SINTEF

Technical Approval

SINTEF Building and Infrastructure

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BSF and BCC beam connections

are approved by SINTEF Building and Infrastructure with properties, fields of application and conditions as stated in this document

1. Holder of the approval

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2. Manufacturer

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3. Product description

BCC and BSF are corbel free, load carrying beam connections consisting of a beam unit with a sliding knife in a "sliding box" and a column unit to receive the knife. Both units are made of structural steel, and the units are moulded into precast concrete beam and column elements, see figu. 1. The sliding knife has a safety notch to lock the connection. The concrete reinforcement for beam ends and around the column units are standardised for various load carrying capacities.

The BSF connection is made of welded steel plates in quality S 355 N/NL according to NS 3472:2001. BSF has an installation slot in the upper part of the beam end for positioning the knife. The connection is produced in six different dimensions, designated BSF 150/20, BSF 200/20, BSF 200/30, BSF 200/40, BSF 200/50 and BSF 250/50, with dimensions as shown in fig. 2 and table 1 and 2.

The BCC connection is mainly made of rectangular steel tubes in quality S 355 N/NL according to NS 3472:2001.The access to the knife is through a steel bar put into a sloping tube in the upper part of the beam end. Alternatively, the BCC connection may be equipped with a string for pulling out the knife from the end of the beam. The connection is produced in three different dimensions, designated BCC 250, BCC 450 and BCC 800, with dimensions as shown in figure 3 and table 3 and 4. BCC 450 and BCC 800 are supplemented with special reinforcement bars fastened to the beam unit with screws before casting the concrete beam, see fig. 4.

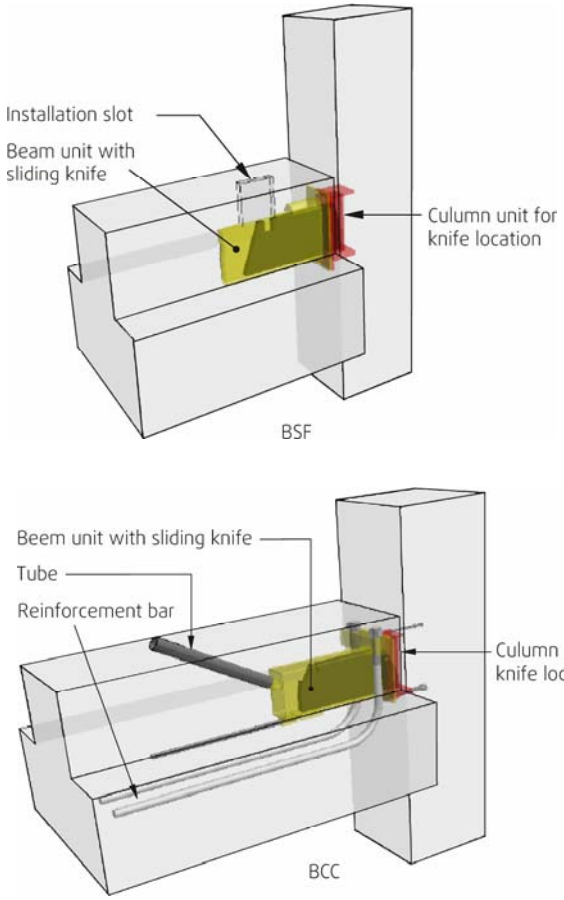

Fig. 1
Principle design of BSF and BCC beam connections

4. Fields of application

BSF and BCC corbel free beam connections are used to connect load carrying precast concrete beams and columns. The units may also be used as beam to beam connections, between beam and wall elements, and between wall elements.

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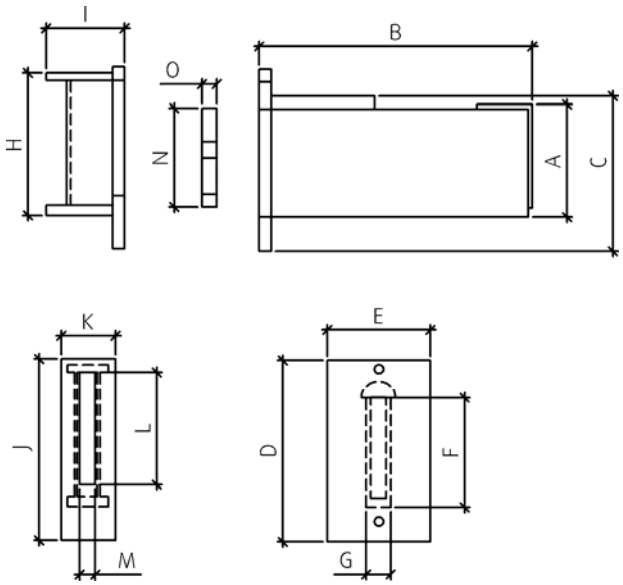

Fig. 2
BSF. Main dimensions. See also table 1 and 2.

Table 1
Main dimensions for BSF beam unit in mm

BSF	A	B	C	D	E	F	G
150/20	216	400	220	250	150	165	22
200/20	216	500	270	300	150	215	22
200/30	222	500	293	320	180	221	32
200/40	215	592	301	330	230	202	43
200/50	215	592	301	330	230	202	54
250/50	268	815	351	380	250	252	54

Table 2
Main dimensions for BSF column unit and knife in mm

BSF	Column unit						Knife	
	H	I	J	K	L	M	N	O
150/20	210	112	270	80	170	25	149	20
200/20	265	112	320	100	220	25	199	20
200/30	272	132	320	120	220	35	199	30
200/40	270	147	325	150	220	45	197	40
200/50	270	147	325	150	220	55	197	50
250/50	320	185	375	170	270	55	247	50

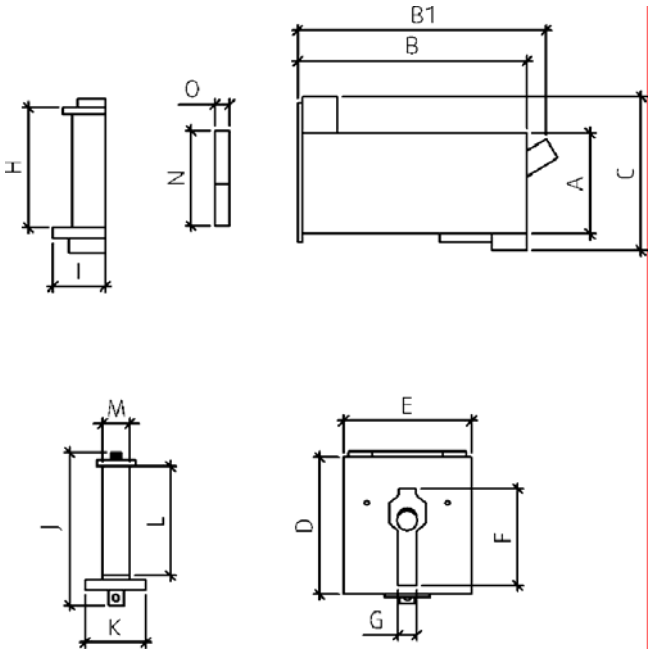

Fig. 3
BCC. Main dimensions. See also table 3 and 4.

Table 3
Main dimensions for BCC beam unit in mm

BCC	A	B	C	D	E	F	G	B1
250	160	458	202	200	100	152	25	507
450	200	453	300	270	250	190	35	510
800	300	573	435	380	260	290	45	627

Table 4
Main dimensions for BCC column unit and knife in mm

BCC	Column unit						Knife	
	H	I	J	K	L	M	N	O
250	215	95	251	100	182	42	147	20
450	255	100	303	120	217	52	185	30
800	350	140	414	150	325	62	285	40

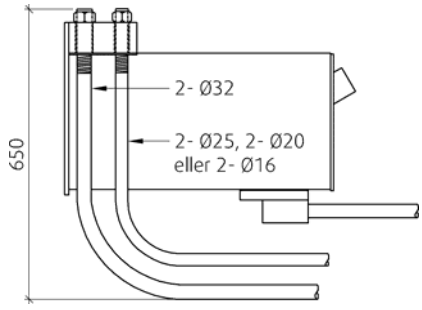

Fig. 4
Example of supplementary reinforcement bars in front of the BCC beam unit. The steel bar dimensions are designed case by case according to the required load capacity. The bars are fixed to the beam unit with screws before casting.

5. Properties

5.1 Load carrying capacity

Table 5 shows the design load carrying capacity for the different beam connections. The values assume standard reinforcement around the beam and column units according to the manufacturer's specifications, and the conditions given in section 6. Horizontal load carrying capacity is limited to 20 % of the design vertical load carrying capacity.

Table 5
Design load carrying capacity [1)] for BSF and BCC connections with standard reinforcement and minimum beam and column dimensions, see section 6.

Beam connection	Vertical load kN	Horizontal load kN
BSF 150/20	200	40
BSF 200/20	300	60
BSF 200/30	450	90
BSF 200/40	600	120
BSF 200/50	700	140
BSF 250/50	950	190
BCC 250	250	50
BCC 450	450	90
BCC 800	800	160

1) The table assumes the following load coefficients:
- Load coefficient for dead load = 1,2
- Load coefficient for imposed load = 1,6

5.2 Properties related to fire

The connections are regarded to have at least the same fire resistance as normal concrete beams and columns when the joint between beam and column is filled with mortar or rockwool insulation plus a joint sealant as indicated in clause 6.7.

5.3 Effect on indoor environment

No special environmental declaration has been worked out for BSF and BCC connections. The products do not contain any chemical substances listed on the Norwegian environmental authorities' observation list of compounds hazardous to human health or the environment, and are not regarded as emitting any particles, gases or radiation that have a perceptible impact on the indoor climate or tha have any significant impact on health.

5.4 Durability

Concrete cover gives normally a sufficient resistance against corrosion. However, the manufacturer recommends to treat the external surfaces and the knife with a protective paint in order to prevent stain and rust during storage. The units may be delivered with galvanized or stainless steel for special cases. Stainless steel gives normally an approx. 20 % reduction of the load carrying capacity.

5.5 Waste treatment/recycling

Steel parts and concrete elements may be recycled under given circumstances. Alternatively they may be delivered to a public waste deposit site at the end of the working life.

6. Special conditions for use and installation

6.1 Design of load carrying capacity

The use of BSF and BCC connections requires that a complete structural design according to the relevant design standards is carried out case by case. This includes the necessary concrete reinforcement around the connections. The manufacturer has developed principles for calculation of reinforcement for the column and beam units plus standard reinforcement guides for various load levels.

The load carrying capacities given in table 5 may be used if no special calculations are prepared for each individual case. The values assume that concrete quality B45 is used.

Torsional moments will cause a visible inclination of the beam due to the clearance between the knife and the beam and column unit. Torsional moments must therefore be taken care of by other means than the torsion capacity of the knife.

6.2 Beam and column dimensions

Table 6 shows the minimum beam dimensions and column widths that are necessary for the various connections to achieve full load carrying capacity or to make sufficient space for the units.

Table 6
Approximately minimum beam dimensions and column widths [1)]

Beam connection	Minimum beam dimension to achieve full capacity w x h in mm	Minimum beam dimension to make sufficient space for the beam unit w x h in mm	Minimum column width mm
BSF 150/20	200x400	150x270	200
BSF 200/20	200x500	150x320	220
BSF 200/30	300x500	180x340	250
BSF 200/40	400x600	230x360	300
BSF 200/50	400x900	230x360	300
BSF 250/50	500x900	250x410	350
BCC 250	200x400	200x300	200
BCC 450	300x530	280x400	250
BCC 800	350x800	350x800	350

1) The values will vary to some extend depending on the concrete reinforcement, allowable bending diameter and required concrete cover.

6.3 Reference levels

In order to secure correct positioning of the units in the concrete elements the manufacturer has prepared drawings with positioning points for each type of connection. It is important that all the reference points are specified on all the production drawings to obtain a correct position.

6.4 Position tolerances

Table 7 shows the required position tolerances for the connections. The tolerances are the sum of maximum allowable deviation between the beam and the column units. The deviation is relative to the theoretical "exact" alignment. If the latch groove in the knife is enlarged, the angular deviation is as shown in the brackets.

Table 7.
Position tolerances for the connections

Beam connection	Maximum allowable deviations for the position of beam and column units	
	Vertically	Transverse horizontally
All	± 20 mm	± 10 mm
	Maximum angular deviation (based on the free space in the column unit)	
BSF (all)	± 5°	
BCC 250	± 11° (± 18,5°)	
BCC 450	± 11° (± 21°)	
BCC 800	± 11° (± 21°)	

6.5 Special design considerations

Special connection designs and installation systems are required when the connections shall serve as expansion joints, be attached to circular columns, used for no right angle connections, or used in prestressed concrete elements. The horizontal reinforcement bars in the lower part must be welded directly to the side plates when the beam units have no bottom plate in order to reduce cost.

6.6 Installation on site

The beams must hang vertically in the lifting device. The lifting points must be in line with the centre of gravity for beams with unsymmetrical cross sections.

Before hoisting the beam into position the knives are retracted inside the beam unit. When the beam is in the correct position, the knives are pushed out of the beam and into the column units by means of a crowbar. The beam is then lowered carefully to the supported position, making sure that the slots on the underside of the knives are hooked over the safety plate in the column unit. Before releasing the lifting device the joint width shall be checked. Normal joint width is 15 - 20 mm. Fig. 5 and 6 show how the width of the joint can be adjusted.

6.7 Joint between beam and column

The joint between beam and column is normally filled with a low shrinkage quick setting concrete based mortar to protect the connection against fire. Alternatively the joint may be filled with mineral wool as shown in fig. 7 if the joint shall be able to make allowance for thermal movements, creep or shrinkage.

6.8 Installation under winter conditions

The openings in the beam and column units must be completely free from water, ice and snow before installation. Ice in the openings must be removed with e.g. a heat blower.

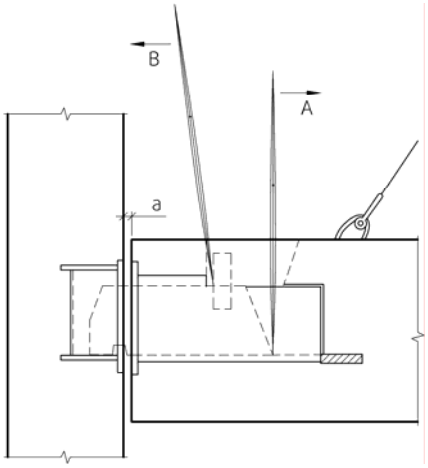

Fig. 5
Adjustment of the joint width (a) for the BSF unit with a crowbar in the slot.

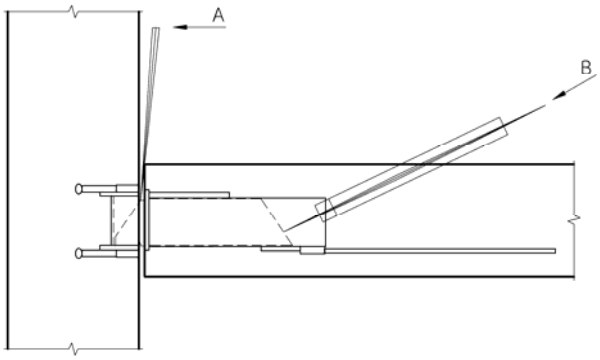

Fig. 6
Adjustment of the joint width for the BCC unit is done with a crowbar (A) and a steel-bar (B).

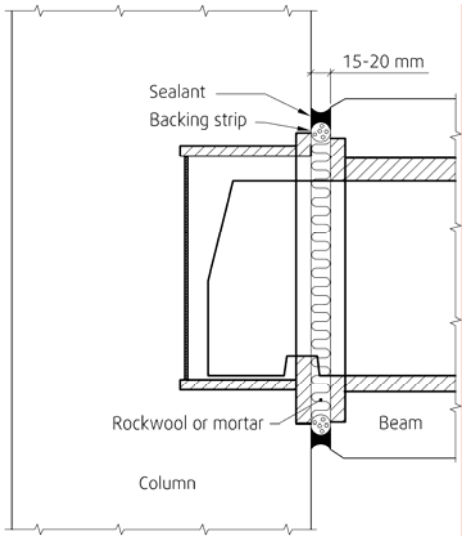

Fig. 7
Fire protection of the connection filled with mortar or with rockwool in the joint.

Frost resistant mortar shall be used for filling the slot in the beam unit and the joint between beam and column. Postponing the installation may be necessary at very low temperatures. If heating is applied the temperature must be kept sufficient high until the mortar has hardened.

6.9 Storage

During outdoor storage all openings in the beam and column units must be covered in order to prevent water or ice to enter the connections.

7. Factory production control

The production of BSF and BCC connections is subject to supervisory factory production control according to contract between SINTEF Building and Infrastructure and SB Produksjon AS as part of the Technical Approval.

8. Basis for the approval

The approval is based on verification of properties that are documented in the following reports:

- Prefabkonsult AS. Load test of the beam unit of BCC 250. Report 20.05.2005)
- Prefabkonsult AS. Statiske beregninger for BCC 250. Rapport av 12.07.2005, revidert 19.12.2005
- Prefabkonsult AS. Beregning av forankringene som brukes i BCC-enhetene. Rapport av 17.07.2005, revidert 19.12.2005
- Prefabkonsult AS. Statiske beregninger for BCC 450. Rapport av 07.07.2005, revidert 19.12.2005
- SINTEF Structures and Concrete. The BSF System – Calculation Modell and Experimental Investigation. Report STF70 F92150. December 1992
- Prefabkonsult AS. Additional report. Supplementary tests of the BCC 250 beam unit. Report 14.12.2005
- Erik Thorendfeldt/Sven Alexander. Kommentarer til TG 2501 og 2512. Notat av 21.03.2007

9. Marking

All BSF and BCC units shall be marked with type identification. The packaging shall be marked with the name of the manufacturer, product type and a production code indicating the time of production. The approval mark for SINTEF Technical Approval TG 2512 may also be used.

Approval mark

10. Liability

The holder/manufacturer has sole product responsibility according to existing law. Claims resulting from the use of the product cannot be brought against SINTEF beyond the provisions of Norwegian Standard NS 8402.

11. Technical management

Project manager for this approval is Sigurd Hveem, SINTEF Building and Infrastructure, dep. Materials and Structures, Oslo.

for SINTEF Building and Infrastructure

Trond Ø. Ramstad
Approval manager