Part 1:

Getting Started with PowerConnect (IS800 edition)

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1Introduction1.1Installing PowerConnect

1.1.1 Hard- & software requirements

PowerConnect is a 32-bit software program for the MS Windows operating system. Although it may be possible to run PowerConnect on previous versions of MS Windows (without any warranty from BuildSoft, however), it is highly recommended to use it on **MS Windows XP** or **MS Windows Vista**.

For a smooth operation of the software program, following requirements should be met:

- a minimum of 512 MB of RAM.
- A graphical card (by preference nVidia or ATI) with minimum 32MB RAM on-board, and supporting OpenGL

1.1.2 Installation procedure

The PowerConnect software can be installed from CD-ROM or over the internet. In this case, you should have a valid LOGIN and PASSWORD to access the "Customer Care" section of the BuildSoft web site <u>http://www.buildsoft.eu</u>. BuildSoft customers receive access to this protected section as part of their maintenance or lease service contract. Other people interested in evaluating PowerConnect receive valid access data for a 30-days period provided they register at the BuildSoft web site.

In case all defaults are accepted as proposed by the PowerConnect installation procedure, the software will be installed on the directory "C:\Program Files\Buildsoft\PowerConnect".

1.1.3 Demo copies of the software

In case PowerConnect is installed on a MS Windows workstation, the user will have access to a demo version of the software when no USB license dongle is available. A valid license on a USB dongle is indeed required to have continued access to all PowerConnect functions. With a demo license, existing PowerConnect models can be opened, while new models can only be defined with a cross-section determined by the program itself.

1.2 Local installations

1.2.1 Administration rights during installation

A correct installation of PowerConnect requires you to log on with appropriate administration rights.

1.2.2 Installing from CD-ROM

Insert the BuildSoft CD-ROM in your computer's CD-drive. After a short while, the BuildSoft installation program will appear on the screen. Select **PowerConnect** from the list of available programs to launch the installation.

1.2.3 Where to install ?

During the installation process, you will be prompted to define the location on your hard drive where PowerConnect should be installed. By default, the installation program will propose the directory *'C : \Program Files\BuildSoft\PowerConnect'*. It is recommended to confirm the default settings, although you are of course free to choose another location if this would be more convenient.

During the remaining part of the installation procedure, the choices made during each step can be confirmed by means of the 'Next'-button.

1.2.4 Completing the installation

Upon completion of the installation process, you will be asked to restart your computer. After a first installation of **PowerConnect** on a particular computer or after re-installation, it is indeed required to shutdown the computer and reboot it to obtain the licenses which are required to use **PowerConnect**.

1.2.5 Activating your license

To start with, it is important to remember that the installation procedure has been completed successfully, taking into account all elements discussed in the previous section.

Your PowerConnect license is delivered on a hardware dongle (CodeMeter-Stick) to be installed on a USB-port. The dongle is shipped to you with this reference manual. Please verify that the dongle is correctly plugged in before PowerConnect is launched. In case the dongle is correctly recognized by the operating system and a valid license is available on the dongle, PowerConnect will function directly with full access to all licensed capabilities. In case the dongle is not recognized by the operating system or does not contain any valid license, PowerConnect will report at start-up that only a demo license is available.

1.3 Network installations

With a network installation, the PowerConnect licenses are administered centrally on the server system. The server system doesn't actually need to be a server "stricto senso", but can actually be any workstation within the network environment that is accessible to all users at all times.

The management of the BuildSoft licenses is based on the license information stored on the hardware dongle (CodeMeter-Stick) that is connected to a USB port of the server system. Apart from installing the CodeMeter Control Center, no extra software needs to be installed on the server system. Is is however required to specify that the dongle should function as a network device, which can be done on the configuration page of the CodeMeter WebAdmin application. This application is a tool which allows to read the contents of the CM-stick, and can be launched by means of the CodeMeter Control Center window. The CodeMeter Control Center itself is launched through the icon S at the bottom right corner of your MS Windows desktop.

Furthermore, it is required to install both the CodeMeter Control Center and PowerConnect locally on workstation as described in <u>Local installations</u>. In case PowerConnect is launched and no CodeMeter dongle is present locally on your workstation, PowerConnect will automatically scan the network for valid PowerConnect licenses and will acquire the necessary licenses (if available).

1.4 Why PowerConnect?

PowerConnect is an exceptionally easy to use software program. Connection design analyses that would require hours when done by hand, can be performed in a very limited time frame when PowerConnect is being used. At the same time, PowerConnect will offer a significantly higher results accuracy because of the more refined analysis methods that have been implemented.

PowerConnect's user interface has been designed to enable the design engineer to define as easily as possible modifications to existing connection designs and to test in the shortest possible time frame the impact of various design changes on the connection strength & stiffness. As a consequence, optimal connection design becomes feasible. Throughout this process, the user will be supported by well-documented dialogue windows, thus easing the design task and minimising error risk.

Although the underlying design analysis methods are quite complex in nature, the user will not be hindered by this complexity during the design analysis process. As the PowerConnect analysis engine is quite fast, results will almost immediately be available so that the impact of various design modifications can truly be tested to gain more insight into the effect of various design parameters.

Each part of every connection can be documented in full detail. The graphics are an excellent aid to visually control all connection design analyses.

At the end of the process, a clear and concise analysis report can be produced. Drawings of connection elements (along with the appropriate dimensions) can directly be included in such a report and/or can be exported to various CAD programs for further exploitation.

1.5 PowerConnect benefits

The PowerConnect software allows for design analysis of various steel connection types, with or without a wide range of stiffening elements.

PowerConnect can be used as a stand-alone program, in which case all geometry and loads data are entered manually by the user. PowerConnect is also integrated within BuildSoft's **PowerFrame** program for 3D frame analysis. The PowerFrame Master license allows for an automated transfer of geometry and loads data from the 3D frame model to the PowerConnect environment for detailed steel connection analysis. During the transfer procedure, the user can apply filter criteria in order to automate the selection of relevant load cases.

1.5.1 Design analysis according to IS800

The IS800 standard (IS800 : 2007, section 10) covers the design analysis of structural joints connecting H- or I-sections. As PowerConnect currently supports a wider range of connection types than the ones which are actually specified in the IS800 design standard, PowerConnect will automatically switch to another design method for connection types not specified by IS800:

- EC3 for beam to column web connections
- EC3 (CEDICT) for hollow structural section joints.

2 PowerConnect tutorials – IS800

The best way to get acquainted with the PowerConnect software is to explore the product's functionality through a number of examples which highlight the various connection types supported by PowerConnect.

A range of examples based on the application of the IS800 design standard are covered in the tutorials below. The objective of the tutorials is not to provide a detailed and complete overview of the PowerConnect capabilities, but rather to concentrate on the information that is needed to get started with PowerConnect in a short time frame. The more detailed documentation of all product functions are covered in a separate reference manual.

Following items should be checked in order to run smoothly through all tutorials which are covered in this manual:

- verify if the proper design standard has been selected using the menu entry Analysis – Design Code – IS800, to ensure that the IS800 design standard will effectively be used during all design analyses.
- define a steel grade FY340 in the PowerConnect material library, and declare it to be the default steel grade for newly created elements. This is done through the menu entry "Edit – Material library", which launches the following dialogue window:

Remove	Material Library Steel S235 Steel S275 Steel S355 Steel S355 Steel S275 M Steel S355 M Steel S460 M Steel FY340 IS800 Concrete C12/15 Concrete C16/20 Concrete C25/30 Concrete C25/30 Concrete C35/45 Concrete C35/45 Concrete C50/60 Timber C18 Timber C12 Add new	Name FY340 IS800 Young's Modulus 210000 Poisson ratio 0.3 Transverse Young's Modulus 10000 Transverse Young's Modulus 1000012 Density 7850 Type Image: steel Image: Concrete Image: Concrete Image: Concrente Image: Concrete
	Remove	

Enter a new material	by using the button	Add new	, give a proper
name to the materia	I and make sure to e	nter the appro	priate strength
properties using the	Advanced parameters > > >	button:	

Advanded steel parameters - Steel FY340 IS800								
Eurocode3 : ENV 1993-1-1	·		Stren	<u>iqth</u>				
IS 800	Thickness (mm)	< 16	16-40	40-63	63-80	80-100	80-100	
	Yield strength fy	340	340	335	325	325	320	N/mm ²
	<u>Ultimate strength fu</u>	470	470	450	440	440	430	N/mm ²
	<u>Safety coef</u> δ _{M0} 1.1 δ _{M1} 1.25	ficient δ _{Mb} [1.2 δ _{Mw} [1.2 δ _{MF} [1.2	25 25 25					
Help						<u>C</u> ancel		<u>о</u> к

In the above dialogue window, make sure to select the IS800 design standard, and enter the appropriate value for f_y .

Inventory of tutorials:

Page	Section	Tutorial contents	Design code	Connection
page 8	§ 2.1	Tutorial 1: bolted beam to column flange (IS800)	IS800	
page 23	§ 2.2	Tutorial 2 : bolted beam to beam with moment end plate (IS800)	IS800	
page 33	§ 2.3	Tutorial 3 : column base with extended end plate (IS800)	IS800	4
page 41	§ 2.4	Tutorial 4 : bolted beam to column web (IS800)	(IS800) EC3	P
page 47	§ 2.5	Tutorial 5: bolted splice (IS800)	IS800	
page 52	§ 2.6	Tutorial 6 : shear connection – beam to column flange with fin plate (IS800)	IS800	
page 61	§ 2.7	Tutorial 7 : shear connection – beam to beam web with bolted angle cleats (IS800)	IS800	

page 66	§ 2.8	Tutorial 8 : HSS connection (circular members)	(IS800) CEDICT	
page 69	§ 2.9	Tutorial 9 : HSS connections (rectangular members)	(IS800) CEDICT	Y

2.1 Tutorial 1: bolted beam to column flange (IS800)



2.1.1 Setting up the model

Launch PowerConnect and use the "File – New" menu instruction or the D icon. A window will appear (the so-called navigation window) in which you can select the type of connection that you want to design. Among the available moment connection types, choose the one labeled

"Single-sided beam to column flange" (note: the labeling is done through the use of tooltips that appear when you move the mouse over the available icons). You will then initiate a tree structure through which you can navigate to select a specific connection type.

Choose the following entries

- haunched beam end plate
- flush moment end plate

to define a haunched connection without any further stiffening elements. Confirm your final choice using the 'OK'-button. Please check that the navigation window appears as illustrated below.



By means of the dialogue window that appears next, the connection definition can quickly be completed. While the proposed default values for length, slope and steel grade of connected members will be accepted, beam and column sections are modified as follows:

- ISMB 300 for the column member,
- ISMB 300 for the beam member.

Verify all other values as proposed by the program and change them, if needed, as shown in the dialogue window below. In particular, choose bolts of type M18. It should be realized that it remains possibly to modify them at any time through a straightforward interaction with the geometry model just by double-clicking on an element that needs modification.

Bolted column - beam connection					
	Braced Material Steel FY340 IS8	800 💌	End plate thickness width	CF CB	mm mm
Column Image: Column (Column) Beam Image: Column (Column) length slope welds	ISMB 300 ISMB 300 5000 0 5	mm °	Bolts		
Haunch height length Help	BH 3*BH	mm 🔛	type dass min. vertical distance horizontal distance	M 18 8.8 70 77	mm mm <u>Q</u> K

Remark: it is possible that some of the input fields in the above dialogue contain parameters rather than numbers (or even arithmetic expressions, rather than parameters by themselves). In this case, the corresponding dimension is linked to the dimension of another element of the connection. The actual meaning of the parameters can be clarified by means of the icon

button **I** in the dialogue window. For more information on this topic, consult the PowerConnect reference manual.

This definition is finally confirmed through the 'OK'-button, and as a consequence a 3D geometry model will be created and visualized on the screen.



2.1.2 Completing the geometry model

The scale which is used for model representation can be modified using the 'Zoom in' ($^{\textcircled{e}}$) and 'Zoom out' ($^{\textcircled{e}}$) icons of the icon toolbar or by using the scrollbar of

the mouse. The geometry model can furthermore be moved across the screen by holding down the left-hand mouse button while moving the mouse across the 'Geometry' window (take care not to position the mouse such that any of the connection elements is selected, it should really be positioned on the drawing canvas of the 'Geometry' window).

The dimensions of various elements of the connection that has just been created will now be further verified and modified, if needed. Double-click for instance with the left mouse button on the haunch and verify if the fields of the dialogue window are as shown below. In particular, **modify the length of the haunch such that it is twice the height of the beam element BH**.

Dimens	sions and position of haunch		x
technical general		geometry ISMB 300 details h:300 w:140 tf:12 tw:8 r:14 material Steel FY340 IS800 dimensions length IFIN? (1) 2TBH mm height (2) BH mm position welds C above beam Image: Comparison of the beam	
Dimens	sions and position of haunch	Help B Cancel OK	×
eneral	The cuts		
6	vertical cutting length :		
nica	thickness for vertical plate :	(5) 10 mm	
tech	thickness for horizontal plate :	(6) 10 mm	
	top corner vertical distance	(8) 20 mm	
	top corner horizontal distance	(7) 20 mm	
		Help 🕒 Cancel OK	

It should be noted that by default, the haunch is based on a ISMB 300 section, which is the section used for the beam element. If needed, the haunch can be based on a different section defined through the icon \blacksquare on the 'general' tab sheet.

The dimensions and the position of the end plate should also be verified. Again, double click on the end plate in the 3D 'Geometry' window to open the dialogue window below and fill out the parameters as shown hereafter.

Dimensions and position of end plate				
eral	geometry			
den de la companya de	total width	(b) ПР !?	CB	mm
	upper extension	(u1)	10	mm
	lower extension	(u2)	10	mm
	total height		620	mm
	thickness		CF	mm
	welds			
u2 o l o l	flange		5	mm
	web		5	mm
b	Steel FY340 IS800		materia	1
	friction coefficient		0.50	
	Help 🕒 🍋	Cancel	(ж

Each time a set of dimensions is confirmed for a selected element, PowerConnect will automatically verify the position and alignment of individual bolts. In case a problem is identified (either with respect to minimum distances imposed by standards or with respect to minimum distances specified by the user), PowerConnect will issue a warning on the matter.

2.1.3 Defining the loads

Now that the basic geometry definition has been completed, loads can be assigned to the connection. Switch to the "Loads" window by clicking on the

→ -icon that is part of the 'Windows'-toolbar:



The following information will appear in the 'Loads'-window.



Following loads should be applied:

- at the lower end of the column, a bending moment of 100 kNm and a normal force of 90 kN. Activate the appropriate dialogue by clicking with the mouse on the label "2" at the lower end of the column and by filling out the values in the dialogue which pops up;
- at the right end of the beam, a bending moment of 100 kNm and a shear force of 90 kN. Activate the appropriate dialogue by clicking with the mouse on the label "3" at the right end of the beam and by filling out the values in the dialogue which pops up.

As a result, the information in the 'Loads'-window should now appear as follows:



2.1.4 Running a first connection design analysis

The connection design analysis can be initiated in 3 different ways:

- through the menu command 'Analysis Analysis',
- through the shortkey F9,
- through the 🕮 icon in the Analysis toolbar.

Prior to running the connection design analysis, verify whether IS800 is defined to be the active steel design code. This can be done through the menu entry 'Analysis – Steel Design Code'. The summary results of the subsequent design analysis are presented below.



A more in-depth analysis of the above results already provides following feedback:

- the current connection design doesn't fulfill the imposed strength requirements, as the ratio of applied loading to resistance achieves a value of 1.19 (looking at the combination of **bending moment and normal force**),
- from the results available for **moments** only, it can be derived that the welds are OK
- from the **work level graph** valid for **moments** only, it shows that the column web, bolts and end plate are loaded up to their maximum capacity,
- from the results available for **shear** only, it can be concluded that the connection largely provides sufficient shear strength

For a more detailed interpretation of analysis results, it is possible to switch to a more advanced reporting lay-out. To this purpose, click with the mouse on the field 'Results preferences" at the right-hand bottom of the PowerConnect window.

Combination - Combination1 -	results prefs

In the dialog which appears now, ask for the results related to Combination 1, rather than to look at summary results. For the time being, it is sufficient to ask for all components results without any further details (as shown below).

show		
🔽 combination	Combination1	-
C headers	 components 	O details
summary		

This will provide the information shown below (only the first part of the screen report is shown; the remaining information can be screened by using the scrollbar on the right hand side of the PowerConnect window), from which following conclusions can be drawn:

- only bolt rows 1 & 2 contribute to the connection's resistance in bending
- the most critical components of the connection are the end plate (failure in bending) and the column web (shear failure)

This information, consistent with the information provided by the work level graphs shown before, allows to modify the connection to achieve the desired level of resistance.

Right-hand connection	
Moment	
Total moment resistance (MRd) = 84.6 kNm < Sollicitating moment (MSd) = 100 kNm Sollicitation must be reduced or connection must be adapted	
Force in bolt row n°1 = 135.7 kN (restrictive component : End plate in bending Force in bolt row n°2 = 29.9 kN (restrictive component : Column web in shear Force in bolt row n°3 = 0 kN	E
Force in bolt row n°4 = 0 kN	
Force in bott row n°6 = 0 kN	
Moment allowed by welds = 168.5 kNm >= Sollicitating moment (MSd) = 100 kNm	
Level arm	
n° bolt-row 1 2 3 4 5 6 Ievel arm(mm) 526 443 361 252 171 89	
Components	
End plate bending	
n° boll-row 1 2 3 4 5 6 Max.tension(kN) 135.7 102.4 135.7 114.6 100.9 137.5	
Tension in beam web	
n° bolt-row 1 2 3 4 5 6 Max.tension(kN) 254.8 204.4 254.8 222.8 202.1 257.5	
Bending in column flange	
n° bolt-row 1 2 3 4 5 6 Max.tension(iNi) 153.8 137.4 137.4 155.4 135.4 155.4	
Tension in column web	
n° bolt-row 1 2 3 4 5 6 Max. tension(i/t) 222.8 204.4 204.4 254.4 202.1 228.3	
4	۳ ۲

2.1.5 Optimizing the connection design

Based on the results provided by the first design analysis, a number of modifications will now be defined to the existing connection such that its resistance is increased by focusing on the most critical component information.

In a first step, it is decided to add a web plate to counteract the column web shear failure to increase the contribution of the second bolt row to overall connection resistance. Therefore, select the column web in the 'Geometry' window and click on the right-hand mouse button to make the following window appear on the screen.

Add or remove element
X Remove element
↓ Add beam (LHS)
11 Add backing plate (RHS)
Add web plate
Add upper stiffener (RHS)
H Add lower stiffener (RHS)
N= Add diagonal stiffener (RHS)
Add transverse stiffener (RHS)
<u>H</u> elp <u>Cancel</u>

Choose the option "Add web plate", and confirm this choice by means of the 'OK'-button.

In order to verify and to possibly modify the web plate dimensions, doubleclick on the web plate that is now visible on the geometry model. A new window will appear providing full access to all geometry details of the web plate:

le l		— ——	positioning	width limits
ger			O double	 full width
			 single 	 minimum width
			C rear	steel
			front	material Steel FY340 IS800
			dimensions	
			min upper length :	0 mm
			min lower length :	0 mm
			thickness :	CW mm (min: 8 mm)
			welds	
	2		a z	

Make sure all parameters match with the ones presented above.

Finally, double-click on one of the bolts that is part of the 3D geometry model to have access to the definition of bolts & bolts lay-out. As only 2 bolt rows have an active contribution to the connection's bending resistance, a number of bolt rows will now be removed as follows:



 select one of the bolts belonging to bolt row 3 and

then use the icon ⁽ to remove this bolt row,

- out of the remaining 5 bolt rows, again select bolt row 3 to remove it using the same icon,
- out of the remaining 4 bolt rows, again select bolt row 3 to remove it using the same icon,
- then use the icon 'Minimum



optimisation'

to

optimize bolt row positions with minimum intermediate distance (the

other icon will optimize bolt row positions with maximum intermediate distance)

In case the user wants to further fine-tune bolt row positions, this can be easily achieved as follows:

- select the bolt row which needs re-positioning
- activate the vertical displacement function I and move the selected bolt row as required
- alternatively, the arrows can be used to move the selected bolt row according to the selected precision level;

10mm

○ 1mm ⊙ 0.1mm

Currently, it is assumed that no such modifications are implemented to the lay-out that was obtained using the minimum optimization function. The bolt row lay-out should thus look like



2.1.6 Re-running the connection design analysis on the optimized connection

Running the connection design analysis will now produce following summary results:



Those results confirm that not all strength requirements have been met yet by the connection, after the described changes have been introduced into the geometry model. Just like before, it remains possible to look at more detailed analysis results by clicking with the mouse on the field 'Results preferences" at the right-hand bottom of the PowerConnect window and by asking for the appropriate detail level for results reporting.

In the example below, detail is given on component level – and it can thus easily be deduced that the connection will now fail due to yielding of the end plate in bending. The most logical next step is therefore to increase end plate thickness.

Monest Tail nonserie resistance (RRd) = 91.1 km × Solicitating moment (RSd) = 100 km Scient bott ow n² = 91.5 kM (resistive component : End plate in bending For in bott ow n² = 91.5 kM (resistive component : End plate in bending Scient bott ow n² = 91.5 kM (resistive component : End plate in bending Moment allowed by welds = 188.5 kMm ×= Solicitating moment (RSd) = 100 kMm Destination Destination Destination	Right-hand connection	*
Total monet residue (MPC) = 91 91 W1 + 5 Suitabiling monet (MSC) = 100 MM Image: Suitability (Vestidue component: End plate in bending Image: Suitability (Vestidue component: End plate) Image: Suitability (Vestidue compone	<u>Moment</u>	
Bit State S	Total moment resistance (MRd) = 91.1 kNm < Sollicitating moment (MSd) = 100 kNm	
Force in bottrow 1 ² = 915 kW (restrictive component: End plate in bending Force in bottrow 1 ² = 105 kW (restrictive component: End plate in bending Woment allowed by weids = 168 5 kWm >= Solicitating moment (WSg) = 100 kWm Economical Solicitation In ¹ bottrow 1 ³ = 102 kW (restrictive component: End plate in bending In ¹ bottrow 1 ³ = 102 kW (restrictive component: End plate in bending Economical Bottrow 1 ³ = 100 kWm Economical Bottrow 1 ³ = 100 kWm Econom	Solicitation must be reduced or connection must be adapted	
Force in bolt row n³ 3 = 10.2 kW (restrictive component: End plate in bending Moment allowed by welds = 168.5 kWm >= Sollicitating moment (MSG) = 100 kVm Evel arm 	Force in bolt row "1 = 915 kN (restrictive component: End plate in bending Force in bolt row "2 = 915 kN (restrictive component: End plate in bending	-
Moment allowed by welds = 168.5 kMm >= Sollicitating moment (MSd) = 100 kMm 	Force in bolt row n°3 = 10.2 kN (restrictive component : End plate in bending	=
Level arm $\frac{1}{1}$ boltrow $\frac{1}{100}$ boltrow <	Moment allowed by welds = 168.5 kNm >= Sollicitating moment (MSd) = 100 kNm	
$\frac{ ^{1} \operatorname{boltrow} }{ ^{1} \operatorname{boltrow} }{ ^{1} \operatorname{boltrow} }{ ^{1} \operatorname{boltrow} $	Level arm	
Level affinitiant Bot Components End plate bending <u>m[*] bolt-row 1 2 3 3</u> <u>Max tension(ktV) 91.5 108.8 141.8</u> Dension in beam web <u>m[*] bolt-row 1 6 85.5 230</u> Bending (ntk) 166 185.5 230 Bending (ntk) 141.9 111.3 166.8 <u>Max tension(ktV) 141.9 111.3 166.8</u> Dension in column web <u>m[*] bolt-row 1 2 3 3</u> <u>Max tension(ktV) 175.6 148.4 222.5</u> Compression in column web <u>Max tension(ktV) 175.6 148.4 222.5</u> Max compression = 209.8 kV	n'bolitow 1 2 3 iudoparteni con	
Components End plate bending $\frac{n^* boltrow}{Max. tension(kN)}$ $\frac{n^* boltrow}{Max. tension(kN)}$ $\frac{n^* boltrow}{166}$ $\frac{n^* boltrow}{166}$ $\frac{n^* boltrow}{166}$ $\frac{1}{Max. tension(kN)}$ $\frac{1}{Max. tension$	iever am(mm) 501 491 02	
$\frac{End plate bending}{m^{2} boltrow} \frac{1}{91.5} \frac{2}{106.8} \frac{3}{141.8}$ $\frac{Dension in beam web}{1000000000000000000000000000000000000$	Components	
n° bolt-row 1 2 3 Max. tension(tN) 91.5 106.8 141.8 Tension in beam web m° bolt-row 1 2 3 Max. tension(tN) 166 85.2 230 Bending in column flange	End plate bending	
Image instant(v) 91.5 100.5 141.0 Tension in beam web 1 2 3 Max tension(k1) 166 185.5 230 Bending in column flange 1 1 2 3 Max tension(k1) 141.9 111.3 165.8 Tension in column web 1 2 3 Max tension(k1) 141.5 148.4 222.5 Compression in column web Max compression = 209.8 kN N	n* bolt-row 1 2 3 How needed bit 1 4 1 9	
Iension in Deam Web m* bolt-row 1 2 3 Max tension(vh1) 166 185.5 230 Bending in column flange m* bolt-row 1 2 3 Max tension(vh1) 141.9 111.3 165.8 Tension in column web m* bolt-row 1 2 3 Max tension(vh1) 175.6 148.4 222.5 Compression in column web Max compression = 209.8 kN Max compression = 209.8 kN Max compression = 209.8 kN 		
Image tension(kN) 166 185.5 230 Bending in column flange in bolt-row 1 2 3 Image tension(kN) 141.9 111.3 165.8 Tension in column web in bolt-row 1 2 3 Max tension(kN) 141.2 3 48.8 422.5 Compression in column web in col		
Bending in column flange n° bolt-row 1 2 3 Max tension(kN) 141.9 111.3 165.8 Tension in column web n° bolt-row 1 2 3 Max tension(kN) 175.6 148.4 222.5 Compression in column web Max compression = 209.8 kN	Max tension(kH) 166 185.5 230	
n° bolt-row 1 2 3 Max. tension(N1) 141.9 111.3 165.8 Tension in column web m². tension(N1) 1 2 3 Max. tension(N1) 175.6 148.4 222.5 Compression in column web Max. compression = 209.8 kN N	Bending in column flange	
Max. tension(N) 141.3 111.3 165.8 Tension in column web Max. tension(N) 1 2 3 Max. tension(N) 175.6 148.4 222.5 Compression in column web Max. compression = 209.8 kN N	n* bolt-row 1 2 3	
Tension in column web n* bolt-row 1 2 3 Max tension(HV) 175.6 148.4 222.5 Compression in column web Max compression = 209.8 kN X	Max.tension(xN) 141.9 111.3 105.8	
n° bolt-row 1 2 3 Max. tension(kN) 175.6 148.4 222.5 Compression in column web Max. compression = 209.8 kN KN	Tension in column web	
Compression in column web Max compression = 209.8 kN	m boltrow n z 3 Maxtension(M) 175.6 148.4 222.5	
Max. compression = 209.8 kN	Compression in column web	
	Max.compression = 2008 NN	
Shaarin collimn woh	Shaar in column wah	+

Increasing end plate thickness is most easily done by double-clicking on the end plate element in the 3D view of the connection to make the following dialogue window appear.

Dimen	isions and position of end plate				X
eral		geometry			
gen		total width	(b)	CB	mm
	ul j	upper extension	(u1)	10	mm
		lower extension	(u2)	10	mm
		total height		620	mm
		thickness		CF+2	mm
		welds			
		flange		5	mm
		web		5	mm
		Steel FY340 IS800		materia	
		friction coefficient		0.50	
		Help 🕒 🐘	Cancel	0	ж

By default, end plate thickness is parametrically defined to be equal to column flange thickness CF. Define end plate thickness to be 2mm larger than column flange thickness CF and rerun the design analysis. As can be seen from the fully detailed results below, the connection now has sufficient strength to resist the applied loading.

Complete results for -Combination1-	^
Right-hand connection	
Moment	=
Total moment resistance (MRd) = 111.1 kNm >= Soliicitating moment (MSd) = 100 kNm	
Force in bolt row n°1 = 124.6 kN (restrictive component : End plate in bending Force in bolt row n°2 = 86.4 kN (restrictive component : Column web in compression Force in bolt row n°3 = 0 kN	
Moment allowed by welds = 168.5 kNm >= Sollicitating moment (MSd) = 100 kNm	
Level arm n° bolt-row 1 2 3 level arm(mm) 551 491 62	
Components	
End plate bending	
n'boltow 1 2 3 Mee trainaidh 0426 455 4550	
max.terisriningvi 124.0 140.3 100.5 Model 140.3 100.5	
Mode 2 (End plate)(kN) 177.4 198.1 245.7	
Mode 3 (End plate)(kN) 124.6 145.3 193	
Mode 4 (Bolls)(NI) 2212 2212 2212 Mode F (2011)(NI) 450 450 450 450 450 1	
mode 5 (2013)(M) 553 1003 1003 1003	
Tension in beam web n° bolt-row 1 2 3 Max tension(th) 166 1865 230	
Bending in column flange	
n° boltrow 1 2 3	
Max.tension(kii) 141.9 111.3 105.8 Uuded (Colume Researchith) 450.7 40.4 00.0	-
	ŕ

It is interesting to look a bit more closely in the design analysis results, in particular those for the end plate bending failure mechanism. It can indeed be seen that the maximum bolt row forces corresponding to bolt failure are significantly higher than those corresponding with an end plate yielding mechanism. As the connection is reported to fail through end plate yielding, this indicates that bolt size can still be reduced without any (or limited) negative impact on connection design strength.

For example, if bolts are changed from type M18 to type M16 (leaving the position of the 3 remaining bolt rows unaffected) then the overall moment resistance of the connection is not reduced (see below).

	_
Complete results for -Combination1-	^
Right-hand connection	
Moment	
Monent	=
Total moment resistance (MRd) = 111.3 kNm >= Sollicitating moment (MSd) = 100 kNm	
Force in bolt row n*1 = 128.3 kN (restrictive component : Bolts in tension on end plate Force in bolt row n*2 = 82.7 kN (restrictive component : Column web in compression Force in bolt row n*3 = 0 kN	
Moment allowed by welds = 168.5 kNm >= Sollicitating moment (MSd) = 100 kNm	
<u>Level arm</u>	
n* boll-row 1 2 3 level arm(mm) 551 491 62	
Components	
End plate bending	
Max tension(KN) 128.3 128.3 128.3	
Mode 1 (End plate)(KN) 153.6 174.4 222	
Mode 2 (End plate)(kN) 177.4 198.1 245.7	
Mode 3 (End plate)(kN) 129.8 150.6 198.2	
Mode 4 (Bolts)(KN) 180.9 180.9 180.9	
Mode 5 (Bolts)(KN) 128.3 128.3 128.3	
Beff(mm) 67 75 93	
Tension in beam web	
n* bolt-row 1 2 3	
Max tension(ivt) 166 1855 230	
Bending in column flange	
n° boll-row 1 2 3	
Max.tension(KN) 135.6 116.9 135.6	
Hade 1 (Column Benney/IAI) 470 5 444 0 005 0	

Of course, the actual failure mechanism that limit the moment capacity of the connection have changes as a result of bolt size reduction. The first bolt row will fail in tension – further reducing bolt size will therefore also reduce connection resistance.

2.2 Tutorial 2 : bolted beam to beam with moment end plate (IS800)



2.2.1 Setting up the model

To define the model for this second tutorial, click on the 'New' icon ^D of the icon toolbar. Among the connection types which are available in the navigation window, select the one labeled "Beam to beam" (remember: the labeling is done through the use of tooltips that appear when you move the mouse over the

available icons). Then further navigate through the tree structure by choosing the following entry

• bolted moment end plate

to finally select a beam to beam connection without any further stiffening elements. Confirm this final choice using the 'OK'-button, checking that the navigation window appears as illustrated below.



In the window that appears next, modify the data as follows:

- beam section : ISMB 300
- beam length : 3000 mm

- slope of beam : -15°
- bolts M18, grade 8.8

to arrive at the input data as shown below.

Bolted beam - beam connection			X
Image: Braced Material Steel FY340 IS800 ISMB 300 length slope -15 welds	End plate thickness width Bolts type class min. vertical distance horizontal distance	CF m CB m 8.8 v 70 m 77 m	m m m
Help		<u>C</u> ancel (<u>о</u> к

Confirm by means of the 'OK'-button to make following geometry model appear.



To re-align the bolt rows from the defaults proposed by PowerConnect, double-click on one of the bolts to make the bolt definition dialogue appear.



Optimize bolt row lay-out by means of the 'Optimization' icon that the following lay-out is obtained:



As a result, the 3D geometry model will look as follows in the 'Geometry'-window:



2.2.2 Defining the loads

Now switch to the 'Loads'-window by means of the icon. 2 loads combinations will be defined:

- in a first combination, a bending moment of 120 kNm will be applied at both sides of the connection
- in the second combination, a bending moment of 90 kNm and a compressive force of 150 kN will be applied at both sides of the connection

By default, PowerConnect presents only 1 loads combination. Before the values for this first combination will actually be filled out, the second combination that is needed with this model will first be created. To do so, click on the label 'Loads preferences" at the right hand bottom of the 'Loads'-window. Then use the button "List of combinations" to open the appropriate definition dialogue.

combinations		
combinations	Combination1	-
[List of combinations)

Use the 'Insert new combination'-button and specify the name "Combination2" for the new combination that has just been created. Now click 'OK' to confirm those definitions and to quit the window

Combinations				
Combination 1 Combination 2				
Name Combination 2				
Insert new combination				
Delete combination				
Finport list of combinations				
Export list of combinations				
Help Cancel QK				

Make sure to leave the combination list visible at the right hand bottom of the 'Loads'-window and check if 'Combination1' is the active combination. Then enter the appropriate load values for this combination, by clicking on the small labeled numbers which are visible on the geometry representation in the 'Loads'-window.

This should deliver the following result :



Now make sure 'Combination2' becomes the active loads combination (combination list at the right hand bottom of the 'Loads'-window !) and enter the loads data as follows:



2.2.3 Running a first connection design analysis

As the connection is perfectly symmetric, it is of course sufficient to inspect the analysis results only for one side of the connection. For the time being, this inspection will be limited to the results summary (so the option "Summary" should be active when opening the window by clicking on the "Results preferences" label at the right hand bottom of the 'Results' window).



2.2.4 Improving the connection design

From the results summary, it is clear that the applied bending moment is too high as compared to the connection's moment resistance (for both loads combinations). To solve such type of problem, a haunch can for instance be added below the connected beams. To do this, select one of the beams in the 'Geometry'-window and make the "Add or remove element" dialogue appear by pressing the right-hand button of the mouse. Select the "Add lower haunch" option.



Now repeat this step for the other beam elements to create a symmetrically haunched connection.

Double-click on of the bolts to enter into the dialogue window to optimize the bolt lay-out taking into account the presence of the haunch (same procedure as before, but now use the MIN option to align bolt rows as close to the outer flanges as possible).



2.2.5 Re-running the connection design analysis on the modified connection

Running the connection design analysis again will now produce following summary results:



As can be seen from the results summary, the connection still has insufficient strength with respect to the applied loads combinations. Failure will occur due yielding of the end plate, which brings us to increasing the thickness of both end plates from CF (= 8mm) to CF+2 (= 10mm) in the dialogue window which is obtained by double-clicking on the end plates.

Dimensions and position of end plate				×
	geometry			
deu	total width	(b) ПРІ ?	CB	mm
ul	upper extension	(u1)	10	mm
\circ \circ	lower extension	(u2)	10	mm
	total height		631	mm
	thickness		CF+2	mm
	welds			
	flange		5	mm
۰- _ا - ۲	web		5	mm
0	Steel FY340 IS800		materia	
	friction coefficient		0.50	
	Help 🕒 🍋	Cancel		ж

After rerunning the analysis, it will be seen that the connection now has sufficient strength.

Complete results for -Combination 1-	
Left-hand connection	
Moment	=
Total moment resistance (MRd) = 152.5 kHm >= Sollicitating moment (MSd) = 120 kHm	
Force in bolt row n°1 = 154.2 kN (restrictive component : End plate in bending Force in bolt row n°2 = 137.4 kN (restrictive component : End plate in bending Force in bolt row n°3 = 10.9 kN (restrictive component : End plate in bending	
Moment allowed by welds = 170.5 kNm >= Sollicitating moment (MSd) = 120 kNm	
Level arm n° bolt-row 1 2 3 level arm(mm) 550 490 39	
Components	
End plate bending	
n' bolt-row 1 2 3	
Max.tension(kN) 154.2 145.3 147.2	
Mode 1 (End plate)(N) 180.6 171.7 174.5	
Mode 2 (Erit Direle)(NV) 207 195.1 201.7 Mode 3 (Erit Direle)(NV) 1542 1453 1472	
Mode (cho)philo() 211 2212 2212	
Mode 5 (Bolts)(N1) 156.9 156.9 158.3	
Bett(mm) 78 75 74	
Tension in beam web	
n* bolk-row 1 2 3 Max tension(KN) 193.8 185.5 183	
Compression in haunch	
Max compression = 637 kN	
Compression in beam web	-
Image: Control of the second secon	•

Inspecting more closely the detailed results for the end plate bending failure component will inform the user maximum bolt force for the first bolt row is

very similar between plate yielding & bolt failure mechanisms. This confirms that bolt size and end plate thickness are optimally "tuned" to each other – the end plate is predicted to fail almost simultaneously with the first bolt row.

The haunched beam to beam connection that has been obtained as the final result, could also have been created directly by making the appropriate choice from the navigation window (see below).


2.3 Tutorial 3 : column base with extended end plate (IS800)



2.3.1 Setting up the model

Use the icon D to define a new project. In the navigation window, select the connection type labeled "Column base plate'. Then further navigate through the window by choosing the entries

- extended base plate (2 sides 2 anchor bolts on each row)
- 2 anchor bolt rows

to arrive at a column base connection without any particular stiffener elements.



To actually create connection geometry, fill out all parameters as shown in the dialogue below.

Column base connection						X
	Braced		Material steel concrete	Steel FY340 I	S800 💌	
Column I III	ISMB 300		Base plate			
length	3000	mm	thickness		20	mm
welds	5	mm	left-right ext	ension	80	mm
Concrete block	,		front-back ex	xtension	20	mm
height	500	mm	🔲 with cram	ηp		
length	1000	mm	Anchor bol	lts		
width	1000	mm	type		A - I 20 💌	
			class		S500 💌	
Help				<u>C</u> a	ncel	<u>О</u> К

Now double-click on the concrete block to make a dialogue appear in which further details of the concrete base can be verified or modified. Check e.g. if the concrete grade of the base on the "General" tab page has really been defined to be M30 during the previous step, and modify (if necessary) by using the "Material"-button.

Column base		×
	Dimensions	
Ger	length (L):	1000 mm
	thickness (E):	500 mm
deta	depth (P) :	1000 mm
-	🔽 Column at center	
	Coordinates X : 500 mm	Y : 500 mm
	Concrete	
	Material Concrete M30 (IS)	
L P		
	Eeip 🔂 Cancel	OK

Switch to the 'Details'-tab for further data on grout thickness & grade.

olur	nn base		
general	Grout grout thickness : 10	mm	Grout thickness should not exceed 0.2 times minimum width of steel base plate
details	Grout grade characteristic compressive strength (fk):		Characteristic strength of grout must at least be 0.2 of characteristic strength of concrete block.
	friction coefficient between plate and grout (Cfd):		
		<u>H</u> elp	Cancel OK

Double-click on the base plate to access its properties.

Base plate caracteristics		
	Geometry	
	Thickness :	BH 20 mm
1.3.2	Length = 460 mm	
	(1) Left extension :	80 mm
	(2) Right extension :	80 mm
U.,	Width = 180 mm	
4	(3) Back extension :	20 mm
	(4) Front extension :	20 mm
	Steel	
Anchors	Material Steel FY340 IS80	0
	Help 🕒 🐴	Cancel OK

Use the 'Anchors'-function to gain access to anchor bolts details. If needed, maximize the window size to get a good view on anchor bolt lay-out & details.



The window not only shows base plate dimensions and anchor bolts positions, but also includes a number of anchor zones that can be used to define the anchor bolts configuration. In case an anchor bolt row needs to be added, the appropriate anchor zone must first be selected using the mouse. The borders of a selected zone will be highlighted in red. Next, the icon

should be used to add a bolt row to the selected zone.

In general, the central part of the base plate can contain up to 4 anchor zones (depending on the available space):

- 2 zones will serve for anchor bolts parallel to the column flanges,
- 2 zones will serve for anchor bolts parallel to the column web. Anchor bolts parallel to the column web will not contribute to the base plate connection's moment resistance, unless no anchor bolts are present in any of the other zones.

The type of anchor bolt should of course also be specified. Use the "Anchor



details" icon to this purpose, which will make the following dialogue window appear.

Anchors and nuts						X
	Anchor :					
II	dimensions			grade		
	diameter :	20 n	nm	Class :	S500	•
	hole diameter :	22 n	nm	fu :	500	N/mm²
	length :	400 n	nm	fy :	500	N/mm²
	A tot :	314 n	nm²	🔲 pret	ensioned	
	A net :	245 n	nm².	free spa	ace	
	type				54	mm
	• —		0		0	mm
	Special -	anchor	1			
	V max :	10 k	dN	T max :	10	kN
<u>Library</u>	Nut :					
Chose anchor	diameter :	34 n	nm			
A - I - 20 ▼	height :	14 n	nm			
		,				
	<u>H</u> elp			Cancel		OK

On the left hand side, a specific anchor bolt can be selected from PowerConnect's library of bolts & anchor bolts. For the time being, keep the default 'A-I-20' proposed by the program. 'A-I-20' corresponds to straight anchor bolts with a diameter of 20mm.

As no modifications must be defined as far as anchor bolt choice is concerned, the "Cancel"-button can be used to return to the anchor bolt lay-



out window. Use the icon **to** optimize anchor bolt positions, to obtain the following lay-out:



Click 'OK' to complete the base plate connection definition. In the 'Geometry'window, the following model will now be presented:



2.3.2 Running the connection design analysis

For the current analysis, no specific external loads will be applied. As a consequence, the design analysis will evaluate the connection's resistance, independent of any loading. The following result will be obtained:



With this particular user scenario, there is no such thing as a "bad" or "good" connection. The resistance that has been calculated should be compared to a specific set of loads to which this type of connection will be subjected to enable that kind of judgment.

Depending on the failure capacity of all parts of the base plate connection, PowerConnect will show a diagram which represents all allowable combinations of bending moment & normal force (compressive forces are positive).

All loads combinations which fall within the green area of this diagram, correspond to loads which can be sustained. In case a particular loads combination falls outside this area, the base plate connection should be modified to resist the applied loading. The more detailed design analysis results that are made available by PowerConnect can be used to better understand the critical connection components and to optimize connection design. Critical components can be identified from the 'Results diagram' as shown below, and from the more detailed results reporting.



2.4 Tutorial 4 : bolted beam to column web (IS800)



2.4.1 Setting up the model

A beam with ISMB 300 section is connected to the web of a column with ISMB 200 section by means of a bolted moment end plate (3 rows of M18 grade bolts). No particular stiffener elements are added.

No loads will be applied on the connection, so that the design analysis will be limited to the evaluation of the connection's resistance in bending & shear.

Use the navigation window to arrive at a single-sided beam to column web connection using a flush end plate:



In the next step, make sure that the beam and column sections are defined correctly. Choose other sections from PowerConnect's section library, if needed.

Bolted colun	nn - beam con	nection				- ×-
	F	☐ Braced <u>Material</u> Steel FY340 IS800	•	End plate thickness width	CF	mm
<u>Column</u> <u>Beam</u>	<u>L</u> 酚 L 酚	ISMB 200 ISMB 300			1	
length slope welds		5000 mm 0 ° 5 mm	1	<u>Bolts</u> type class	M 18 ▼ 8.8 ▼	
				min. vertical distance horizontal distance	70 77	mm mm
Help	■I? BH				Cancel	<u>O</u> K

When confirming the above parameters, the following 3D geometry model will be presented.



If needed, end plate & bolt characteristics may still be modified. Double-click on one of the bolts to open the bolt definition dialogue window,

and use the

	Í 🚛
1	

icon to verify whether the currently selected bolts are grade M18 indeed.

\bigcirc	∏ }
ò	t t
	-

Finally, use the icon to optimize bolt row positions, to arrive at the following lay-out:





All parameters have now been defined so that now the connection design analysis can be launched.

2.4.2 Running the connection design analysis

Launch the design analysis to evaluate connection resistance. As the IS800 standard does not give any specifications with respect to this type of connection, following warning is issued by PowerConnect.

ĺ	PowerConnect
	This connection can not be calculate with IS800. PowerConnect uses the Eurocodes
	ОК

PowerConnect will automatically switch to the EC3 design standard, and will deliver following results.



In case a beam is directly connected to the column web (albeit through the use of an end plate), it may happen that the column web does not provide a sufficiently high resistance. Both local or global failure of the column web may occur. A local failure mechanism occurs when e.g. a bolt row that is subjected to tension, fails.

Three types of local failure mechanisms are possible on the column web: bending, punching or a combination of bending & punching. PowerConnect will screen all possible local & global failure mechanisms and will present detailed analysis results for all of them. In the current case, the connection will fail globally.

Moment			· · · · · · · · · · · · · · · · · · ·
Total moment resistance (MRd) = 14.5	5 kNm >= Sollicitating moment (MSd) = () kNm	Г
Bolt row n°1, Restrictive component: Column web global failure (weak a Bolt row n°2, Restrictive component: Column web global failure (weak a Bolt row n°3, Restrictive component: Column web global failure (weak a (Reference : §6.2.7)	xis orient.), Moment : 11.3 kNm xis orient.), Moment : 2.5 kNm xis orient.), Moment : 0.6 kNm		
Moment allowed by welds = 103.8 kNr	m >= Sollicitating moment (MSd) = 0 kNr	n	
Components			
Bolt row level arm and tensile force in bolt-row n° bolt-row 1 level arm (mm) 2 level arm (mm) 22 level arm (mm) 25 other (signal armonic signal ar	3 38 110.6 1 948.4 kN orient.) on (weak ass orient.) =817.1 kN 86 (M)		
(1): 59.1	(2+1): 92.6	(3++1): 126.2	
	(2): 59.1	(3+2): 92.6	
		(3): 59.1	
(Reference : (J-P. Jaspart thesis,ULg))		
Column web punching (weak axis	s orient.)		
Column web punching with compress tensile forces for each bolt group Ft(x)	ion (weak axis orient.) =419.6 kN Rd (kN)		
(1): 96.5	(2+1): 913.7	(3++1): 2451.6	,
•			m · · · · · · · · · · · · · · · · · · ·

2.4.3 Improving the connection design

Now return to the geometry window and select the beam element with the mouse. Using the right-hand button of the mouse, make all available stiffening elements appear, and select the lower haunch.

Add or remove element
X Remove element
Add upper haunch
Add Iower haunch
Add upper gusset
Add lower gusset
F Add transverse stiffener on beam
<u>H</u> elp



Now double-click on one of the bolts and then use the optimize bolt row positions, to arrive at the following lay-out:

icon to



2.4.4 Re-running the connection design analysis on the modified connection

Running the connection design analysis on the modified connection will produce following summary results:



As a result, the connection's bending resistance has been increased from 14.5 kNm to 31.1 kNm.

2.5 Tutorial 5: bolted splice (IS800)



Define a new connection and make the proper choice in the navigation window shown below, to define a bolted beam splice.



Upon confirmation of the above choice, a new dialogue window is presented to complete the definition. In particular, remember to enter the following parameters:

- ISMB 300 section for the beam element
- bolts M18 grade 8.8 for web & flange plates
- minimum intermediate distances for web plate bolts 120 mm in both directions, to ensure that only 2 bolt rows are used over the height of the web plate

	Bea	m	ISMB 300]
	leng	th	500	mm	
	weld	ls	5	mm	
Web plate			Bolts on plate bolted to	web	
thickness	BW n	nm	type	M 18 💌	
length	2*BH n	nm	dass	8.8 💌	
			min. vertical distance	120	mm
			min. horizontal distance	120	mm
Flange plates			Bolts on plates bolted to	o flange	
thickness	BF n	nm	type	M 18 🔻	
length	2*BH n	nm	dass	8.8 💌	
🗖 with basiling slats			min longitudinal distance	70	mm
j with backing plate			min. perpendicular distance	77	mm



As a result, the beam splice as illustrated in the 3D representation is obtained.

Bolted beam splices are always considered to be symmetrical by PowerConnect. As а consequence, the left half of the connection is identical to the right half of the connection. and anv

modification that is specified for any of the flanges will automatically be applied also to the other flanges.

During the previous steps, the bolt type and the number of bolt rows for the web plate have been defined. The lay-out of the different bolt rows will now be screened in more detail and bolt positions will be optimized when needed.

Just double-click on any of the bolts on the web plate to enter the appropriate dialogue window. The number of bolts in a vertical row can freely be chosen by the user. Adding a bolt to a specific row is done by selecting a bolt from

that row and then use the



icon to actually add a row. Adding a

complete bolt row is done by means of the same icon, but ensuring no single bolt row is currently selected. To remove a bolt row, selected one of its bolts





The same procedure can be used for the bolts of the flanges plates. It is sufficient to define the required modifications for one of the flange plates. Because of symmetry conditions, those changes will automatically be propagated to the other flange plate.

For this particular tutorial, it is not required to define any changes. The values that were proposed by PowerConnect after the initial definition steps can be accepted.

2.5.1 Defining the loads

Switch to the 'Loads'-window by means of the icon, and apply a tensile load of 500 kN at both sides. Remember: click on the small squares labeled "1" and "2" to actually assign those values to the node and to end up with the situation illustrated below.



2.5.2 Running the connection design analysis

The connection design analysis will deliver following results, using the previously defined parameters:



For this type of connection, PowerConnect will report the ultimate bending moments (both positive and negative). Those bending moments are calculated taking into account the shear force and normal force that have previously been applied to the connection (V = 0 kN & N = -500 kN).

The analysis results in terms of maximum normal force or shear force do not consider however the presence of a bending moment that is applied to the

connection. In case the connection is loaded by a bending moment, maximum shear & normal force values should be reduced.

Further details on the analysis results can be obtained by clicking with the mouse on "Results Preferences" field in the right hand bottom of the PowerConnect window. Choose the appropriate option to obtain the required level of reporting detail.

2.6 Tutorial 6 : shear connection – beam to column flange with fin plate (IS800)



In this first tutorial on shear connection design, the focus will be on a beam to column flange connection through fin plates.

2.6.1 Setting up the model

In the PowerConnect navigation window, first select the **Shear Connection** icon to start the navigation. Then choose following specifications to complete the

connection type selection:

- Single-sided beam to column flange
- Fin plate

to end up with a selection tree as below:



Upon confirmation of this choice through the "OK"-button, a new dialogue window appears in which further details on the connection elements can be entered.

Shear connection with fin plate			
	Material Steel FY340	IS800 💌	[
<u>Column</u>	IM	ISMB 300	
<u>Beam</u>	IM	ISMB 300	
Fin plate			
thickness		BF	mm
width		80	mm
upper off-set		30	mm
lower off-set		30	mm
welds		5	mm
Bolts			
type		M 18 🔻	
class		8.8 🔻	
min. vertical distance		70	mm
horizontal distance		70	mm
Help		<u>C</u> ancel	<u>0</u> K

In particular, following parameters should be verified:

- section of column & beam : ISMB 300
- bolts type M18, grade 8.8
- width of fin plate : 80 mm



Column and beam length have no impact on the analysis results whatsoever, as all verifications during the analysis are related to shear force only. As this type of connection is verified only for shear force, no bending stiffness is evaluated and the connection is thus assumed to be a pinned connection.

Confirm any modifications to defaults values by means of the 'OK'-button, to arrive at the connection as illustrated alongside.

2.6.2 Verifying the geometry model

Further details on specific connection element scan be obtained by doubleclicking on any element with the mouse. For example, double-click on the beam to verify that a gap of 10mm has been specified between the beam and column, and modify if needed.

Dimer	nsions of right-hand beam	×
details general		geometry ISMB 300 details h:300 w:140 tf:12 tw:8 r:14 material Steel FY340 IS800 length
		beam position
		gap 10 mm
		Help 🕒 🍋 Cancel OK

The position of the bolts will also be verified. Double-click on any of the bolts to see that all bolts are positioned centrally with respect to the fin plate.



Assume now that all bolts should be moved horizontally to the right over a distance of 5mm. PowerConnect has a number of tools, next to the optimized bolt positioning functions, to define bolt positions manually. To start with, it is important to understand that those tools operate on horizontal bolt rows, and that each tool requires the selection of a single horizontal bolt row. As in the current example each bolt row contains exactly 1 bolt, bolts need to be selected individually in this example and then the requested horizontal shift can be specified.

Select the first bolt, and a number of items on the left hand side of the window will be activated

Use the icon and the color will switch to red

indicates that the selected bolt can easily be moved horizontally by sliding it with the mouse. Use this tool only for roughly repositioning selected bolts.



This function can be used in case an exact repositioning of bolts is required. First select the requested precision (0.1, 1 or 10mm - select 1mm for the current application. Then press the **b** icon five times to move the selected bolted by 5mm to the right. Repeat this operation for the other bolts, to arrive at the status illustrated below.



Confirm the new lay-out using the 'OK'-button to return to the 3D 'Geometry'window.

This

2.6.3 Defining the loads

Switch to the 'Loads'-window using the 12 icon, click with the mouse on the label "3" shown on the 2D geometry representation to enter a shear force of 200 kN. As a result, the contents of the 'Loads'-window should look as follows:



2.6.4 Running the connection design analysis

Use the icon to launch the design analysis. This analysis will present following summary, from which it can be concluded that the connection needs modification in order to be able to resist to the applied shear force.

[Note : Connection analyses are based on Indian Standard 19800 IS800] Summary Right-hand connection Shear Maximum shear force (VRd) = 182.7 kN < Sollicitating shear force (VSd) = 200 Most critical combination : - Combination 1 - Graph with work level for all combinations	kN					
Graph with applied shear	100-95 90-85 80-75 70-65 60-55 50-45 40-35 30-25			Graph 1	with calculated shear	100-95 90-85 80-75 60-55 50-45 40-35 30-25
<u>Normal force</u> Maximum tension (TRd) = 1842 kN >= Applied tension (TSd) = 0 kN Most critical combination : - Combination 1 - Maximum compression (CRd) = 212.8 kN >= Applied compression (CSd) = 0 Most critical combination : <u>Shear force and normal force</u>	ĸN					
Combination name	VSd	VRd	NSd	NRd	VSd NSd VRd + NRd < 1	
Combination1	200.00	162.67	0.00	184.20	1.23	X

The color graphs above indicate that the bolts are the most critical elements of the connection. To better understand the connection's actual failure mechanism, switch to more detailed reporting by clicking with the mouse on the 'Results Preferences' field at the right hand bottom of the PowerConnect window.

Results with components for -Combination1-		<u>^</u>
Right-hand connection		
Shear		
Shear resistance (VRd) for the connection = 162.7 kN		
The shear sollicitation (VSd) = 200 kN > Shear resistance (VRd) = 162.7 kN		
Restrictive component = Shear in boits on right-hand fin plate		
Components		
Shear in welds on fin plate		
Shear resistance of welds = 221.5 kN		Ξ.
Shear in bolts on fin plate		
Shear resistance of bolts = 162.7 kN		
Bearing of bolts on fin plate		
Bearing resistance = 310.4 kN		
Shear force in fin plate		
Shear resistance of fin plate - 398.6 kN		
Shear in net section = 422 kN		
Shear in total section = 513.9 kN		
Shear by block = 398.6 KN		
Shear in beam web		
Shear resistance of beam web = 265.7 kN		
Shear in total section = 501.2 kN		
Shear In Het Section = 494 9 NN Shear In Het Section = 494 9 NN		
anea log door a 2007 Me		
Shear resistance limited by bending in fin plate = 791 3 kN		
Buckling of fin plate		
Shear resistance limited by buckling of fin plate = 4557.7 kN		
Normal force	show	
Comparison (CS4 = 0.40 z= 21.2.8.40 (CB4)	Combination	
Comprovement (Course on W) = 2.120 m (COU) Restrictive element for max compression : Shear in holts on fin plate	C headers (components	C details
Tension = (TSd = 0 kN) <= 184.2 kN (TRd)		
۲ III		

This information confirms that the connection's resistance is limited by bolt shear. Furthermore, it is clear that the next critical component is shear in the welds – the corresponding failure load is about 10% higher than the shear force that is applied to the connection. This is important information, as it indicates that increasing the number of bolts should normally deliver the required design strength.

2.6.5 Improving the connection design

Considering previously specified minimum distances between bolts, this can only be achieved by increasing the fin plate width from 80mm to 150mm. Just double-click on the fin plate and adapt the width in the dialogue window that appears (see below).

Fin plate		×
uT	Geometry Width (b) :	■IB 150 mm
h	Off-set above (u1) : Off-set below (u2) : Height (h) : Thickness :	30 mm 30 mm 240 mm BF mm
u2	Welds Steel material Steel	FY340 IS800
Bolts details	Friction coefficient	0.50
	Help 🕒 Car	ncel OK

Next, a bolt will be added on each bolt row. Proceed as follows:

• select the bolt on the first row and use the on the same row



icon to add a bolt

• repeat the previous step for the second and the third bolt row



• use the

icon to automatically reposition the bolts



2.6.6 Re-running the connection design analysis on the modified connection

Running the connection design analysis on the modified connection will produce following component-level detail:

Results with components for -Combination1-	
Right-hand connection	
Shear	
Shear resistance (VRd) for the connection = 190.2 kN	
The shear sollicitation (VSd) = 200 kN > Shear resistance (VRd) = 190.2 kN	
Restrictive component = Shear in welds on right-hand fin plate	
Components	
Shear in welds on fin plate	
Shear resistance of welds = 190.2 kN	
Shear in bolts on fin plate	
Shear resistance of bolts = 246.7 kN	
Bearing of bolts on fin plate	
Bearing resistance = 353.1 kN	
Shear force in fin plate	
Shear resistance of fin plate = 328.2 kN	
Shear in net section = 422 kN	
Shear in total section = 513.9 kN	
Shear by block = 328.2 kN	
Shear in beam web	
Shear resistance of beam web = 375.1 kN	
Shear in total section = 501.2 kN	
Shear in net section = 454.9 kN	
Shear by block = 375.1 kN	
Bending in fin plate	
Shear resistance limited by bending in fin plate = 445.1 kN	
Buckling of fin plate	
Shear resistance limited by buckling of fin plate = 811.2 kN	
Normal force	
Compression = (CSd = 0 kN) <= 425.7 kN (CRd)	
Restrictive element for max compression : Shear in bolts on fin plate	
Tension = (TSd = 0 kN) <= 184.2 kN (TRd)	

Connection shear resistance has been increased from 162.7 kN to 190.2 kN, which is insufficient to resist the applied shear load of 200 kN. It can be seen from the results that shear in the welds has now become the most critical component. The maximum shear in the welds has been reduced from 221.5 kN to 190.2 kN by introducing an extra bolt row. This can easily be explained by the fact that the eccentricity between the C.O.G. of the bolts and the C.O.G. of the welds has increased, thereby introducing an extra moment load on the welds. The connection resistance can only be enhanced if weld throat thickness is increased, eg. from 5 to 6mm (see dialogue below, which will appear on the screen by double-clicking on one of the welds).



As can be seen from the below results summary, connection resistance has been increased up to 228.3 kN.



2.7 Tutorial 7 : shear connection – beam to beam web with bolted angle cleats (IS800)



As a second example for shear connections, a beam to beam connection, using bolted angle cleats will be considered.

2.7.1 Setting up the model

Create a new PowerConnect project using the icon. In the PowerConnect navigation window, first select the Shear Connection icon to start the navigation. Then choose

following specifications to complete the connection type selection:

- Single-sided beam to web
- Coped beam to bolted angle cleat

to end up with a selection tree as below:



Confirm this choice with the 'OK'-button and then define further details in the following dialogue window.

Shear connection with angle cleats		
	Material Steel FY340 IS800	
Supporting beam	ISMB 300	
Beam	ISMB 250	
Angle cleat	ISA 100×100-6	
upper off-set	30 mm	
lower off-set	30 mm	
<u>Bolts</u>		
type	M 18	
class	8.8 💌	
min. vertical distance	70 mm	
Help	<u>C</u> ancel <u>O</u> K	

In particular, following parameters should be verified:

- section of supporting beam : ISMB 300
- section of beam : ISMB 250
- angle cleat : ISA 100x100-6
- bolts of type M18, grade 8.8

Confirm with the 'OK'-button to end up with the connection shown below.



With this type of connection, the upper surfaces of both beams are automatically aligned. In case the lower surfaces of the beams should be aligned, click with the right-hand button on the PowerConnect 'Geometry'window and choose the appropriate entry in the floating which allows to align the bottom surfaces of both beams. With this particular example, remain with the upper surfaces aligned.

Verifying the connection elements 2.7.2

The connection which has just been created can directly be used for design analysis. It remains however possible to manually change the characteristics of any connection element (or at least to verify them) by double-clicking on the element. This can be done for the supporting beam and for the other beam, but keep the values as they are proposed by default.

Now double-click on the angle cleat, and verify if angle cleats have been foreseen at both sides of the beam web. If not, make sure both the "Front side" and "Rear side" options have been checked.

Angle cleat on beam web	×
	Geometry
	LSA 100x100-6
	details B: 100 H: 100 t: 6 R1: 9 R2: 6
	material Steel FY340 IS800
	Length :
	Distance from de upper edge : 30 mm (> 30)
	Position
	✓ At front side ✓ At rear side
Bolts position	Friction coefficient 0.50
	Help 🚯 🍋 Cancel OK

Finally, have a closer look at the bolts. Just double-click on any one of them,



grade).

icon to change the bolt type from M18 to M16 (8.8 and use the

Bolts and nuts			X
	<u>Bolt :</u> dimensions		grade
	diameter : hole diameter : head diameter : head height : A tot : A pat :	16 mm 18 mm 27 mm 11 mm 201 mm² 157 mm²	Class : 8.8 fu : 800 N/mm² fy : 640 N/mm² pretensioned
	free space po	sition 60 mm	50 mm
Library Chose bolts M - 16	<u>Nut :</u> diameter : height :	27 mm 11 mm	
	<u>H</u> elp		Cancel OK



Optimize bolt positions by means of the button this change to arrive at the following bolt lay-out:

, and finally confirm



which corresponds to the connection below:



2.7.3 Running the connection design analysis

No loads are applied on the connection, as the only interest is to evaluate maximum shear resistance.



2.8

Tutorial 8 : HSS connection (circular members)



2.8.1 Setting up the model

Click on the icon to start a new PowerConnect project and select the **HSS Connections** icon from the navigation window. Choose following specifications to complete the connection type selection:

- Y/T connections
- Y (circular)

corresponding to the selection tree shown below:



In a next dialogue window, further details can be provided on hollow structural sections (including their relative orientation) and welds. Make sure to enter values as given in the dialogue window below.

Hollow structural section	connection 💽
0	
<u>Chord</u>	PIPE 135x4.5
welds	5 mm
<u>Diagonal 1</u>	正 師 PIPE 100x4.5
angle	45 °
<u>Material</u>	Steel FY340 IS800
Help	<u>C</u> ancel <u>Q</u> K

If wanted, further details on the hollow structural sections can be obtained (or modifications can be defined) by double-clicking on the corresponding members in the 3D visualization of the connection geometry.

2.8.2 Defining the loads

To apply a tensile load of 120kN to the diagonal chord, switch to the 'Loads'-

window by means of the 120 icon. Click with the mouse on the label "3" of the 2D geometry representation in this 'Loads'-window to impose the load (use a value of -120kN to ensure a tensile load is defined).



2.8.3 Running the design analysis

Launch the design analysis At this time, it should be remarked IS800 does not give any specification with respect to HSS connection design. Therefore, PowerConnect will inform the user that this connection type cannot be calculated according to IS800. It will automatically switch to the EC3 method, of which the implementation is actually based on a number of formula published by CIDECT, allowing for the analysis of a limited type of HSS connection configurations. This limits somewhat the number of connection types that can currently be analyzed by PowerConnect. Limitations are mostly related to the type of loads that can be considered during the analysis.

For the HSS connection that has been defined, the analysis will deliver following results.



PowerConnect evaluates the maximum values for different types of loads that can be applied on the connection, in particular normal forces and in-plane & out-of-plane bending moments.

PowerConnect will furthermore use those values to summarize the overall "loading level" of the connection, by comparing applied loads to maximum resistance using a dedicated combination formula. As such, judgment of connection strength really becomes a straightforward matter.
2.9 Tutorial 9 : HSS connections (rectangular members)



2.9.1 Setting up the model

Click on the icon to start a new PowerConnect project and select the **HSS Connections** icon from the navigation window. Choose following specifications to complete the connection type selection:

- KT connections
- KT (rectangular)

corresponding to the selection tree shown below:



For the main chord, a 100*80*5 section will be used, whereas for a 60*30*3 section will be used for all diagonals. Accept all other values as proposed by default by PowerConnect.

Hollow structural section	connection	Geometry	
<u>Chord</u>	RHS 100x80x5		
welds	5 mm		
gap	-40 mm		
Diagonal 1	正 師 RHS 60x30x3		_
angle	45 °		
Diagonal 2	RHS 60x30x3		
Diagonal 3	RHS 60x30x3		
angle	45 *		
<u>H</u> elp	<u>C</u> ancel <u>O</u> K	J	

2.9.2 Defining the loads

Now switch to the 'Loads'-windows and apply the loads as illustrated below, by clicking with the mouse on the appropriate labels with the 2D geometry representation.



2.9.3 Running the connection design analysis

The design analysis will present following results, and thus confirm that the connection can withstand the specified loads.

<u>Su</u>	mmary								
Le	ft-hand hollow	section							
Мо	ments and normal	force							
[NRd	NDd	MiQd	MiDd	MoRd	MoRd	NSd	MiSd	MoSd
	NSC	INRO	Misu	MIRC	MoSu	MORG	NRd	MiRd	MoRd
[25 kN	90,5 kN	-0,3 kNm	1,6 kNm	0 kNm	0 kNm		0,470	
	VSd = Sollicitating norr VRd = Normal force re: diSd = Sollicitating in-p diRd = In-plane mome doSd = Sollicitating out doRd = Out-of-plane m	nal force in secondary t sistance of secondary tr lane moment on secor nt resistance of second -of-plane moment on s ioment resistance of se	tube ube ndary tube lary tube econdary tube econdary tube						
Miz	de hollow com	nation is : Combination							
	adle hollow sec	-							
Mo	ments and normal	force		1					
	NSd	NRd	MiSd	MiRd	MoSd	MoRd	NSd +	MiSd	MoSd
	20 kN	55.7 kN	0 kNm	1.6 kNm	0 kNm	0 kNm	INRU	0.359	MURU
Ric Mor	<pre>dliRd = In-plane mome dloSd = Sollicitating out dloRd = Out-of-plane m The most critical combi int-hand hollow ments and normal</pre>	nt resistance of second L-of-plane moment on s ioment resistance of se ination is : Combination <u>section</u> force	tary tube iecondary tube icondary tube						
ſ	NSd	NRd	MiSd	MiRd	MoSd	MoRd	NSd +	MiSd +	MoSd
-	25 kN	90.5 kN	-0.3 kNm	1.6 kNm	0 kNm	0 kNm	NRO	0.470	MORG
יי א א א א א א א א א א א א א א א א א א	ISd = Sollicitating norm IRd = Normal force res IISd = Sollicitating in-p IIRd = In-plane moment IoSd = Sollicitating out IoRd = Out-of-plane m The most critical combin Upper hollow s Iane moment Combination 1 : [MISd(3)	al force in secondary to istance of secondary to iane moment on secon it resistance of second orbpiane moment on s oment resistance of se nation is . Combination <u>ections</u>) + MiSd(2) - MiSd(1)] (=	ube ube idary tube any tube econdary tube condary tube 11 =0 kNm) <= MiRd (= 4,8	i kNm)					
Out	-ot-plane moment								

Combination1: |MoSd(1) + MoSd(2) + MoSd(3)| (=0 kNm) <= MoRd (= 0 kNm)

3 PowerConnect reporting tutorials – IS800

Using some of the tutorial examples described in section 2 of this manual, the current section will focus on the information that is needed to get started with PowerConnect reporting in a short time frame. The reporting capabilities will not be described in detail, as the documentation related to this subject is covered in a separate reference manual.

Page	Section	Tutorial contents	Design code	Connection
page 72	§ 3.1	Tutorial 1 : bolted beam to column flange (IS800)	IS800	
page 78	§ 3.2	Tutorial 2 : bolted splice (IS800)	IS800	
page 83	§ 3.3	Tutorial 3 : shear connection – beam to column flange with fin plate	(IS800) EC3	

Inventory of reporting tutorials:

3.1 Tutorial 1 : bolted beam to column flange (IS800)

This reporting tutorial is based on the model created in section 2.1 of this manual.

3.1.1 Page setup

Before the actual report contents will be defined, the report page setup should be specified. Any page setup definition performed by the user will be remembered by PowerConnect, and will therefore be used also to create any subsequent report until new modification to the current page setup will be specified. For all reporting tutorials in this manual, we will stick with the page setup definition as specified in this section.

To start the page setup, use the menu command 'File – Page setup', so that the dialogue window below will be launched.

Apart from the rather obvious options related to definition of margins, fonts and font size, this dialogue allows to define the location of a bitmap file that

should be used to include a logo in the report. If needed, the user can also request the text and graphics of the report to be included in a frame by selecting the option 'Use a frame for report'. This option is not activated with the current reporting tutorial.

age setup				
<u>Margin</u>		10	mm	
	*	15	mm	
		10	mm	
	Ŀ	10		
		110	mm	
<u>Font</u>	Arial			-
Font size				
	normal	19	Title 1	16
	header	9	Title 2	14
	footer	9	Title 3	12
			Title 4	11
			Title 5	10
<u>Frame</u>	🔲 Use a fra	ame for report		
logo (bmp)	C:\Program	Files\BuildSoft	t\PowerCon	nect\LogoBu
<u>Header</u>				
left		-		Advanced
middle		Ŧ		🔽 Use
right		-		Set-up
Footer	,			
left		-		Advanced
middle		-		🔽 Use
right		v		Set-up
Help	1		Canc	el OK

To define report header & footer, the user can either use a number of preconfigured fields or enter into an advanced definition mode. Switch to this advanced definition mode, and enter the data as shown below:

• for the report header:

Advanced header configuration			
Left	Middle	Right	
Add file name	Add file name	Add file name	
Add file name with path	Add file name with path	Add file name with path	
Add page number	Add page number	Add page number Add logo (nothing else)	
Add logo (nothing else)	Add logo (nothing else)		
[&Logo]	BuildSoft NV Hundelgemsesteenweg 244/1 B-9820 Merelbeke, Belgium	Project : [&FileName]	
	 ₩ 		
Help		<u>C</u> ancel <u>D</u> K	

• for the report footer:

dvanced footer configuration		
Left	Middle	Right
Add date	Add date	Add date
Add file name	Add file name	Add file name
Add file name with path	Add file name with path	Add file name with path
Add page number	Add page number	Add page number
Add logo (nothing else)	Add logo (nothing else)	Add logo (nothing else)
[&Date]	·	[&PageNumber]
-	-	-
< >	K	<
Help		<u>C</u> ancel <u>D</u> K

3.1.2 Report configuration

The report can be configured in either one of the following three modes:

- **Preview** (initiated by the 🛕 icon of the icon toolbar),
- Print report (initiated by the 🚔 icon of the icon toolbar),
- Print report to RTF (initiated by the ¹ icon of the icon toolbar).

Irrespective of the chosen configuration mode, the working procedure is the same. In the scope of this tutorial, we will use the **Preview** mode.

In Preview or another configuration mode, 5 tab pages are available in the dialogue window used to define report contents. In this tutorial, only the first 3 tab pages will be used.

Start by selecting the option 'Summary drawing' on the first tab page. By doing so, the report will start with a summary overview of the entire connection geometry. How this summary overview should look like, can be defined by using the button 'Printing parameters', which opens a canvas window in which the summary overview definition can completed.

eview General Load	ds Results Element info Connection view	EX
Print p F	roject data Project data	
⊽ Summ	ary drawii	
	<mark>ary drawi</mark> ı Printing parameters	
I Summ	ary drawiı Printing parameters	
Adv	ary drawiı Printing parameters	

To create the kind of summary drawing shown below, make sure to select all connection views shown at the right-hand bottom part of the canvas window. Use the cursor icons to position the selected drawings in the appropriate positions, and also make sure the proper scale is selected (the selected scale of 1/10 is appropriate for a report on A4 paper format).



As soon as a proper lay-out has been defined, confirm by means of the 'OK'button to return to the definition dialogue window.

Now switch to the second tab page, and make sure that the option 'Loads combinations' is selected. This will ensure that the report includes an overview of all defined loads combinations. In case more than 1 loads combination is present, you should also make sure to select the loads combinations to be used for reporting in the list on the left-hand side. In the current tutorial example, 'Combination1' should be selected as indicated below.

review			•
General Load	ls Results Elen	nent info Connection view	
Combinations		✓ Loads combinations	
Adv	anced parameters		>>>
Help		Preview	<u>C</u> ancel

Now switch to the third tab page to specify how analysis results should be reported. Within this first reporting tutorial, the entire focus is on the creation of a concise analysis report. To do so, select the options 'Results summary' and 'Plots' as indicated below.

Preview	
General Loads Results Eler	nent info Connection view
Combinations	Results Detailed results Results for all components Major results Results summary Plots Work level with max. calculated moment Work level with applied moment Rigidity graph
Advanced parameters	<<< >>>
Help	Preview <u>C</u> ancel

The report configuration can now be considered to be complete, and the report itself can be visualized by means of the 'Preview' button at the bottom of the dialogue window. The outcome will be a report as shown below.

PowerConnect				- 8 💌
🖨 🍯 🖸 Oose	⊕् < > ∎ □			
	A 1 1 1	Builden W		
	(#) BuildSoft	D-9227 Merebena Begum	BuildSoft BEETWEER BUT	
	, 100 million		Loads	
	1 dameter 11 = 42 0W			
	8.8 111 - 110 340 Mm1, 340 Mm1, 5, 01 web = 5, 01 web	52.600 <u>429.6</u> 78.4.		
	vro natrices ally: N= number n	1 8 0 0 0 0 100 100-3000-100	Ĵ	
	Scale : Bott- A Dottda Steel da Web ps Peam : Haurol		<u></u>	
			V = 0 km V = 0 km V = 0 km M = 10 km	
			Summary Bible Land connection	
			Moment Memory Netwind postly moment (MEd) = 111.1 kNm >= Solistating moment (NSs) = 100 kNm	
			Neter offets contraints Control tation Net poster moment allower (webs -+6.5 kNm Solitotating moment (NSo) 100 kNm Neter ordical complication Otmohration	
		100 000 000 000 000 000 000 000 000 000	Graph with work level for all combinations Graph with applied moment Graph with abulated moment	
	T T			
			8455	
			Naminum tension in the beam (FRg) = 4.4 8 k/s = 50 licitating tensie force (TSc) = 0 k/s Next offsci constraints = - Comp ation 1 = - Tensim memory in the part of (TSc) = 0 k/s Tensim memory in the part of (TSc) = 0 k/s	
	2402005	Rage (Paul Converting Galadian	240000 Page P	
1/4				
PowerConnect			1	
🖨 🍯 🖸 🖸 Qose	€् < > ∎			
	闭 BuildSoft	eu eta orrang 19. nodejem sela en vegi 344.4 19. 9227 Mende eta, Beglum		
	Shear Maximum shear force (VRd) = 425.7 kN	+= Solicitating shear force (VSd) = 90 kN	Data	
	Nest critical combination Combination Normal force, moment and shear	ni- r combined	Aterial Data Steel F '240 (5800	
	Combination name MSd MPb	NSc NRc VSc VRc (1850 + NSc) + (VSc) + (1	Desity +780 0 gm* Young bould E + 21000 Nmm* Paters Patrix + 0.3	
	Constration Fraction (11.12	000 44737 3000 42567 032 V	Transversa francis G - 30 Transversa francis G - 800fe Nimm* Themic distation coefficient - 0.000ft2 //C	
			bitcomes critic [16 - ab] ab - 52 52 - 10 100 - 100 100 - 158 yield strength fy (Nmm) 340 340 335 225 220	
			(ultimeter steingth in (ultimeter)) 270 270 450 440 430 Secult coefficient: vide = 125 vide = 125 vide = 000	
			y MH - 125 Y MG - 125 Y MG - 0.00 Y MF - 0.00	
	24032009	Page 3	2402225 Page 4	
		PauxConner Is Suidert	Factorerbätt	

In case the current report should be available in PDF-format, use the appropriate PDF button. If not, use the 'Close'-button to return to the PowerConnect working environment. To actually print the report that has just been configured, use the icon to enter in **Print report** mode, and use the 'Print' button to send the report to the selected printer.

3.2 Tutorial 2 : bolted splice (IS800)

This reporting tutorial is based on the model created in section 2.5 of this manual.

3.2.1 Page setup

No changes will be made to the page setup defined in section 3.1.1 of this manual. The user should return to this section for more information on the current page setup.

3.2.2 Report configuration

Go to **Preview** mode by means of the <u>A</u> icon of the icon toolbar.

Again, start by selecting the option 'Summary drawing' on the first tab page and define how this summary overview should look like by using the button 'Printing parameters', which opens a canvas window to complete the summary overview definition.

Preview	x
General Loads Results Element info Connection view	
Project data	
🔽 Summary drawii	
Printing parameters	
Advanced parameters <<< >>>	
Help Preview <u>C</u> ancel	

To create the kind of summary drawing shown below, make sure to select all connection views shown at the right-hand bottom part of the canvas window. Use the cursor icons to position the selected drawings in the appropriate positions, and also make sure the proper scale is selected (the selected scale of 1/10 is appropriate for a report on A4 paper format).



As soon as a proper lay-out has been defined, confirm by means of the 'OK'button to return to the definition dialogue window.

Now switch to the second tab page, and make sure that the option 'Loads combinations' is selected. This will ensure that the report includes an overview of the loads combination that is part of this project, at least if 'Combination1' is selected as indicated below.

review			×
General Loads	Results Elen	nent info Connection view	
Combinations		✓ Loads combinations	
Adva	nced parameters	<<<	>>>
Help		Preview	<u>C</u> ancel

Now switch to the third tab page to specify how analysis results should be reported. Within this second reporting tutorial, the focus is on the creation of a more detailed analysis report. To do so, select the options 'Results – Results for all components' and 'Plots' as indicated below.

Preview	×
General Loads Results Eler	nent info Connection view
Combinations $\!$	Results
	C Detailed results
	Results for all components
	C Major results
	Results summary
	Plots
	✓ Work level with max. calculated moment
	✓ Work level with applied moment
	🗖 Rigidity graph
Advanced parameters	<<< >>>
Help	Preview <u>C</u> ancel

Now switch to the fourth tab page to specify that detailed drawings and data of all individual connection elements are to included into the report. For all elements, make sure to specify 'Yes' for both the 'Data' and 'Drawing' columns. This can be done for each entry individually, by selecting 'Yes' from the available pull-down menus. Alternatively, the buttons 'V Yes' on top of the columns can be used to convert globally to this setting for all elements.

In the 'Scale' column, a proper scale can be defined to be used for the individual element drawings. Again, this scale can be defined globally by choosing the proper scale factor through the pull-down menu on top of the column. It should be remarked that the drawing will always be rescaled automatically by PowerConnect in case it will not fit on the selected page format. If it does fit, the scale as defined by the user will not be modified.

eview							
General Loads Results	Element info C	onnectio	on vi	ew			
<u>Right-hand connection</u>		V no V	/ yes	V no N	/ yes	1/5	•
Element na	me	Data	a	Drawi	ing	Scale	2
Beam		yes	-	yes	-	1/5	-
Left-hand connection		V no V	/yes	V no 👔	Z.982	1/5	•
Element na	me	Data	a	Drawi	ing	Scale	
Beam		yes	-	yes	-	1/5	-
Plate on w	eb	yes	•	yes	-	1/5	-
Plate on upper	flange	yes	T	yes	-	1/5	-
Plate on lower	flance	ves	Ŧ	ves	-	1/5	v
Drawing with welds							
Advanced parame	sters		<<	<		>	>>

The report configuration can now be considered to be complete, and the report itself can be visualized by means of the 'Preview' button at the bottom of the dialogue window. The outcome will be a 10 page report as shown in part below (first 6 pages only).

		BuildSoft
		Loads
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2ah : 10 Piko bako oran e ante recentra piko bako oran piko bako aran piko bako aran piko bako aran bako aran bako aran bako aran bako aran		Combination1 barr11: barr12: N - 400 N N - 500 N V - 51N V - 20N M - 51N M - 50 N
		Plote: Connection analyzes a to based on Indian Standard (ISB00 (ISB00) Summmary
		Marrient Natinum, politike nomet (ME)+ - P A Life -+ Solidate grownet (ME) - Q Life Natinum register nomet (ME) 2 A Life A Nor - Solidating moment (ME) - D Life Nationum register - Come Janz - Solidating moment (ME) - D Life
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		Shear Mailmur sear took (VRI) = 117 8 N-> Soliciting sear toos (VSI) = 0 KN Net ortuit arona tab - Contention 1 - Normal force
		Maximum compression force (ORio) = 1580 kNx = Soliticitating compression force (OSd) = 0 kN Note official combination Combination 1 - Maximum tempts force (TMI) = -1330 kN ×= Soliticitating tensile force (TSd) = -500 kN
247 3330	Page 1	2402000 Page 2



In case the current report should be available in PDF-format, use the appropriate PDF button. If not, use the 'Close'-button to return to the PowerConnect working environment. To actually print the report that has just been configured, use the icon to enter in **Print report** mode, and use the 'Print' button to send the report to the selected printer.

3.3 Tutorial 3 : shear connection – beam to column flange with fin plate (IS800)

This reporting tutorial is based on the model created in section 2.6 of this manual.

3.3.1 Page setup

No changes will be made to the page setup defined in section 3.1.1 of this manual. The user should return to this section for more information on the current page setup.

3.3.2 Report configuration

Go to **Preview** mode by means of the <u>A</u> icon of the icon toolbar.

Again, start by selecting the option 'Summary drawing' on the first tab page and define how this summary overview should look like by using the button 'Printing parameters', which opens a canvas window to complete the summary overview definition.

Preview General Loads Results Element info Connection view	
Project data Project data	
🔽 Summary dra w ii	
Printing parameters	
Advanced parameters <<<	>>>
Help Preview	<u>C</u> ancel

To create the kind of summary drawing shown below, make sure to select all connection views shown at the right-hand bottom part of the canvas window. Use the cursor icons to position the selected drawings in the appropriate positions, and also make sure the proper scale is selected (the selected scale of 1/5 is appropriate for a report on A4 paper format).



As soon as a proper lay-out has been defined, confirm by means of the 'OK'button to return to the definition dialogue window.

Now switch to the second tab page, and make sure that the option 'Loads combinations' is selected. This will ensure that the report includes an overview of the loads combination that is part of this project, at least if 'Combination1' is selected as indicated below.

Preview		
General Loads R	esults Element info Connection view	1
Combinations	✓ ↔ ୮ ✓ Loads combinations	
Advanced	parameters <<<	>>>
Help	Preview	<u>C</u> ancel

Now switch to the third tab page to specify how analysis results should be reported. Within this second reporting tutorial, the focus is on the creation of a more detailed analysis report. To do so, select the options 'Results – Results for all components' and 'Plots' as indicated below.

Preview	×
General Loads Results Eler	nent info Connection view
Combinations $\!$	Results
	C Detailed results
	Results for all components
	C Major results
	Results summary
	Plots
	✓ Work level with max. calculated moment
	✓ Work level with applied moment
	🗖 Rigidity graph
Advanced parameters	<<< >>>
Help	Preview <u>C</u> ancel

Now switch to the fifth tab page to specify that rendered views of the entire connection are to included into the report. Select the option 'View' and make sure to select both the 3D and the front view icons.

Preview
General Loads Results Element info Connection view
view scale : 100 %
Advanced parameters <<< >>>
Help Preview Cancel

The report configuration can now be considered to be complete, and the report itself can be visualized by means of the 'Preview' button at the bottom of the dialogue window. The outcome will be a 5 page report as shown below.





In case the current report should be available in PDF-format, use the appropriate PDF button. If not, use the 'Close'-button to return to the PowerConnect working environment. To actually print the report that has just been configured, use the icon to enter in **Print report** mode, and use the 'Print' button to send the report to the selected printer.