A Short Guide to the BSF 700

The BSF Invisible Connection has been re-designed to minimize internal forces on the spanning member, to eliminate welding and to optimize production of the units. The table below is a summary of the legacy BSF units and the 2014 redesign of the BSF units. Where applicable, the equivalent 2014 BSF is horizontally aligned with the legacy BSF. If no 2014 equivalent is available, the line has been left blank.

Legacy BSF Unit	Ultimate Vertical Load kip	Minimum Beam Height* in	Minimum Beam Width* in	2014 BSF Unit	Ultimate Vertical Load kip	Minimum Beam Height* in	Minimum Beam Width* in
150/20	44.96	22.00	8.00	225	50.58	17.72	11.81
200/20	67.44	24.00	10.00	300	67.44	19.68	11.81
200/30	101.16	24.00	14.00	450	101.16	21.65	13.78
200/40	134.89	30.00	15.00				
200/50	157.37	34.00	16.00	700	157.37	31.50	21.65
250/50	213.57	36.00	21.00				

* Dimensions based on approximate minimum beam geometry to obtain mechanical capacity of Unit. Beam geometry and required reinforcing should be evaluated for each specific condition by a qualified engineer.

The following documentation has been compiled to introduce the 2014 BSF 700.

Additional Information is available by clicking here.

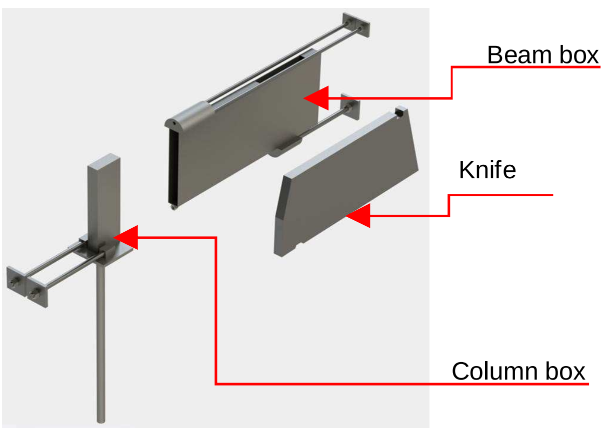
A SHORT GUIDE TO BSF SLIDING INSERTS

This short guide is intended to give a brief overview of the use and design methods for the BSF without going into the details.

BSF inserts are a mechanical alternative to other beam supports such as integral corbels, bolt-on corbels or cast-in solid billets. Four different BSF units are available, with various capacities according to their size.

The system consists of 3 main parts.

a) A beam box. This is cast into the beam which is being supported. It works in conjunction with purpose-bent reinforcing bars and threaded rods to transfer loads into the body of the concrete.
b) A column box. This is cast into the column. Threaded rods, and a welded-on bar transfer loads into the concrete.
c) A sliding 'knife'. This solid steel member actually carries the load from one member to another. It is placed within the beam box, and then partially slid out when in position, to bear on the bottom of the column box.



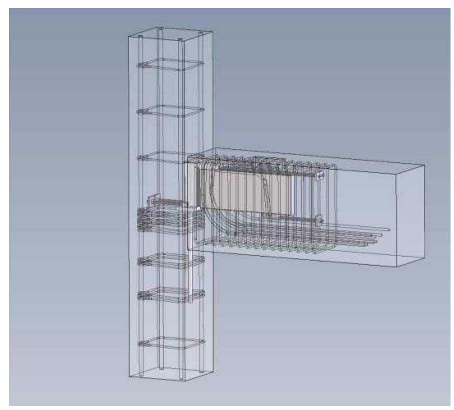


Figure 1: Illustration of unit

The nominal capacities and approximate minimum beam dimensions for the different units are as given in Table 1. A final evaluation of the beam dimension and required reinforcement in the beam end shall be done by qualified engineer in each case. For this purpose, Memo 521 from the manufacturer may be used as guideline along with the general rules in EC2.

Type	Max vertical ultimate limit load on unit	Approximate absolute minimum beam dimension to allow for space of the unit		
	[kN]	W×H [MM]	X [MM]	Y [MM]
BSF225	225	190×370	≈116mm	≈306mm
BSF300	300	190×420	≈116mm	≈349mm
BSF450	450	190×440	≈116mm	≈369mm
BSF700	700	310×500	≈239mm	≈424mm

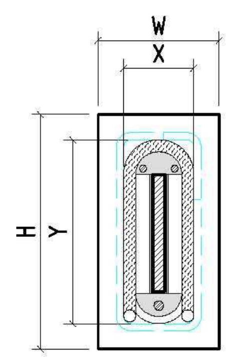


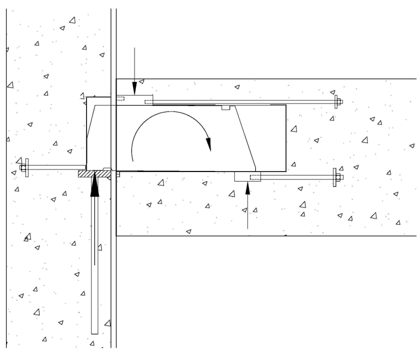
Table 1: Capacities and approximate minimum beam dimension to allow for space of the different units.

A SHORT GUIDE TO BSF SLIDING INSERTS

MATERIALS

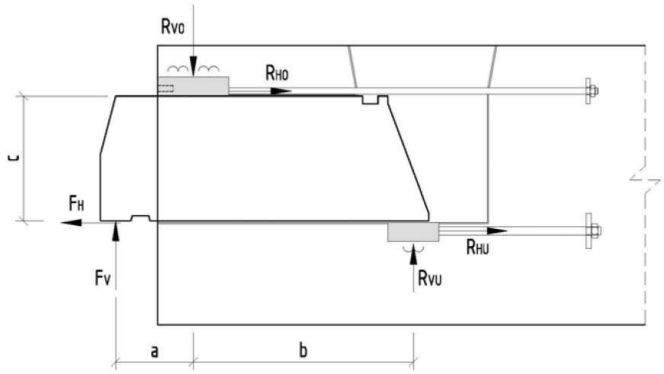
All parts are made from steel. The three main components shown above are grade S355 steel. Threaded rods are grade 8.8, and plate washers are grade S355. Designs are based on concrete grade C35/45. Stronger concrete will not increase capacities as they are 'steel limited'. Weaker concrete **may** lower capacities.

DESIGN PRINCIPLES



When deployed, the sliding knife cantilevers from the beam into the column. It bears onto the base of the column box at the free end, which induces rotation of the knife. This is resisted by bearing against half-round bearing blocks in the beam (see below). These half-round blocks in turn bear against reinforcement which is not shown in the diagram, but is dealt with later in the guide.

VERTICAL FORCES



The horizontal forces R_{HO} and R_{HU} are assumed to be $0.2F_V$ and $0.1F_V$ respectively (see later for explanation of why).

Considering rotation about the rear stress block at equilibrium:

$R_{VO} \times b = F_V \times (a+b) + R_{HO} \times c = F_V \times (a+b) + 0.2F_V \times c$ from which

$R_{VO} = F_V \times (a + b) / b + 0.2F_V \times c / b$

and vertically: $R_{VU} = R_{VO} - F_V$

From these equations, values for R_{VO}, R_{VU}, R_{HO} and R_{HU} are found as below.

Type	Fv (kN)	a (mm)	b (mm)	c (mm)	R_{VO} (kN)	R_{VU} (kN)
BSF225	225	115	340	195	327	102
BSF300	300	125	330	235	456.4	156.4
BSF450	450	152.5	432.5	250	660.7	210.7
BSF700	700	165	420	280	1068	368

Table 2: Vertical forces (nominal).

A SHORT GUIDE TO BSF SLIDING INSERTS

The above table is for 'ideal' values for a, b and c. More critical values are obtained by including the unfavorable tolerance on position of the anchoring reinforcement (±5mm) and the maximum site erection tolerance (10mm). This will lead to the values given in table 3 below.

Type	Fv (kN)	a (mm)	b (mm)	c (mm)	R_{VO} (kN)	R_{VU} (kN)
BSF225	225	130	330	195	340.2	115.2
BSF300	300	140	320	235	475.3	175.3
BSF450	450	167.5	422.5	250	681.7	231.7
BSF700	700	180	410	280	1103	403

Table 3: Vertical forces (maximum).

These higher values are used to evaluate reinforcement quantities.

Reinforcement is grade 500C, with working stress = 435 N/mm^2

VERTICAL ANCHORAGE REINFORCEMENT

Special bars, commonly called 'saddle bars' are provided to transmit vertical forces imposed on the half round blocks by the knife. The front saddle bars should transmit forces into the lower part of the member, preferably lapping on to the main tension steel in a beam. Similarly, the rear saddle bars should transmit forces into the top of the member. It is considered good practice for the bends in saddle bars to be greater than the minimum allowable to prevent any local concrete crushing inside the bend.

Reinforcement to carry force R_{VO} is as below.

Type	R_{VO} (kN)	A_s reqd (mm^2)	Bars	A_s prov (mm^2)
BSF225	340.2	782	2 x 16 dia	804
BSF300	475.3	1093	3 x 16 dia	1206
BSF450	681.7	1567	4 x 16 dia	1608
BSF700	1103	2536	3 x 25 dia	2940

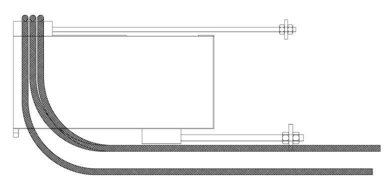


Table 4: Reinforcement for R_{VO}.

Reinforcement to carry force R_{VU} is as below.

Type	R_{Vu} (kN)	A_s reqd (mm^2)	Bars	A_s prov (mm^2)
BSF225	115.2	265	2 x 10 dia	312
BSF300	175.3	403	2 x 12 dia	452
BSF450	231.7	533	2 x 16 dia	804
BSF700	403	926	2 x 16 dia + 1 x 12 dia	1030

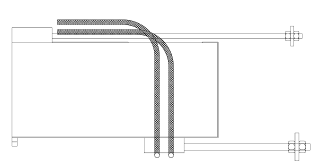


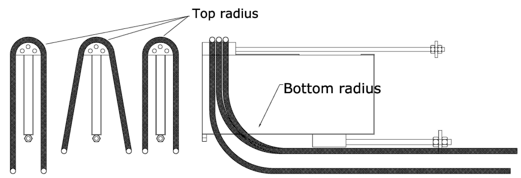
Table 5: Reinforcement for R_{VU}.

A SHORT GUIDE TO BSF SLIDING INSERTS

Memo 521 gives guidance for calculating the required bending radii. Typical bending radii for saddle bars will be as below. Values shown ' * ' are to suit the half round bearing blocks and cannot be reduced.

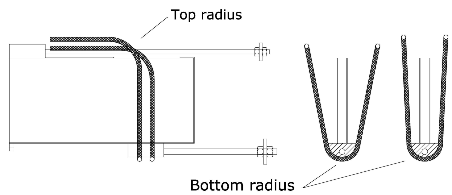
Type	Bar dia (mm)	Top radius (mm) *	Bottom radius (mm)
BSF225	16	38	125
BSF300	16	38	175
BSF450	16	38	225
BSF700	25	87,5	225

Table 6: Front saddle bars – typical bending radii.



Type	Bar dia (mm)	Bottom radius (mm) *	Top radius (mm)
BSF225	10	38	50
BSF300	12	38	80
BSF450	16	38	75
BSF700	16 & 12	38	100

Table 7: Rear saddle bars – typical bending radii.



HORIZONTAL FORCES

Significant horizontal forces may be developed due to shrinkage and thermal effects, especially if the column is stiff. Once these forces exceed frictional resistance, the knife will slide, thus relieving the stresses. Typical steel/steel coefficients of friction range between 0.2 and 0.5. The design assumes a global value for μ of 0.3. Thus the connection is designed to resist a longitudinal tension of 0.3 x F_V. Due to the geometry of the knife, it will be seen from Table 3 that R_{VU} is approximately half of F_V Assuming the minimum value of μ = 0.2 at the back of the knife, then a horizontal force of 0.1 F_V can be taken at this contact point, and the remaining 0.2 Fv must be taken at the front.

Threaded bars to carry force R_{HO} and R_{HU} are as below. Bars are grade 8.8 steel.

Type	R_{HO} (kN)	Bars	$Capacity_{prov}$ (kN)	R_{HU} (kN)	Bars	$Capacity_{prov}$ (kN)
BSF225	45	2 x M12	96	22.5	1 x M16	90
BSF300	60	2 x M12	96	30	1 x M16	90
BSF450	90	2 x M12	96	45	1 x M16	90
BSF700	140	2 x M16	180	70	1 x M20	141

Table 8: Bars for R_{HO} and R_{HU}.

COLUMN BOX

These same longitudinal forces are transferred into the column box by friction. The forces are then resisted by a pair of threaded horizontal bars. Bars are grade 8.8 steel. The horizontal force must be included in the design of the column. More information on this issue is found in Memo 521.

Type	Force (kN)	Bars	Capacity $_{prov}$ (kN)
BSF225 - Column box	67.5	2 x M12	96
BSF300 - Column box	90	2 x M12	96
BSF450 - Column box	135	2 x M16	180
BSF700 - Column box	210	2 x M20	282

Table 9: Threaded bars in column box.

Vertical forces in the column are taken by a combination of a vertical welded-on bar, and by direct bearing under the base of the column box. This determines both the diameter and length of bar, as well as the size of the base. Calculations and design method are given in Memo 521.

Type	Bar dia / length (mm)	Base plate Depth x Width x Thickness (mm)
BSF225 - Column box	20 x 600	110 x 100 x 20
BSF300 - Column box	20 x 600	110 x 100 x 20
BSF450 - Column box	25 x 600	125 x 140 x 25
BSF700 - Column box	25 x 790 x 2	150 x 150 x 40

Table 10: Sizing of column box base.

BB BOXES

These are a variation of the column box for use where the vertical welded-on bar cannot be used because of a lack of concrete depth below the box. They are used in beam – beam situations, either onto the end, or onto the side of a supporting beam. They may also be used in other situations where there is no concrete depth below the box. Memo 525 and Memo 526 gives some examples on use and calculations.

The base plate and vertical bar is substituted by a half-round pressure block and stirrup bars that pass under the box. Following the same principals as used in the beam unit, these stirrup bars will take the vertical load. The size and number of bars are given in Table 11. Due to the possible variations in concrete profile however, the geometry of these bars is highly variable and is a matter for practical consideration depending on how the flow of forces is intended to be. The BB-boxes also have a threaded bar, with plate washer on the rear face to take horizontal loads. The required length of the threaded bar will depend on the concrete cover and reinforcement in the anchoring zone.

Type	Stirrup bars	Threaded bars	Plate washer
BSF225 - BB box	2 x 16 Ø	2 x M12 x 650	50 x 50 x 8
BSF300 - BB box	2 x 16 Ø	2 x M12 x 650	50 x 50 x 8
BSF450 - BB box	3 x 16 Ø	1 x M20 x 750	90 x 90 x 12
BSF700 - BB box	2 x 25 Ø	2 x M20 x 750	160 x 90 x 12

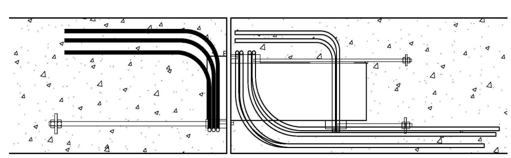
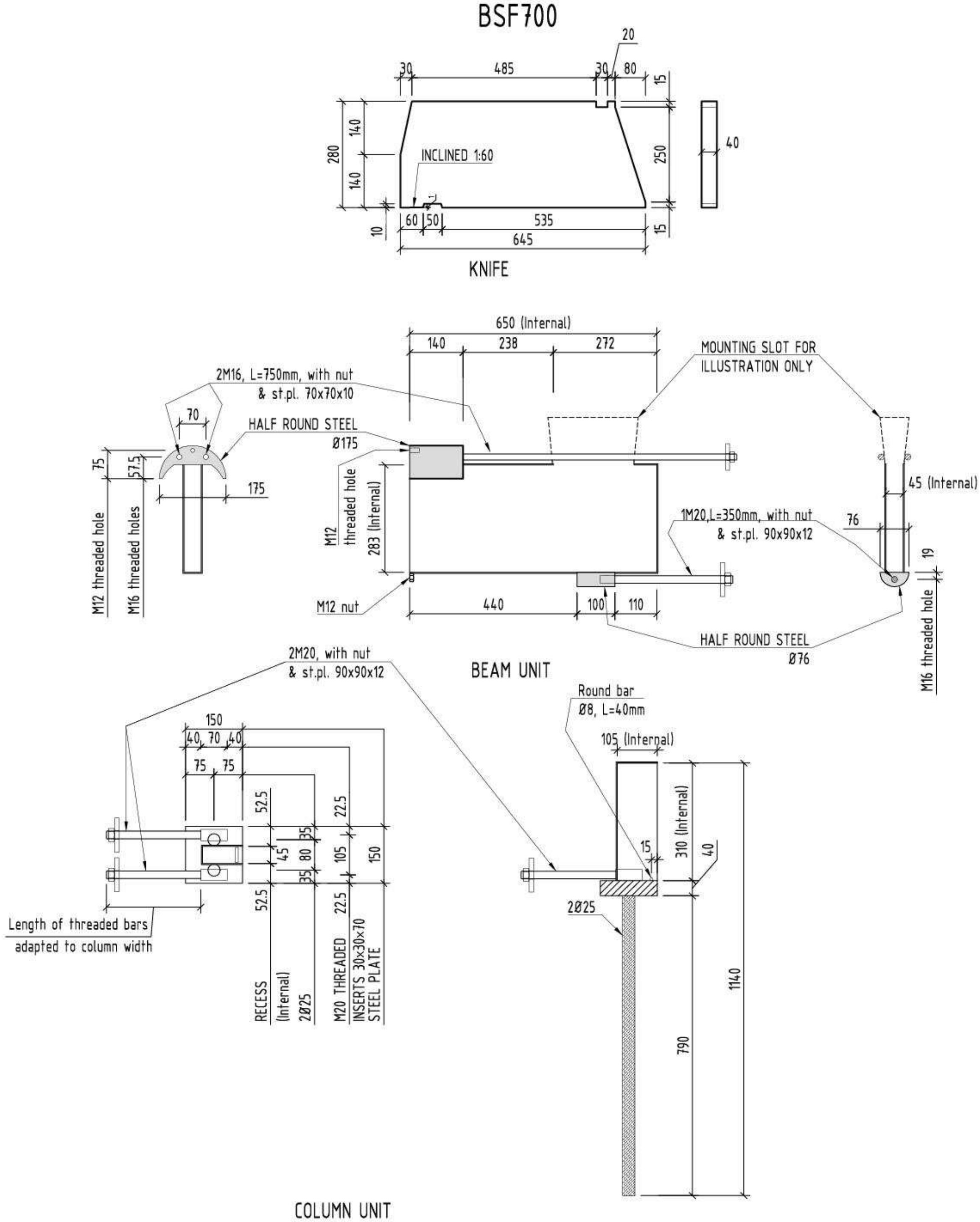


Table 11: Bars for BB boxes.

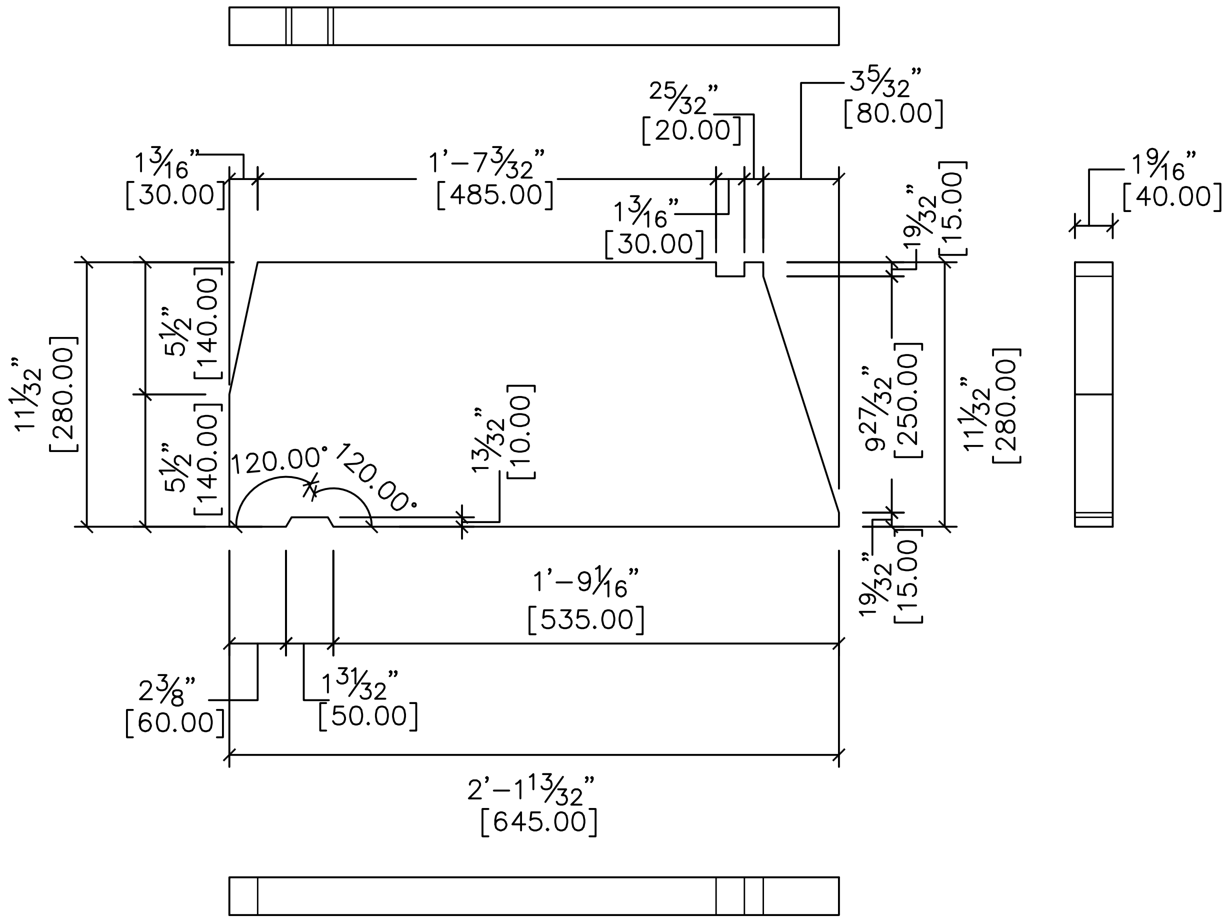
A SHORT GUIDE TO BSF SLIDING INSERTS

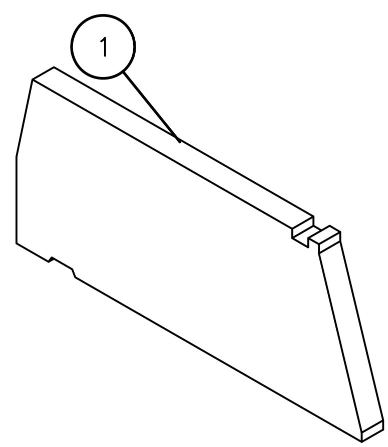
REVISION HISTORY	
Date:	**Description:**
11.09.2014	First Edition

BSF - MAIN DIMENSIONS AND MATERIAL PROPERTIES OF BEAM AND COLUMN UNITS [1)]



[1)] The design of the column unit and horizontal anchoring of the threaded bars in the beam/column is based on the assumption of minimum concrete grade C35/45. For NDP's and further information, see Memo 521 "BSF units – Design of reinforcement" and Memo "BSF- Design of steel units"





Part No.	Description	QTY.
1	S355 STEEL PL	1
—	—	—
—	—	—
—	—	—
—	—	—
—	—	—
—	—	—

JVI INC.

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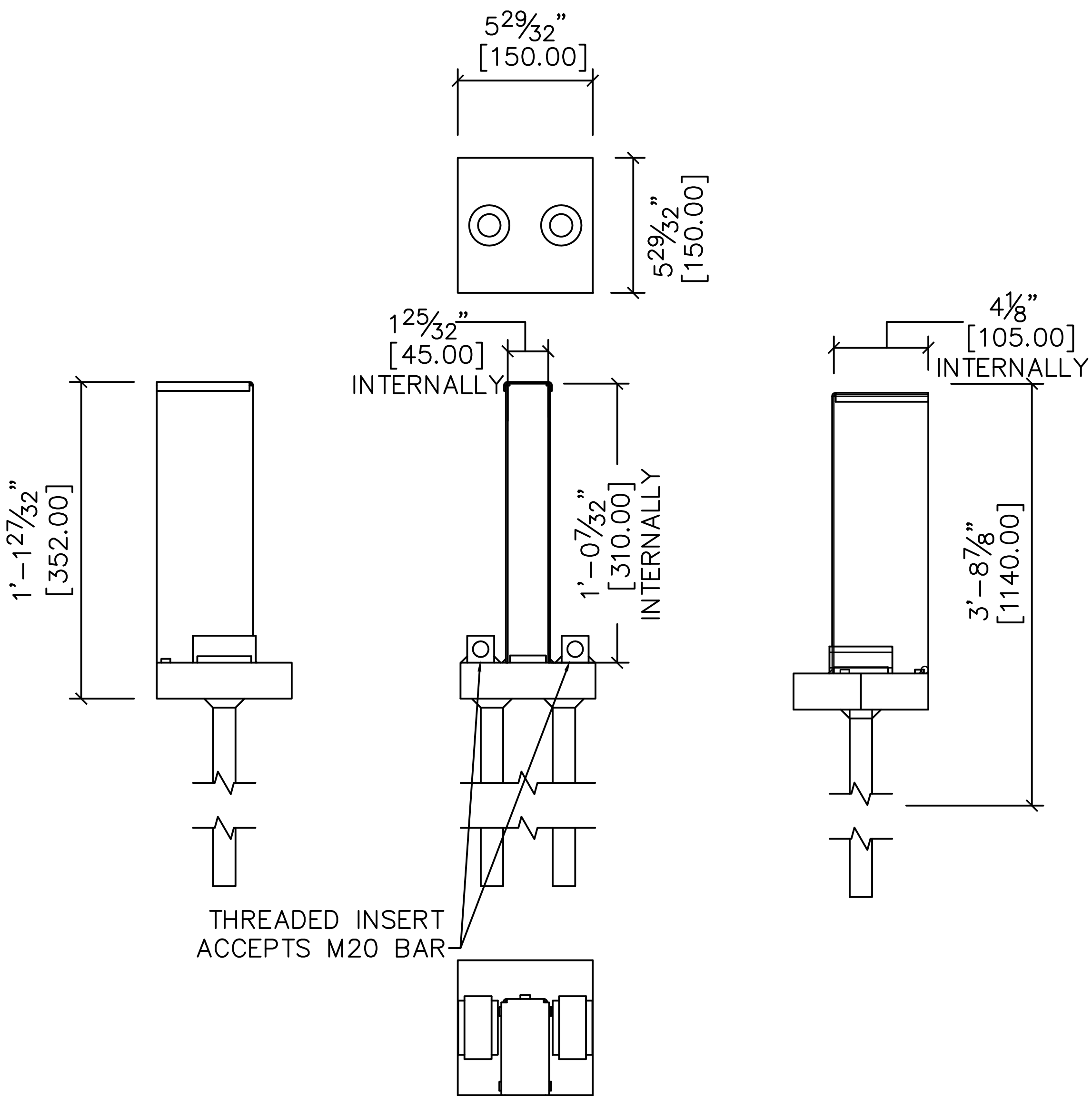
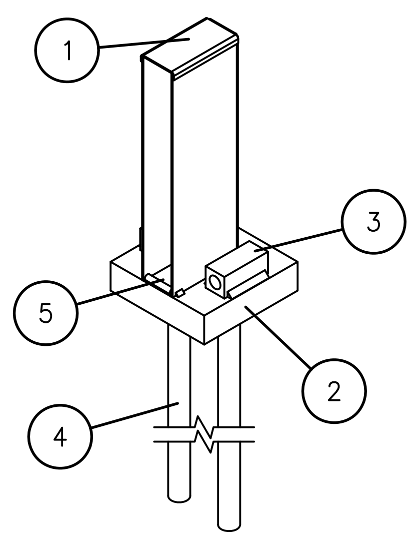
BSF CONNECTION 700

BSF CONNECTION
KNIFE PLATE

DATE	DRAWN	CHECKED	SCALE
02.18.2015	JVI	___	1 1⁄2"=1'





Part No.	Description	QTY.
1	U-CHANNEL	1
2	STEEL PLATE	1
3	THREADED INSERT	2
4	25MX790mm REBAR	2
5	ROUND BAR	1
—	—	—
—	—	—

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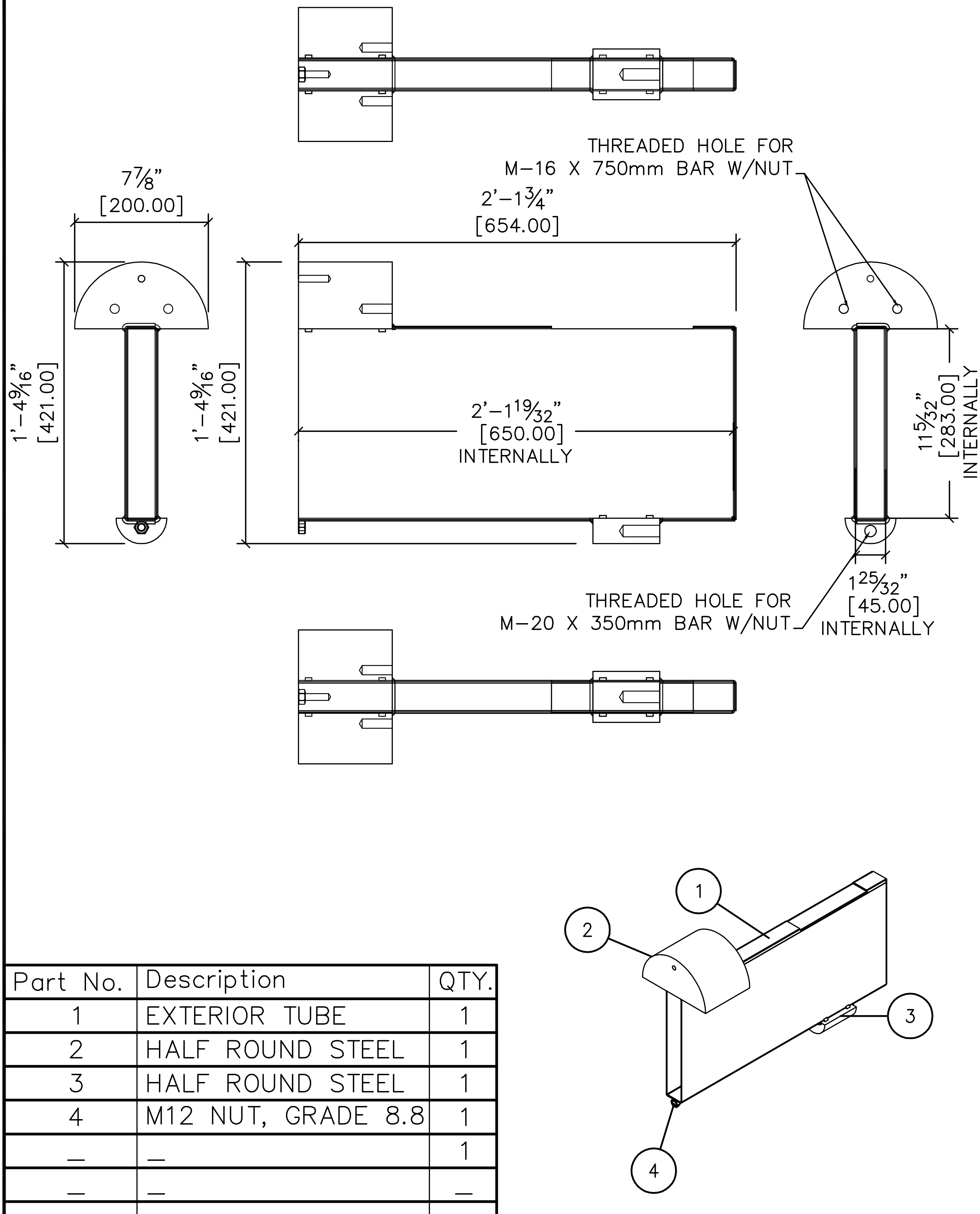
BSF CONNECTION 700

BSF CONNECTION COLUMN BOX

DATE	DRAWN	CHECKED	SCALE
02.18.2015	JVI	———	1½"=1'



Part No.	Description	QTY.
1	EXTERIOR TUBE	1
2	HALF ROUND STEEL	1
3	HALF ROUND STEEL	1
4	M12 NUT, GRADE 8.8	1
_	_	1
_	_	_
_	_	_

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BSF CONNECTION 700

BSF CONNECTION
BEAM BOX

DATE	DRAWN	CHECKED	SCALE
02.18.2015	JVI	___	1½"=1'

EXAMPLE: REINFORCEMENT IN BEAM END BSF700 WITH MAXIMUM LOAD 700KN

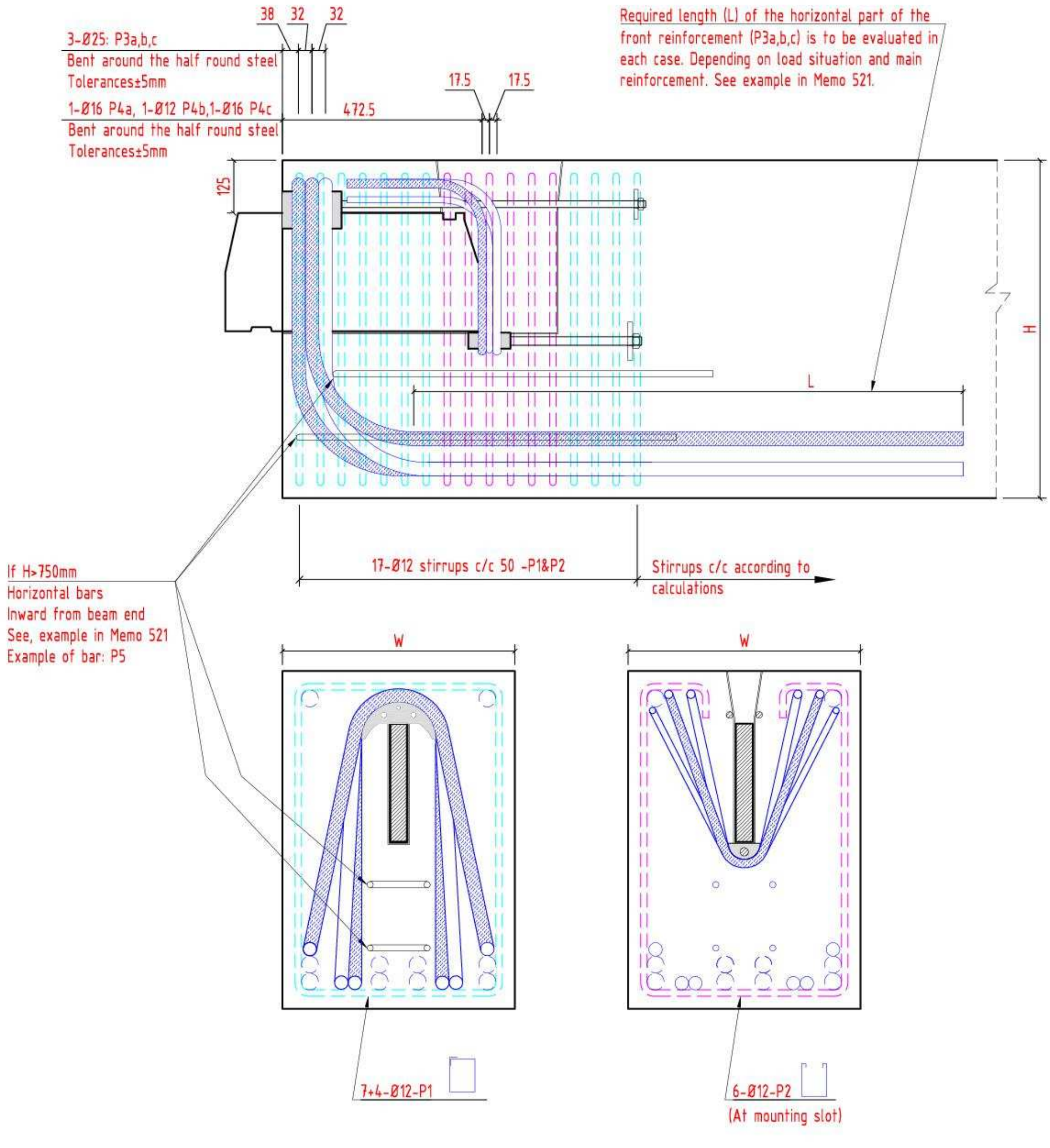


Figure 1: Reinforcement in beam end.

The basis for the illustrated reinforcement is found in the example calculations in Memo521. The amount of reinforcement and final shape of several of the bars has to be evaluated in each case. This can be done according to the procedures outlined in the Memo. Concrete quality C35 and beam dimension: W×H=550×800 is used in the example calculation. This corresponds to the approximate minimum cross section of the beam in order to utilize the full capacity of the unit.

EXAMPLE: REINFORCEMENT IN BEAM END BSF700 WITH MAXIMUM LOAD 700KN

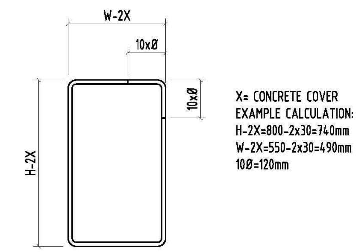
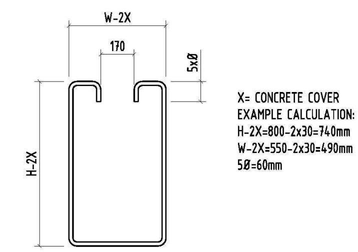
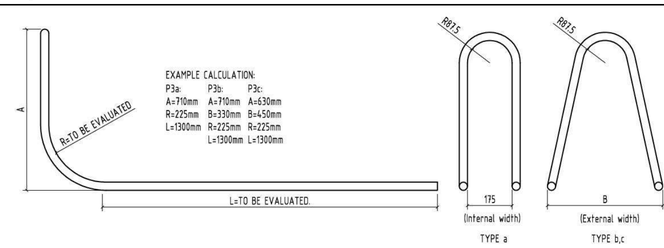
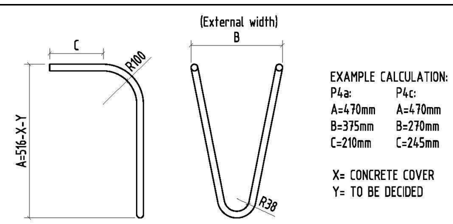
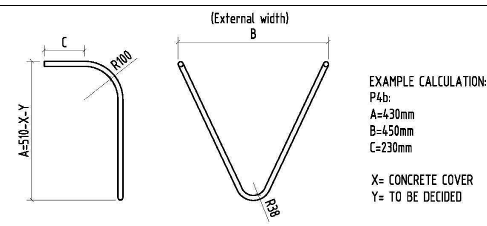
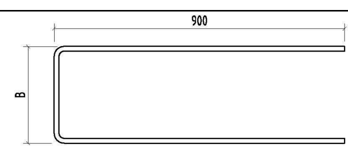
Pos.	Ø	No. pr. unit	Bar schedule	Grade
P1	Ø12	11		500C (EC2, Annex C)
P2	Ø12	6		500C (EC2, Annex C)
P3a,b,c	Ø25	1+1+1		500C (EC2, Annex C)
P4a,c	Ø16	1+1		500C (EC2, Annex C)
P4b	Ø12	1		
P5	Ø12		 In beams with H>750mm. Number to be decided.	500C (EC2, Annex C)

Table 1: List of reinforcement.

EXAMPLE: REINFORCEMENT IN BEAM END BSF700 WITH MAXIMUM LOAD 700KN

REVISION HISTORY	
Date:	**Description:**
17.04.2013	First Edition (for ETA)
12.06.2013	Updated before ETA. Corrected reinforcement quality notation from: B500C to 500C.
28.08.2013	Included revision signature.
27.06.2014	Changed the half round steel on the BSF700 unit.
19.08.2014	Changed position of the M16 threaded bars on the half round steel.