MAXIMUM HORIZONTAL FORCE F_{xy} kN	DEFORMATION EQUIVALENT TO Fxy v_{eq} mm	HORIZONTAL STIFFNESS K_o kN/mm	VERTICAL STIFFNESS K_v kN/mm	NUMBER OF ELASTOMER LAYERS n n	THICKNESS OF ELASTOMER LAYERS t_i mm
EF 25-2	250	20	20,7	0,96	99	3	7
EF 50-3	500	30	18,7	1,61	264	3	7
EF 75-4	750	40	17,8	2,25	552	3	6
EF 100-5	1000	50	19,4	2,57	689	3	7
EF 125-7	1250	70	20,4	3,43	1114	3	7
EF 150-8	1500	80	20,7	3,86	1339	3	7
EF 175-9	1750	90	19,9	4,82	2181	3	7
EF 200-10	2000	100	20,7	4,82	2181	3	7
EF 225-12	2250	120	23,7	5,06	2251	3	8
EF 250-13	2500	130	23,1	5,63	2404	3	8
EF 275-14	2750	140	31,6	4,43	2284	4	8
EF 300-15	3000	150	38,1	3,94	2178	5	8
EF 325-17	3250	170	39,2	4,33	2540	5	8
EF 350-18	3500	180	38,1	4,73	2911	5	8
EF 375-19	3750	190	35,3	5,63	2078	3	12
EF 400-20	4000	200	39,1	5,12	3289	5	8
EF 450-23	4500	230	29,2	7,88	3923	3	10
EF 500-25	5000	250	29,8	8,40	4319	3	10
EF 550-28	5500	280	35,0	8,00	3600	3	12
EF 600-30	6000	300	35,3	8,50	3949	3	12
EF 650-33	6500	330	41,1	8,04	3447	3	14
EF 700-35	7000	350	40,8	8,57	3832	3	14
EF 750-38	7500	380	41,7	9,11	4226	3	14
EF 800-40	8000	400	41,5	9,64	4626	3	14
EF 850-43	8500	430	43,4	9,90	4703	3	15
EF 900-45	9000	450	47,1	9,56	4312	3	16
EF 950-48	9500	480	47,4	10,13	4740	3	16
EF 1000-50	10000	500	53,6	9,33	3848	3	18
EF 1100-53	11000	530	53,0	10,00	4378	3	18
EF 1200-55	12000	550	64,9	8,47	4276	4	17
EF 1300-58	13000	580	53,7	10,80	4632	3	20
EF 1400-60	14000	600	55,6	10,80	4632	3	20
EF 1500-63	15000	630	66,1	9,53	5257	4	17
EF 1750-67	17500	670	77,9	8,61	5438	5	16
EF 2000-70	20000	700	73,2	9,56	4679	4	20

NUMBER OF STEEL PLATES	THICKNESS OF STEEL PLATES	DIMENSIONS OF REINFORCED CONCRETE CORE	DIMENSIONS IN LOWER STEEL PLATE PLANT	PIN DIAMETER	PIVOT PROTUSION	LOWER BAR		DIAGONAL CENTER TO CENTER BAR DISTANCE	TOTAL SUPPORT HEIGHT	SUPPORT WEIGHT INCLUDING ANCHORS
t_s	t_s	a x b	X x Y	$F_{p\phi}$	h_p	n_{zan}		i	H_{tot}	W
n	*mm*	*mm*	*mm*	*mm*	*mm*	*n*	*tipo*	*mm*	*mm*	*kg*
2	2	150 x 150	170 x 240	55	15	2	1	195	55	9
2	2	150 x 250	170 x 340	55	15	2	1	295	55	14
2	2	150 x 300	170 x 390	55	15	2	1	345	52	15
2	2	200 x 300	220 x 390	55	15	2	1	345	55	21
2	2	200 x 400	220 x 490	55	15	2	1	445	55	27
2	2	200 x 450	220 x 540	55	15	2	1	495	55	30
2	2	250 x 450	270 x 540	55	15	2	1	495	55	37
2	2	250 x 450	270 x 540	55	15	2	1	495	55	37
2	2	300 x 450	320 x 540	55	15	2	1	495	58	44
2	2	250 x 600	270 x 690	55	15	4	1	645	58	49
3	2	350 x 450	370 x 540	55	15	4	1	495	68	56
4	2	350 x 500	370 x 590	55	15	4	1	545	78	66
4	2	350 x 550	370 x 640	55	15	4	1	595	78	73
4	2	350 x 600	370 x 690	55	15	4	1	645	78	79
2	3	450 x 500	470 x 590	55	15	4	1	545	78	92
4	2	350 x 650	370 x 740	55	15	4	1	695	78	85
2	3	350 x 750	370 x 880	55	15	2	2	815	72	106
2	3	350 x 800	370 x 930	55	15	2	2	865	72	112
2	3	400 x 800	420 x 930	55	15	4	2	865	78	132
2	3	400 x 850	420 x 980	55	15	4	2	915	78	140
2	3	500 x 750	520 x 880	80	17	4	2	815	84	157
2	3	500 x 800	520 x 930	80	17	4	2	865	84	167
2	3	500 x 850	520 x 980	80	17	4	2	915	84	176
2	3	500 x 900	520 x 1030	80	17	4	2	965	84	186
2	3	550 x 900	570 x 1030	80	17	4	2	965	87	207
2	3	600 x 850	620 x 980	80	17	4	2	915	90	215
2	3	600 x 900	620 x 1030	80	17	4	2	965	90	226
2	4	700 x 800	720 x 990	80	17	2	3	895	102	279
2	4	750 x 800	770 x 990	80	17	2	3	895	102	297
3	4	800 x 800	820 x 990	80	17	2	3	895	120	348
2	4	800 x 900	820 x 1090	80	17	4	3	995	108	366
2	5	800 x 900	820 x 1090	80	17	4	3	995	110	377
3	4	800 x 900	820 x 1090	80	17	4	3	995	120	395
4	4	850 x 900	870 x 1090	80	17	4	3	995	136	454
3	5	850 x 1000	870 x 1190	80	17	4	3	1095	135	494

EF HIGH TABLE

EF HIGH

CODE	NOMINAL VERTICAL LOAD F_{zd} kN	MAXIMUM HORIZONTAL FORCE F_{xy} kN	DEFORMATION EQUIVALENT TO Fxy v_{eq} mm	HORIZONTAL STIFFNESS K_o kN/mm	VERTICAL STIFFNESS K_v kN/mm	NUMBER OF ELASTOMER LAYERS n n	THICKNESS OF ELASTOMER LAYERS t_i mm
EF 25-3	250	30	20,3	1,48	227	3	7
EF 50-5	500	50	20,8	2,40	610	3	7
EF 75-8	750	80	35,6	2,25	760	5	8
EF 100-10	1000	100	44,4	2,25	922	6	8
EF 125-13	1250	130	40,4	3,22	993	4	11
EF 150-15	1500	150	41,9	3,58	1195	4	11
EF 175-18	1750	180	47,9	3,94	1285	4	12
EF 200-20	2000	200	46,9	4,27	1464	4	12
EF 225-23	2250	230	46,7	4,92	1834	4	12
EF 250-25	2500	250	47,6	5,25	2023	4	12
EF 275-28	2750	280	43,8	6,40	1994	3	15
EF 300-30	3000	300	44,1	6,80	2193	3	15
EF 325-33	3250	330	48,9	6,75	2024	3	17
EF 350-35	3500	350	49,0	7,15	2217	3	17
EF 375-38	3750	380	53,6	7,08	2173	3	18
EF 400-40	4000	400	53,3	7,50	2387	3	18
EF 450-45	4500	450	57,0	7,89	2441	3	19
EF 500-50	5000	500	76,0	6,58	2323	4	20
EF 550-55	5500	550	79,2	6,95	2547	4	20
EF 600-60	6000	600	95,2	6,30	2577	5	20
EF 650-65	6500	650	98,3	6,62	2796	5	20
EF 700-70	7000	700	107,7	6,50	3261	6	18
EF 750-75	7500	750	125,0	6,00	3242	7	18
EF 800-80	8000	800	138,3	5,79	2849	7	20
EF 850-85	8500	850	149,5	5,68	3216	8	19
EF 900-90	9000	900	156,9	5,74	3177	8	20
EF 950-95	9500	950	175,9	5,40	3144	9	20
EF 1000-100	10000	1000	194,9	5,13	3126	10	20
EF 1100-105	11000	1050	192,5	5,45	3016	9	22
EF 1200-110	12000	1100	192,1	5,73	3295	9	22
EF 1300-115	13000	1150	191,7	6,00	3581	9	22
EF 1400-120	14000	1200	185,5	6,47	3515	8	24
EF 1500-125	15000	1250	192,9	6,48	3422	8	25
EF 1750-130	17500	1300	169,1	7,69	4167	7	25
EF 2000-135	20000	1350	175,0	7,71	4202	7	25

NUMBER OF STEEL PLATES	THICKNESS OF STEEL PLATES	DIMENSIONS OF REINFORCED CONCRETE CORE	DIMENSIONS IN LOWER STEEL PLATE PLANT	PIN DIAMETER	PIVOT PROTUSION	LOWER BAR		DIAGONAL CENTER TO CENTER BAR DISTANCE	TOTAL SUPPORT HEIGHT	SUPPORT WEIGHT INCLUDING ANCHORS
t_s	t_s	a x b	X x Y	$F_{p\phi}$	h_p	n_{zan}		i	H_{tot}	W
n	*mm*	*mm*	*mm*	*mm*	*mm*	*n*	*tipo*	*mm*	*mm*	*kg*
2	2	150 x 230	170 x 320	55	15	2	1	275	55	13
2	2	200 x 280	220 x 370	55	15	2	1	325	55	20
4	2	250 x 400	270 x 490	55	15	2	1	445	78	38
5	2	300 x 400	320 x 490	55	15	2	1	445	88	49
3	2	350 x 450	370 x 540	55	15	4	1	495	86	67
3	2	350 x 500	370 x 590	55	15	4	1	545	86	73
3	2	350 x 600	370 x 690	55	15	4	1	645	90	88
3	2	350 x 650	370 x 780	55	15	2	2	715	90	98
3	2	350 x 750	370 x 880	55	15	2	2	815	90	112
3	2	350 x 800	370 x 930	55	15	2	2	865	90	118
2	2	400 x 800	420 x 930	80	17	4	2	865	85	131
2	2	400 x 850	420 x 980	80	17	4	2	915	85	139
2	2	450 x 850	470 x 980	80	17	4	2	915	91	158
2	2	450 x 900	470 x 1030	80	17	4	2	965	91	166
2	2	500 x 850	520 x 980	80	17	4	2	915	94	176
2	2	500 x 900	520 x 1030	80	17	4	2	965	94	186
2	2	500 x 1000	520 x 1130	80	17	4	2	1065	97	207
3	2	650 x 900	670 x 1090	80	17	2	3	995	126	299
3	2	650 x 950	670 x 1140	80	17	4	3	1045	126	322
4	2	700 x 1000	720 x 1190	80	17	4	3	1095	148	389
4	2	700 x 1050	720 x 1240	140	17	4	3	1145	148	407
5	2	650 x 1200	670 x 1390	140	17	4	3	1295	158	448
6	2	700 x 1200	720 x 1390	140	17	4	3	1295	178	514
6	3	750 x 1200	770 x 1390	140	17	4	3	1295	198	606
7	2	800 x 1200	820 x 1390	140	17	4	3	1295	206	630
7	3	850 x 1200	870 x 1390	140	17	4	3	1295	221	734
8	3	900 x 1200	920 x 1390	140	17	4	3	1295	244	828
9	3	950 x 1200	970 x 1390	140	17	4	3	1295	267	927
8	3	1000 x 1200	1020 x 1390	140	17	4	3	1295	262	945
8	3	1050 x 1200	1070 x 1390	200	20	6	3	1295	262	999
8	3	1100 x 1200	1120 x 1390	200	20	6	3	1295	262	1045
7	3	1150 x 1200	1170 x 1390	200	20	6	3	1295	253	1050
7	3	1200 x 1200	1220 x 1390	200	20	6	3	1295	261	1108
6	4	1150 x 1300	1170 x 1490	200	20	6	3	1395	239	1135
6	4	1200 x 1250	1220 x 1440	200	20	6	3	1345	239	1140

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leading technologies

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