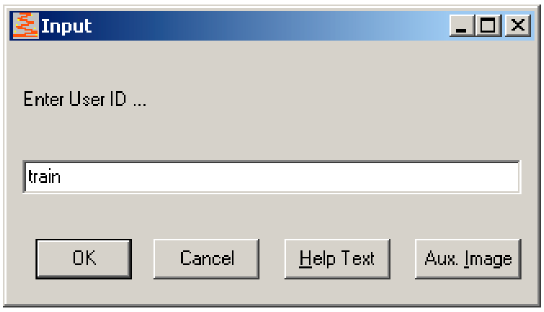
5. Working with SR1

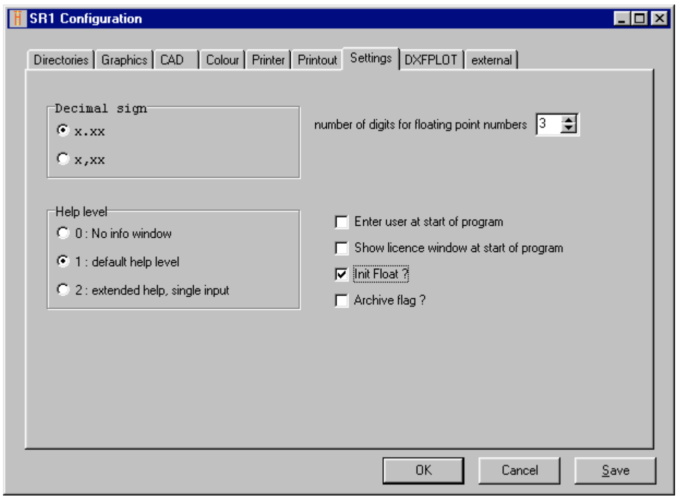
Demo Mode

The SR1 demo runs automatically and demonstrates how the program works by showing a sample calculation. The Demo is started by using the menu item "Help" followed by the menu item "Demo". Always click OK or Close to get the next step.

Program Start

Start the program at “Start->Programs->HEXAGON->SR1”.
If password option is set, you are asked to enter your password. All names of existing subfolders are valid passwords. The user directory "TRAIN" is automatically created by setup program.





SR1 will accept capital letters and small letters equally. If there has no User Directory been created for you yet, FED5 will be terminated. Thus your files are protected from access of unauthorized users. See under Chapter 3 (Installation) in such a case and create the respective user folders.
At "File->Settings" you can configure the program not to show license window and ask for password at program start.

5.1. Main Menu

Title	Sub-title	Function
File	New	Carry out new calculation A-Z
File	Open	Load previous calculation
File	Open (Table)	Load previous calculations from preview table
File	Save	Save calculation to file
File	Save As	Save calculation with new name
File	Print	Print screen graphic
File	Settings	Configure graphic, printer, etc.
File	Exit	Program end
Edit	Text	Input draw. name, draw. no., text
Edit	Pre-Dimensioning	Determine required bolt size
Edit	Bolt	Input bolt dimensions
Edit	Clamping Plates	Input strained parts
Edit	Nut	Input nut or bolt hole
Edit	Load	Input forces
Edit	Friction	Input friction coefficents
Edit	Tightening	Input assembly tool
Edit	Temperature	Input operating temperature
Edit	Ecc.Application	Input data for eccentric load
Edit	Flange	Input flange dimensions and load (SR1+ only)
Edit	Calc.Method	Configure calc.method, friction input, preload

View	Printout	Output of results
View	Load-Extension Diagram	Graphic display elevation
View	Assembly Condition req.	Load-extension diagram assembly required
View	Assembly Condition	Load-extension diagram assembly max/min
View	Working Condition req.	Load-extension diagram Fvmin,req. with FA
View	Working Condition max	Load-extension diagram Fvmax with FA
View	Working Condition min	Load-extension diagram Fvmin with FA
View	Drawing	Bolt joint drawing
View	Table Drawing	Drawing and tables with results
View	Load	Load-extension diagram and load valcues
View	Flange	Flange drawing with bolts (SR1+ only)
View	M-alpha diagram	Torque - tightening angle diagram
View	F-alpha diagram	Clamping load – tight.angle diagram
View	FM-MA diagram	Clamping load - tightening torque
View	MA-FM	Tightening torque – clamping load
View	FM Statist.	Statistical distribution of clamping load FM
View	Diagrams	All diagrams
View	Material	Material properties
View	Error Messages	Description of Error messages
CAD	Projection	Bolt joint graphic
CAD	Side View	Bolt joint graphic
CAD	Top View	Bolt joint graphic
CAD	Bottom View	Bolt joint graphic
CAD	Bolt	Drawing
CAD	Nut	Drawing
CAD	Clamping Plates	Drawing of all clamping plates
CAD	Flange	Flange Drawing (SR1+ only)
CAD	Diagrams	Select diagram to be exported
Database	Thread	Modify or add thread data
Database	Bolt head	Modify or add screw head dimensions
Database	Material Bolt	Bolt material base data, Re=f(T), E=f(T)
Database	Material Plates,Nut	Plate and nut material base data, Re=f(T), E=f(T)
Database	Nut	Nut types and dimensions
Database	Tightening tool	alpha A coefficient
Database	Friction	Friction head, thread, mating surface
Database	Friction min/max	Max/min friction head, thread, mating surface
Document	Drawing data	Drawing date, edited, checked, standard
Document	Modifications-Info	List of changes
Document	Modifications-Printout	Printing out the list of changes
Document	Modification-New	Append new changes
Document	Edit previous modif.	Edit previous change
Document	Delete prev. modif.	Delete last change
Document	Document 1..5	Load external document and program
Document	Setup	Configure external programs and files
OLE	Start Excel	Execute MS-Excel, if installed on computer
OLE	Export to Excel	Copy input data to Excel worksheet
OLE	Import from Excel	Load input data from Excel worksheet
OLE	Printout to Excel	Copy printout to MS-Excel worksheet
Help	Auxiliary Image	Show Auxiliary Images
Help	Error Messages	Show error messages
Help	History	Show alterations and additions to FED5
Help	Demo	Run Demo Mode
Help	HEXAGON Homepage	Display www.hexagon.de
Help	E-Mail to HEXAGON	Send E-Mail to HEXAGON
Help	Licence	Display Licence Information

5.2. File

The SR1 Files are text files which contain all input data.

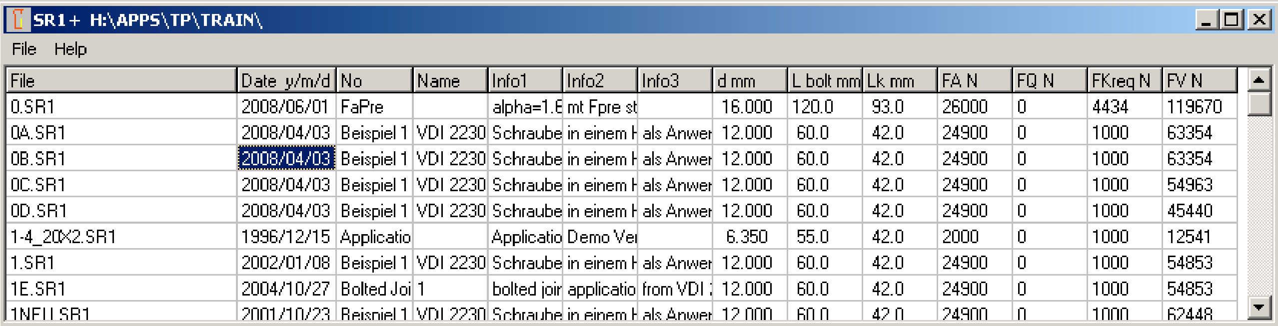
File - New

Guides you through all input windows. See following chapters for details.

File – Open

All created SR1 Files are listed. Select desired file with mouse or cursor keys. Then the file is opened by SR1 and can be printed or modified and re-calculated. After loading a SR1 file, a calculation of the geometrical values and mechanical strength properties is carried out. To erase a file, select it, then press DEL key.

File - Open (Table)


SR1+ H:\APPS\TP\TRAIN\

File Help

File	Date y/m/d	No	Name	Info1	Info2	Info3	d mm	L bolt mm	Lk mm	FA N	FQ N	FKreq N	FV N
0.SR1	2008/06/01	FaPre		alpha=1.6	mt Fpre st		16.000	120.0	93.0	26000	0	4434	119670
0A.SR1	2008/04/03	Beispiel 1	VDI 2230	Schraube	in einem H	als Anwer	12.000	60.0	42.0	24900	0	1000	63354
0B.SR1	2008/04/03	Beispiel 1	VDI 2230	Schraube	in einem H	als Anwer	12.000	60.0	42.0	24900	0	1000	63354
0C.SR1	2008/04/03	Beispiel 1	VDI 2230	Schraube	in einem H	als Anwer	12.000	60.0	42.0	24900	0	1000	54963
0D.SR1	2008/04/03	Beispiel 1	VDI 2230	Schraube	in einem H	als Anwer	12.000	60.0	42.0	24900	0	1000	45440
1-4_20X2.SR1	1996/12/15	Applicatio		Applicatio	Demo Ver		6.350	55.0	42.0	2000	0	1000	12541
1.SR1	2002/01/08	Beispiel 1	VDI 2230	Schraube	in einem H	als Anwer	12.000	60.0	42.0	24900	0	1000	54853
1E.SR1	2004/10/27	Bolted Joi	1	bolted joir	applicatio	from VDI 2	12.000	60.0	42.0	24900	0	1000	54853
1NEU.SR1	2001/10/23	Beispiel 1	VDI 2230	Schraube	in einem H	als Anwer	12.000	60.0	42.0	24900	0	1000	62448

Main properties of all fed files in the current folder are displayed in a table. You can sort to desired property by right mouse click into title cell. By cursor keys or mouse click, file is opened and calculation results are shown in Quick View.

File - Save

After entering the filename, a SR1 file with the current input data is created. All letters and numbers, as well as the characters - & ( ) % $ # ! ' can be used. Upper and lower case letter can be used. Special characters such as " , ; . : # ? = / > < " are not permitted. The filename may have up to 255 characters. The extension input .SR1 is not absolutely necessary, as it is automatically added by the program.
If previously opened and modified, data are saved under the same name without asking for file name.

File - Save as

Save File under a new file name. See also "File Save".

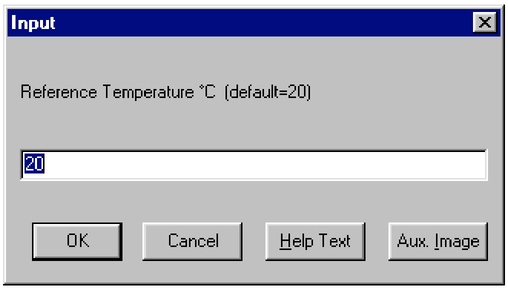
NULL File

If you save data to a file called "NULL", that file will be loaded automatically after program start. You can use this option for storing your preferred material data and quality classes.

ACTUAL File

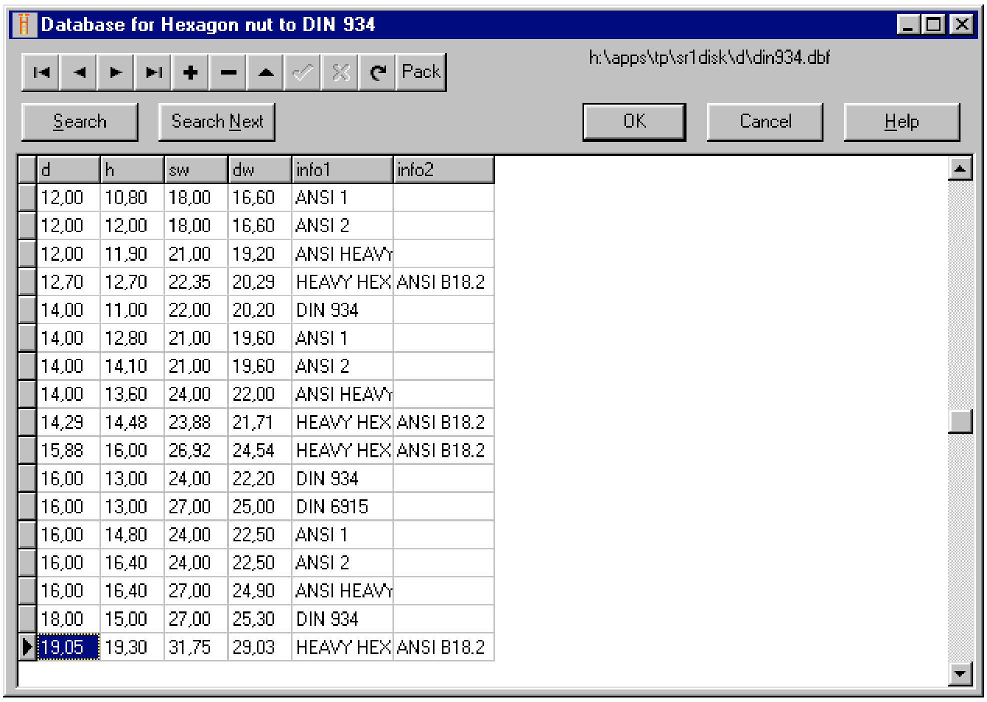
When you exit the program, the data is automatically saved to a file "ACTUAL". When restarting the program, you can obtain the latest data by loading the ACTUAL file.

5.3. Input/Edit



When inputting numeric values or text, usually a default value or text will appear in the input window. If you wish to accept these defaults just confirm by OK or Enter key. If you later wish to alter individual values in order to carry out optimization, all you do is go to input, confirm the correct values or enter new data as you require. As soon as you begin to enter a new value, the default immediately disappears. If you wish to append an existing text, then you first move the cursor one space to the left and then one space to the right.
By using the cursor keys you can change or edit the default values. The insert mode is switched on and off with the <INS> key. By using the <DEL> key, you can delete individual characters.
The help button allows you to display the help texts. The help texts, which are in the file SR1.HLP, can be altered and appended with your own texts (see chapter 9).
With the Windows version the help pictures appear in the background, in order to be able to see them, the dialogue window must be moved down.

Databases
SR1 software includes many table values in the database (e.g. thread, bolt head, material, etc.). This provides the optimum method for calling up standard or manufacturer specific data. Compared to manual input of these values there is the advantage that you no longer have to look up the values in tables. In addition, as the values are not a solid part of the program you can alter the data or add your own values.



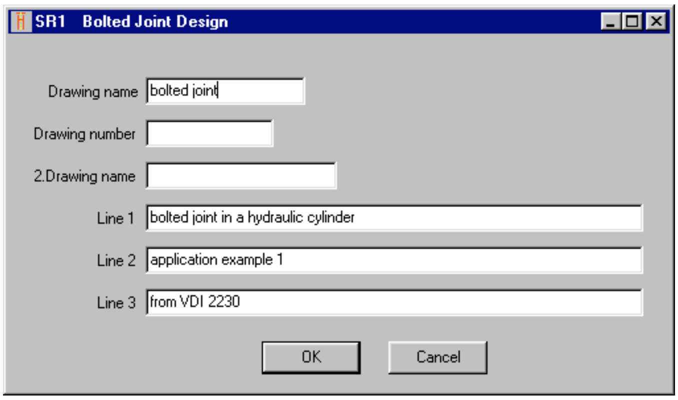
d	h	sw	dw	info1	info2
12,00	10,80	18,00	16,60	ANSI 1	
12,00	12,00	18,00	16,60	ANSI 2	
12,00	11,90	21,00	19,20	ANSI HEAVY	
12,70	12,70	22,35	20,29	HEAVY HEX	ANSI B18.2
14,00	11,00	22,00	20,20	DIN 934	
14,00	12,80	21,00	19,60	ANSI 1	
14,00	14,10	21,00	19,60	ANSI 2	
14,00	13,60	24,00	22,00	ANSI HEAVY	
14,29	14,48	23,88	21,71	HEAVY HEX	ANSI B18.2
15,88	16,00	26,92	24,54	HEAVY HEX	ANSI B18.2
16,00	13,00	24,00	22,20	DIN 934	
16,00	13,00	27,00	25,00	DIN 6915	
16,00	14,80	24,00	22,50	ANSI 1	
16,00	16,40	24,00	22,50	ANSI 2	
16,00	16,40	27,00	24,90	ANSI HEAVY	
18,00	15,00	27,00	25,30	DIN 934	
19,05	19,30	31,75	29,03	HEAVY HEX	ANSI B18.2

The hi-lited bar is moved up and down with the cursor keys in order to choose the appropriate data record. You then accept the data from the choosen record with the <ENTER> key or "OK" button. With <ESC> or "Cancel" button you can leave the database without accepting any of the values for your calculation.

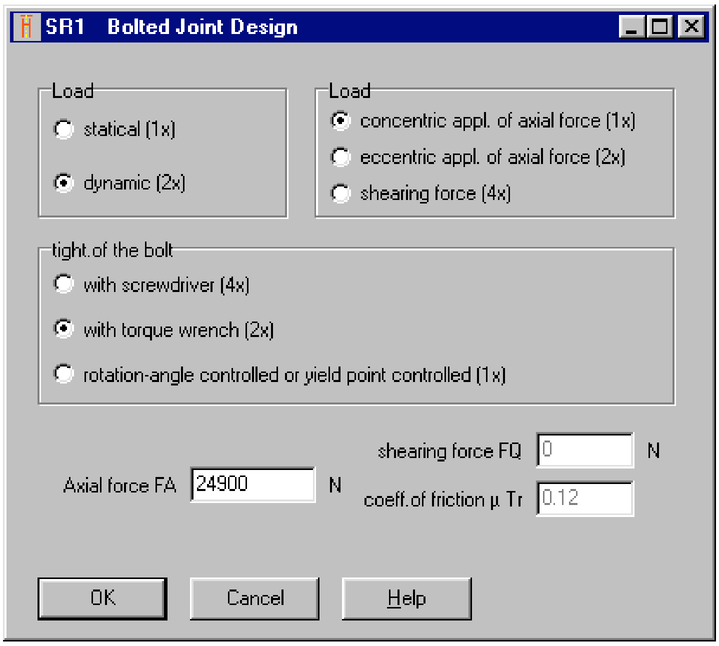
Indexed Database:
Wherever possible the databases are indexed. This allows the data records to be sorted and displayed according to size.
The Thread Database has a double-index first on "TYP" (type) and then on nominal diameter "D". This allows the contents to be displayed in according to diameter, first the metric threads (M) and then all fine threads (N). If you wish to add data records to the database, these will be indexed and added to the database in the appropriate place. Tool bar: You have the possibility to append the database with further data records, or to alter the existing values to reflect company own values.
Edit: Simply write over the existing value in the data field with the new value.
Append: In order to append the database with further values just click into "+" button.
Empty fields will appear in the first line which you can fill-in. If the database is indexed, the new values will automatically be moved to the correct place in the database.
Remove: If you choose "-" button, the data record on which the cursor is located will be marked for deleting. If you then do not wish to delete the record, go to "-" again, the mark will then be removed. The marked record will be physically deleted when you carry out "Pack".
Pack: With "Pack" the marked data record will be deleted from the database
First: Go to first data record.
Last: Go to last data record.
Search: This function is very useful for searching the whole database for a specific character string (e.g. "15 CrNi" in the material database). The hi-lited bar goes to the field with the character string. With "Search Next" you can search for further character strings.
dBase Format: HEXAGON software uses the dBase format for its databases. This allows you to edit the DBF files with dBase or other dBase compatible databases. In addition, you can also load company-own specific data into HEXAGON software via dBase files.

5.3.1. Text Input

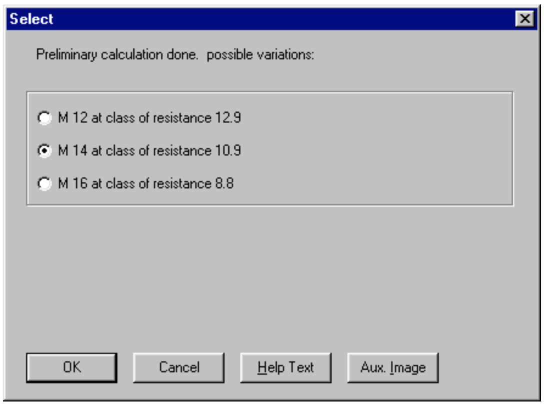
When outputting results to printer, three lines are reserved for designation, drawing number, name, comments, etc. The first line includes the drawing name and number, the other two lines can be filled with comments, names etc.



5.3.2. Pre-Dimensioning



By inputting a few data, the required bolt size can be approached in steps with dimensioning. A combination of three bolt sizes and strength classes are available.



The strength class from the choosen combination is used as the standard for the bolt input. This is not possible with the bolt size as the thread has not yet been defined as metric normal or fine thread.

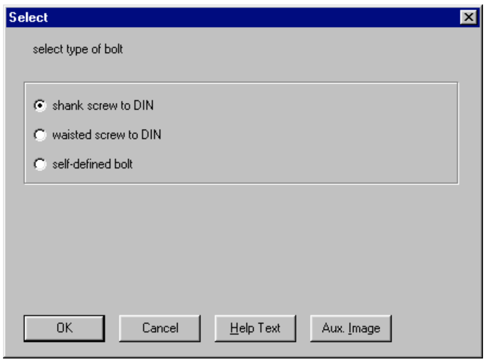
Specifications for dimensioning:
- Load
- static/dynamic
- Load from axial force concentric/eccentric or shearing force
- Amount of axial or shearing force
- Bolt strength class
- Tightening tool

The bolt load is significantly increased by the additional bending load with non-central force introduction.

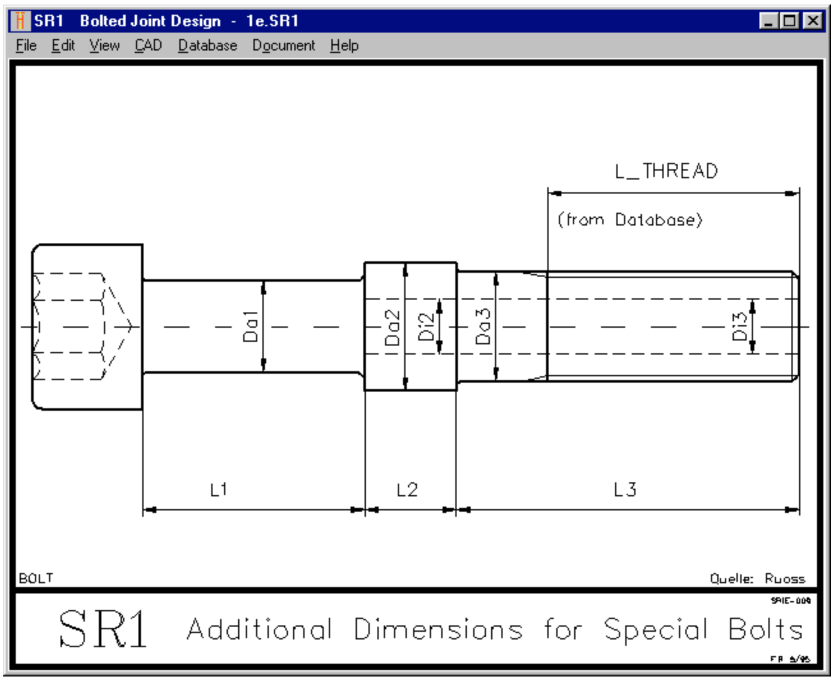
Dimensioning must be relatively large in case of shearing force, as the residual screw clamping force must prevent slipping of the clamping piece.

The scattering of assemble pre-gripping force is dependent on the tightening method.

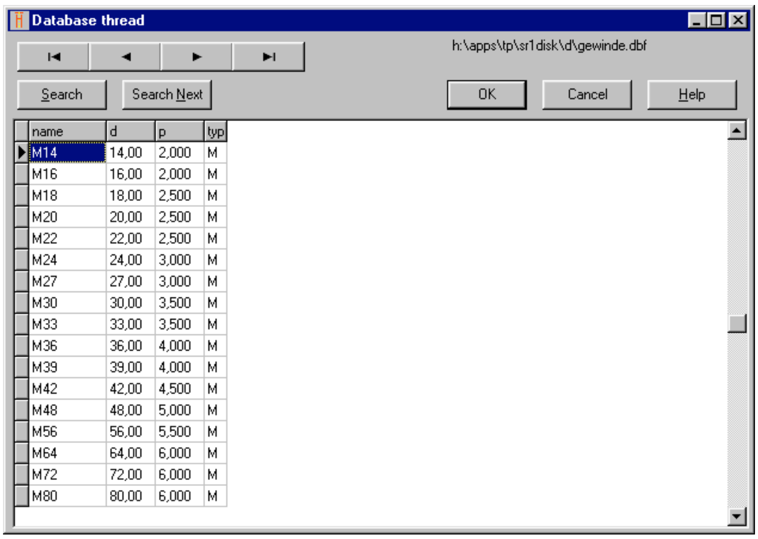
5.3.3 Bolt Input



In most cases you will work with shank bolts or waisted bolts in accordance with DIN. SR1, however, offers the possibility of freely defining bolt geometry.



A database for selecting the thread will appear on screen when you select a shaft or waisted bolt.



name	d	p	typ
M14	14,00	2,000	M
M16	16,00	2,000	M
M18	18,00	2,500	M
M20	20,00	2,500	M
M22	22,00	2,500	M
M24	24,00	3,000	M
M27	27,00	3,000	M
M30	30,00	3,500	M
M33	33,00	3,500	M
M36	36,00	4,000	M
M39	39,00	4,000	M
M42	42,00	4,500	M
M48	48,00	5,000	M
M56	56,00	5,500	M
M64	64,00	6,000	M
M72	72,00	6,000	M
M80	80,00	6,000	M

The cursor is positioned on the thread size which was calculated in pre-dimensioning. You can choose the required thread size from the database. The database can be altered or appended with additional thread sizes (at "Database" menu).

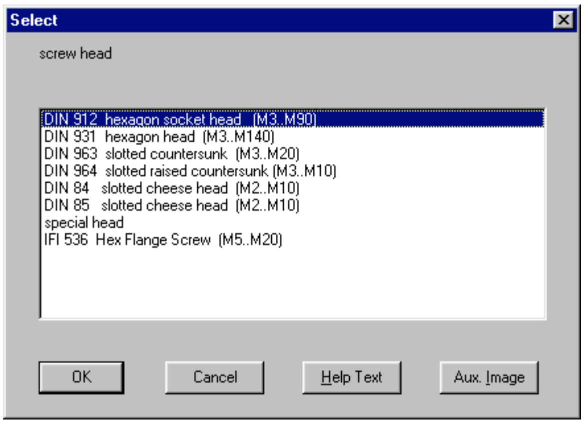
The abbreviations have the following meanings:

Sign	Meaning	Unit
D	Rated Diameter of thread	mm
P	Pitch	mm
AS	Stress cross-section area	mm^2
D3	core diameter	mm^2
TYP	thread type (M=metric N=metr.fine)	"M","N"

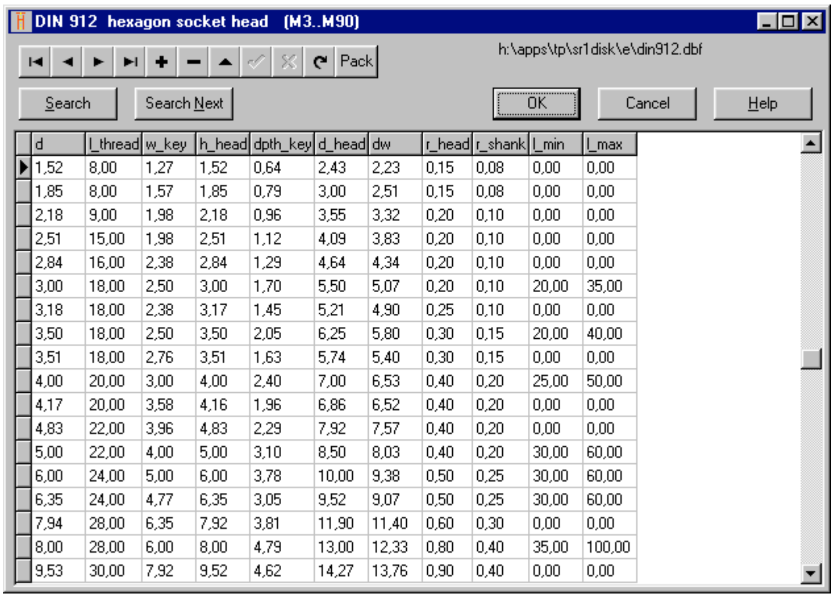
Diameters d2, d3

The exact value for min. diameter d3 and flank diameter d2 depends on the allowance and tolerance grade. You can enter d2 and d3, or SR1 calculates it for you according to allowance grade 4h and 6h (max. value) The diameters d2 and d3 influence strength calculation (min. stress area) and torque (friction area and radius).

Input Bolt Head

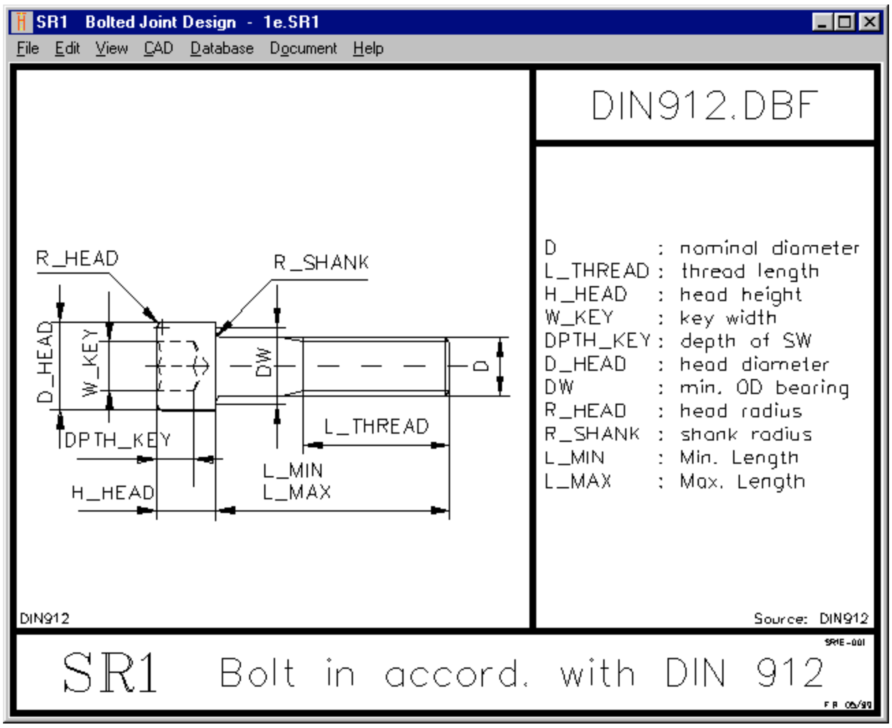


The bolt head is selected from the list. Each bolt head has a matching database file. The data for the drawing and calculation are obtained from the matching database file (minimum head lining dw), which is to be found under "Database->Screw Head".

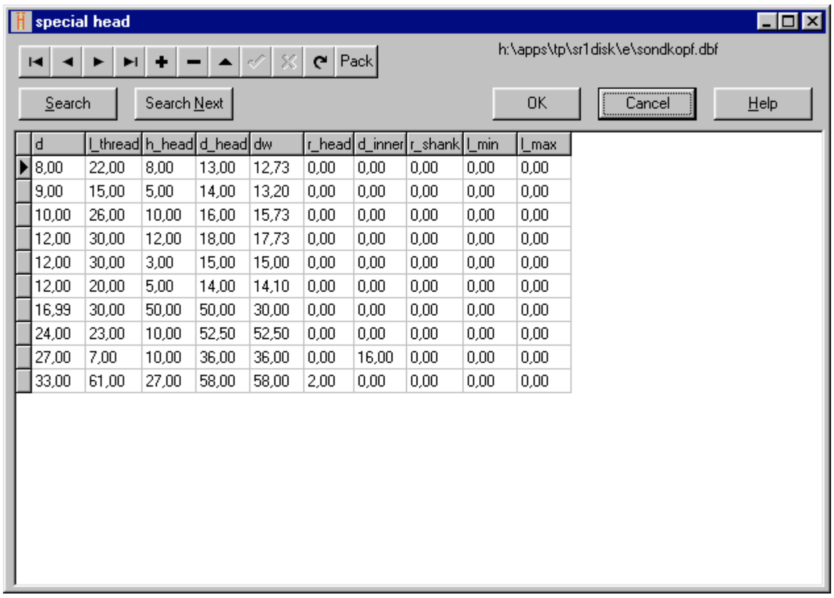


d	l_thread	w_key	h_head	dpth_key	d_head	dw	r_head	r_shank	l_min	l_max
1,52	8,00	1,27	1,52	0,64	2,43	2,23	0,15	0,08	0,00	0,00
1,85	8,00	1,57	1,85	0,79	3,00	2,51	0,15	0,08	0,00	0,00
2,18	9,00	1,98	2,18	0,96	3,55	3,32	0,20	0,10	0,00	0,00
2,51	15,00	1,98	2,51	1,12	4,09	3,83	0,20	0,10	0,00	0,00
2,84	16,00	2,38	2,84	1,29	4,64	4,34	0,20	0,10	0,00	0,00
3,00	18,00	2,50	3,00	1,70	5,50	5,07	0,20	0,10	20,00	35,00
3,18	18,00	2,38	3,17	1,45	5,21	4,90	0,25	0,10	0,00	0,00
3,50	18,00	2,50	3,50	2,05	6,25	5,80	0,30	0,15	20,00	40,00
3,51	18,00	2,76	3,51	1,63	5,74	5,40	0,30	0,15	0,00	0,00
4,00	20,00	3,00	4,00	2,40	7,00	6,53	0,40	0,20	25,00	50,00
4,17	20,00	3,58	4,16	1,96	6,86	6,52	0,40	0,20	0,00	0,00
4,83	22,00	3,96	4,83	2,29	7,92	7,57	0,40	0,20	0,00	0,00
5,00	22,00	4,00	5,00	3,10	8,50	8,03	0,40	0,20	30,00	60,00
6,00	24,00	5,00	6,00	3,78	10,00	9,38	0,50	0,25	30,00	60,00
6,35	24,00	4,77	6,35	3,05	9,52	9,07	0,50	0,25	30,00	60,00
7,94	28,00	6,35	7,92	3,81	11,90	11,40	0,60	0,30	0,00	0,00
8,00	28,00	6,00	8,00	4,79	13,00	12,33	0,80	0,40	35,00	100,00
9,53	30,00	7,92	9,52	4,62	14,27	13,76	0,90	0,40	0,00	0,00

Usually, you don't need to worry about the bolt head database as it contains all DIN standard values. However, if you wish to add additional thread sizes (e.g. M9), then you will also have to add the data for the additional sizes to the bolt head database. The abbreviations for naming the data fields are explained in the appropriate help pictures (see Appendix).



If you select a special head, then you must add the data for the appropriate thread diameter to the "SONDKOPF" database. The calculation requires the thread length and minimum head seat diameter dw. A special head is then drawn as a cylinder with the diameter d_head and the height h_head.

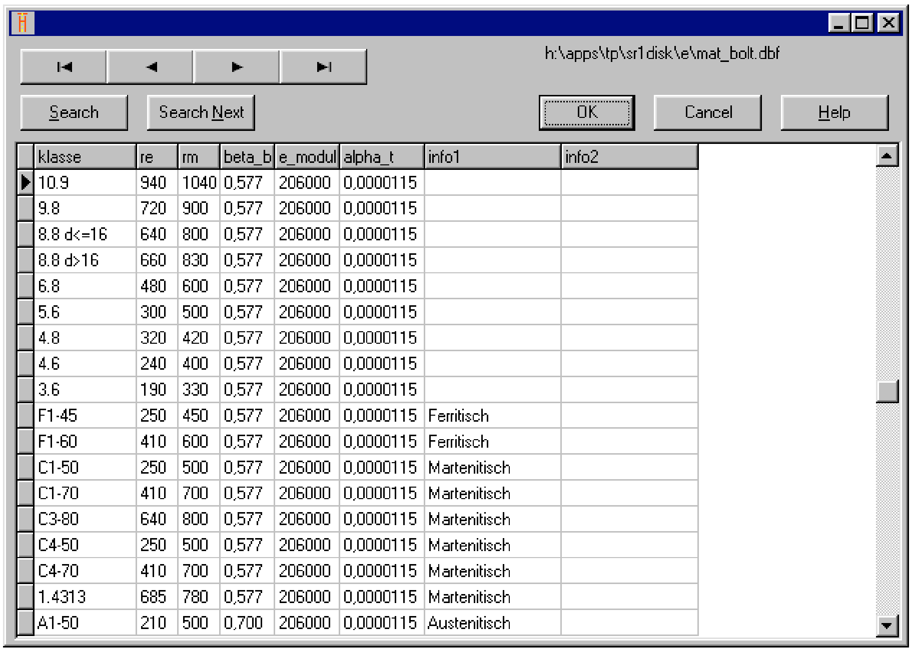


d	l_thread	h_head	d_head	dw	r_head	d_inner	r_shank	l_min	l_max
8,00	22,00	8,00	13,00	12,73	0,00	0,00	0,00	0,00	0,00
9,00	15,00	5,00	14,00	13,20	0,00	0,00	0,00	0,00	0,00
10,00	26,00	10,00	16,00	15,73	0,00	0,00	0,00	0,00	0,00
12,00	30,00	12,00	18,00	17,73	0,00	0,00	0,00	0,00	0,00
12,00	30,00	3,00	15,00	15,00	0,00	0,00	0,00	0,00	0,00
12,00	20,00	5,00	14,00	14,10	0,00	0,00	0,00	0,00	0,00
16,99	30,00	50,00	50,00	30,00	0,00	0,00	0,00	0,00	0,00
24,00	23,00	10,00	52,50	52,50	0,00	0,00	0,00	0,00	0,00
27,00	7,00	10,00	36,00	36,00	0,00	16,00	0,00	0,00	0,00
33,00	61,00	27,00	58,00	58,00	2,00	0,00	0,00	0,00	0,00

Bolt Length

After selecting a bolt head, you have to enter the shaft length (up to the head) for shaft and waisted bolts. You can select the shaft length from the database "LSCHRAUBE.DBF" by entering 0. You can adapt the database to internal company own required steps of the bolt length. If the clamping piece has already been entered, the program will suggest an appropriate bolt length.

Strength Class

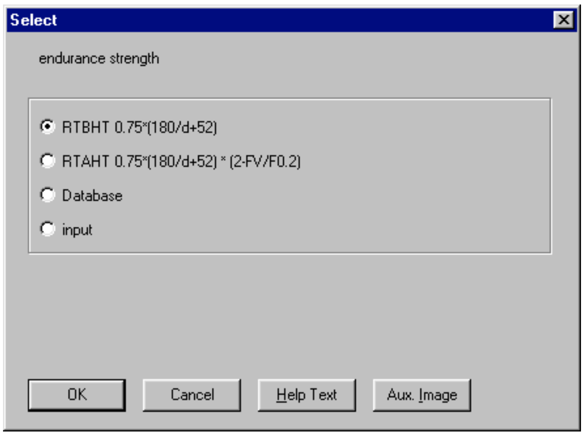


klasse	re	rm	beta_b	e_modul	alpha_t	info1	info2
10.9	940	1040	0,577	206000	0,0000115		
9.8	720	900	0,577	206000	0,0000115		
8.8 d<=16	640	800	0,577	206000	0,0000115		
8.8 d>16	660	830	0,577	206000	0,0000115		
6.8	480	600	0,577	206000	0,0000115		
5.6	300	500	0,577	206000	0,0000115		
4.8	320	420	0,577	206000	0,0000115		
4.6	240	400	0,577	206000	0,0000115		
3.6	190	330	0,577	206000	0,0000115		
F1-45	250	450	0,577	206000	0,0000115	Ferritisch	
F1-60	410	600	0,577	206000	0,0000115	Ferritisch	
C1-50	250	500	0,577	206000	0,0000115	Martenitisch	
C1-70	410	700	0,577	206000	0,0000115	Martenitisch	
C3-80	640	800	0,577	206000	0,0000115	Martenitisch	
C4-50	250	500	0,577	206000	0,0000115	Martenitisch	
C4-70	410	700	0,577	206000	0,0000115	Martenitisch	
1.4313	685	780	0,577	206000	0,0000115	Martenitisch	
A1-50	210	500	0,700	206000	0,0000115	Austenitisch	

The bolts are divided into strength classes and listed according to tensile strength and yield point. The first value shows the approximate tensile strength, the yield point can be calculated from both values.

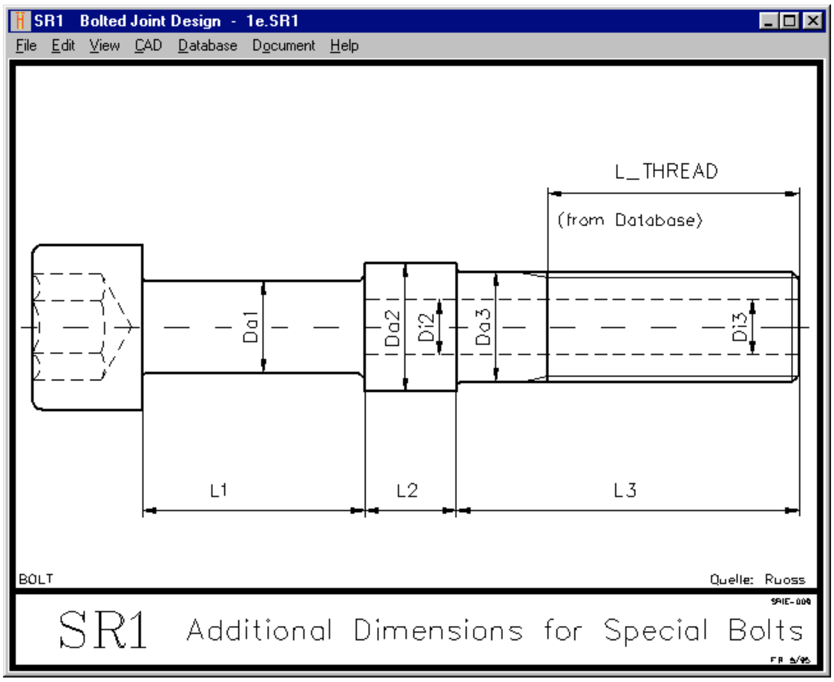
Example for 10.9:
Tensile Strength : 1000 N/mm²
Yield Point : 900 N/mm²

Fatigue Strength
You can SR1 let calculate fatigue strength to one of the two formulas in VDI 2230, or you can enter the Sigma a perm. value for the bolt, or you can select it from a (appendable) database (MAT_B_SA.DBF).

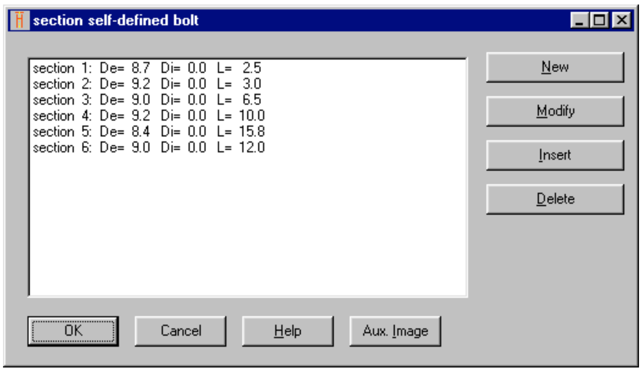


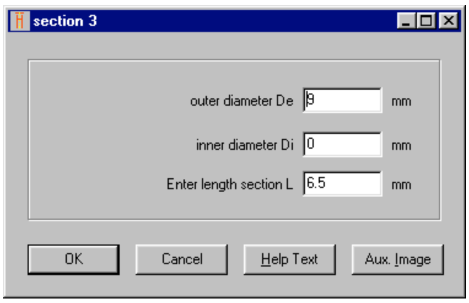
Special Bolts

As well as shaft and waisted bolts, you can freely define any number of stepped bolts by entering the part-cylinder.



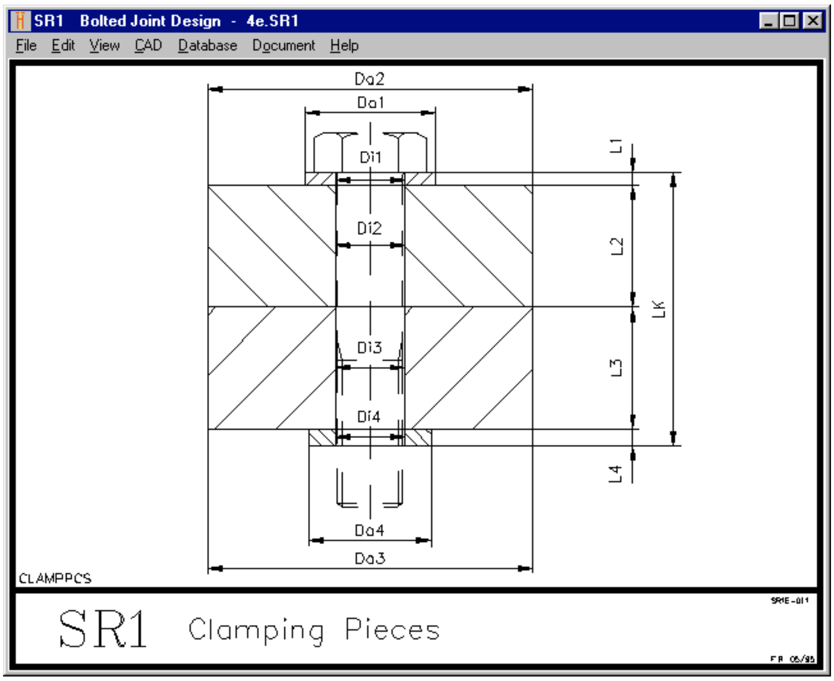
If you first choose a waisted bolt in accordance with DIN, then exit the input, after that go to input for special bolts, you will see how the individual bolt steps are defined. First the bolt head of the part-cylinder is entered followed by length, diameter and inner diameter (for hollow bolts).



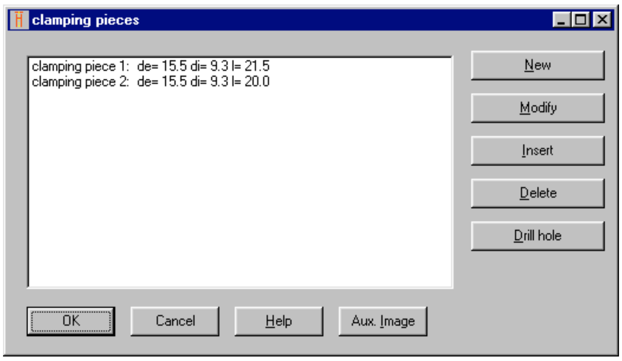


After all part-cylinders have been defined, don't forget to enter thread, head and bolt material. By entering and deleting individual part-cylinders you can easily make changes and optimize the bolt.

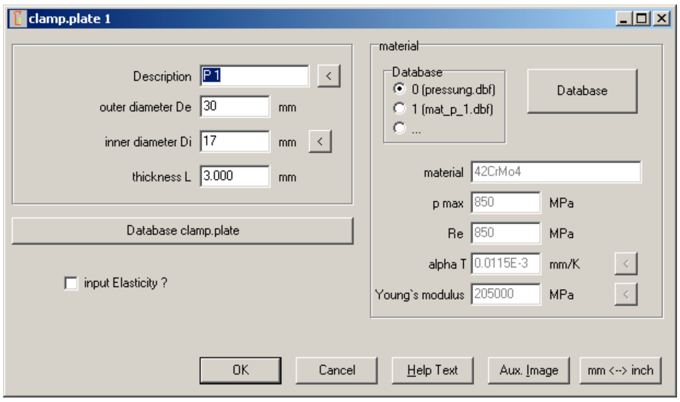
5.3.4. Input Clamping Plates



SR1 allows you to define up to 10 clamping pieces held by the bolt. Enter length, outer diameter and drill-hole diameter of the clamping pieces. If the clamping piece is not cylindrical, enter the equivalent diameter. If the clamping piece is a large plate, simply enter a very large diameter. SR1 will calculate a substitute diameter when calculating the elastic compliance.



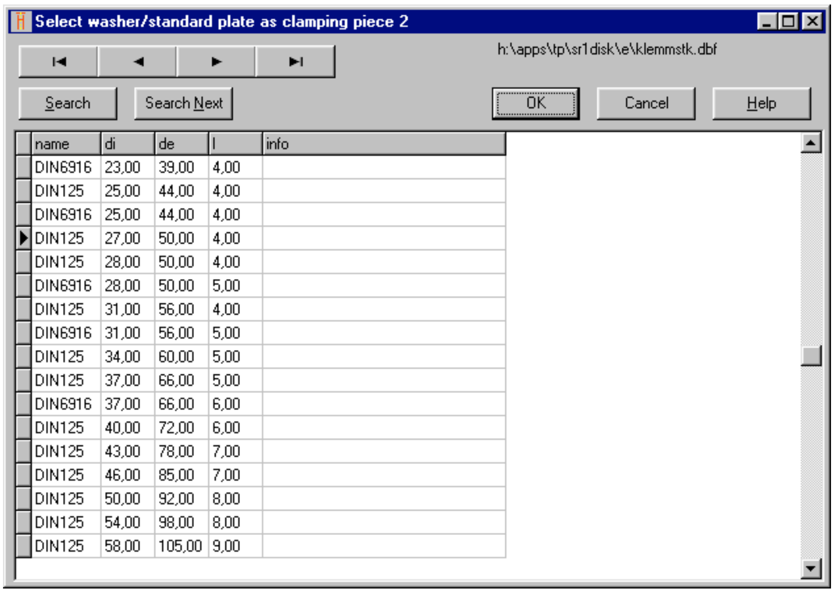
Material data can be selected from database "pressung.dbf" or "mat_p_1.dbf", or you enter material name, permissible pressure, yield point, temperature extension coefficient and modulus of elasticity.



SR1 calculates elasticity delta from E module, cross-section an length of clamping plate. If clamping plate is a spring or spring washer, you can check "Input elasticity" and enter elasticity (delta = 1 / spring rate R)

Washer Database

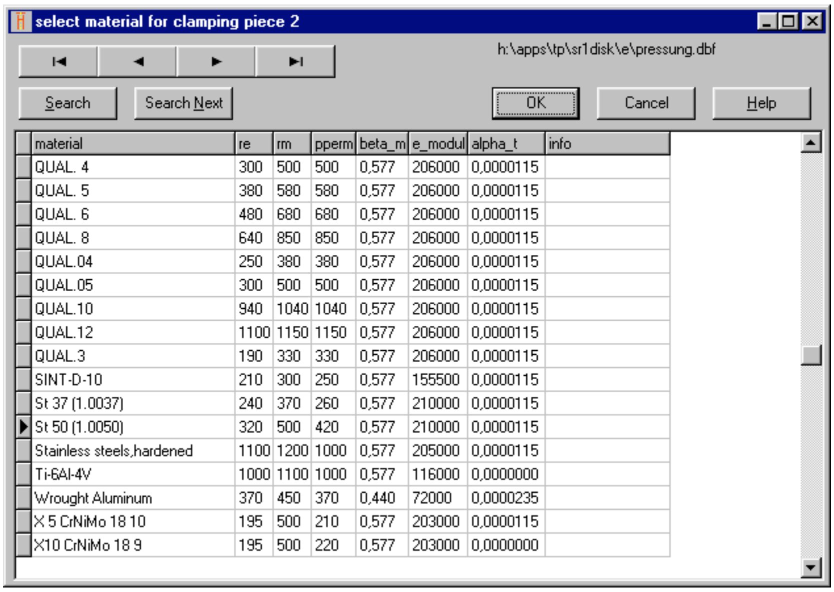
By entering 0 for the length of the clamping piece, the database with the file "KLEMMSTK.DBF" will be called up. Select a washer from the database. Thickness as well as inner and outer diameters will be taken directly from the table. You can append the database with parts you use a lot and distancing sleeves.



name	di	de	l	info
DIN6916	23,00	39,00	4,00	
DIN125	25,00	44,00	4,00	
DIN6916	25,00	44,00	4,00	
DIN125	27,00	50,00	4,00	
DIN125	28,00	50,00	4,00	
DIN6916	28,00	50,00	5,00	
DIN125	31,00	56,00	4,00	
DIN6916	31,00	56,00	5,00	
DIN125	34,00	60,00	5,00	
DIN125	37,00	66,00	5,00	
DIN6916	37,00	66,00	6,00	
DIN125	40,00	72,00	6,00	
DIN125	43,00	78,00	7,00	
DIN125	46,00	85,00	7,00	
DIN125	50,00	92,00	8,00	
DIN125	54,00	98,00	8,00	
DIN125	58,00	105,00	9,00	

Clamping Piece Material Database

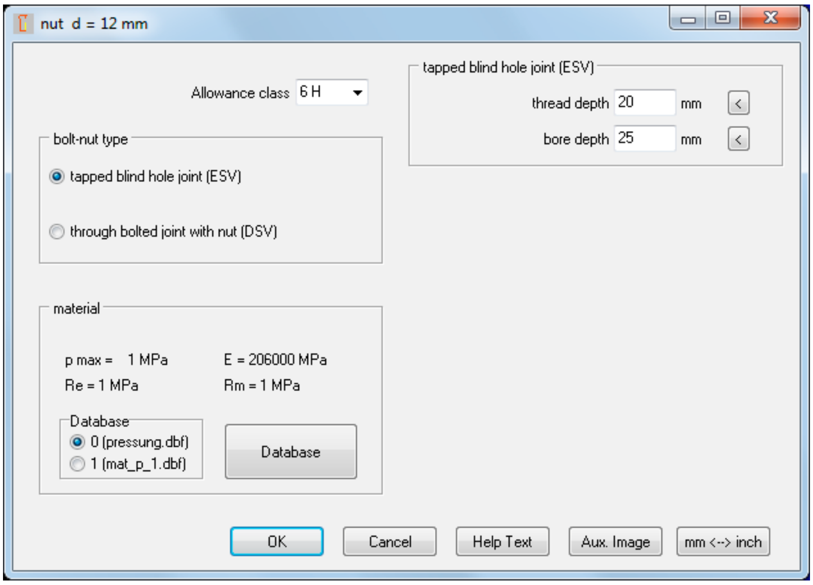
The material for the individual clamping pieces is selected from the "PRESSUNG" database. During calculation all seam lines will be checked that the permissible surface pressure is not exceeded. Should the material you require not be in the database, then you can add it (see the beginning of this chapter).



material	re	rm	pperm	beta_m	e_modul	alpha_t	info
QUAL. 4	300	500	500	0,577	206000	0,0000115	
QUAL. 5	380	580	580	0,577	206000	0,0000115	
QUAL. 6	480	680	680	0,577	206000	0,0000115	
QUAL. 8	640	850	850	0,577	206000	0,0000115	
QUAL.04	250	380	380	0,577	206000	0,0000115	
QUAL.05	300	500	500	0,577	206000	0,0000115	
QUAL.10	940	1040	1040	0,577	206000	0,0000115	
QUAL.12	1100	1150	1150	0,577	206000	0,0000115	
QUAL.3	190	330	330	0,577	206000	0,0000115	
SINT-D-10	210	300	250	0,577	155500	0,0000115	
St 37 (1.0037)	240	370	260	0,577	210000	0,0000115	
St 50 (1.0050)	320	500	420	0,577	210000	0,0000115	
Stainless steels,hardened	1100	1200	1000	0,577	205000	0,0000115	
Ti-6Al-4V	1000	1100	1000	0,577	116000	0,0000000	
Wrought Aluminum	370	450	370	0,440	72000	0,0000235	
X 5 CrNiMo 18 10	195	500	210	0,577	203000	0,0000115	
X10 CrNiMo 18 9	195	500	220	0,577	203000	0,0000000	

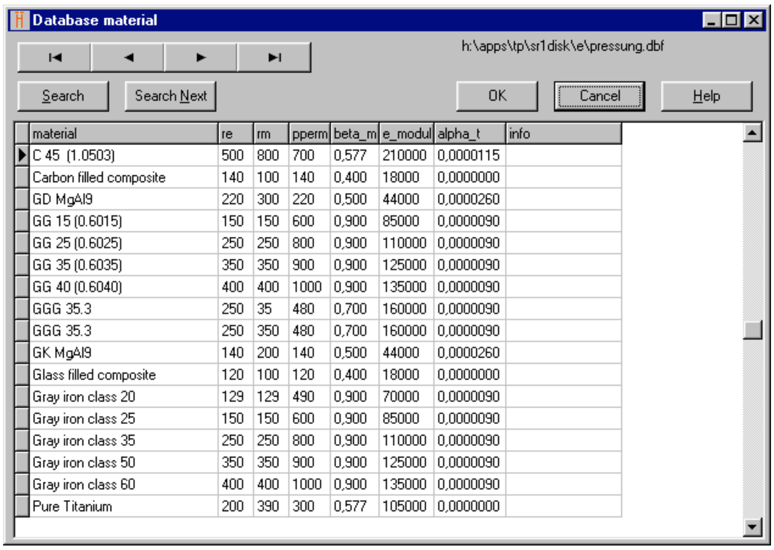
5.3.5 Edit Nut

The nut thread can be a dead-end hole or a nut.



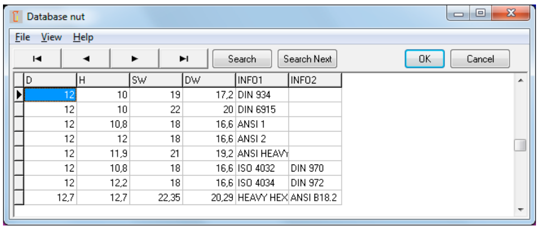
Dead-end Hole

With a dead-end hole you must also enter thread depth and drill depth. The dead-end hole joint will be shown as a cutout in the CAD drawing. The pull-out stability is calculated according to the DOSE formulas, see auxiliary picture. For this reason nut thread material must be choosed. A calculation of pull-out stability should be carried out for dead-end holes with shallow depth and nuts of soft materials.



Nut

The most common DIN nuts are listed in a database. Please note that a data record must exist for the entered thread size.

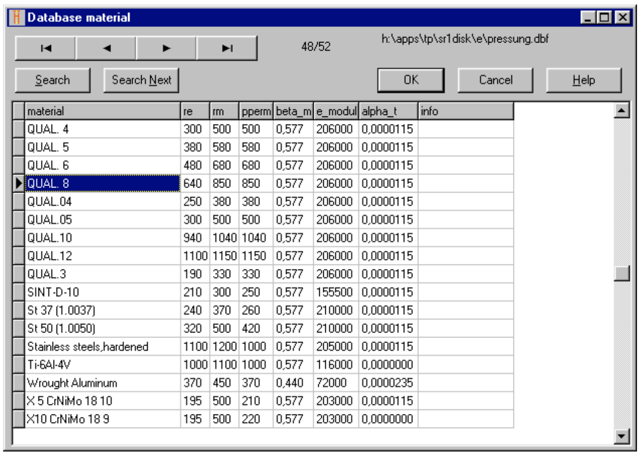


D	H	SW	DW	INFO1	INFO2
12	10	19	17,2	DIN 934	
12	10	22	20	DIN 6915	
12	10,8	18	16,6	ANSI 1	
12	12	18	16,6	ANSI 2	
12	11,9	21	19,2	ANSI HEAVY	
12	10,8	18	16,6	ISO 4032	DIN 970
12	12,2	18	16,6	ISO 4034	DIN 972
12,7	12,7	22,35	20,29	HEAVY HEX	ANSI B18.2

The required nut is selected with the cursor keys and accepted with the ENTER key.
Under the menu item "special" the nut is simply defined by entering the head contact surface (for surface pressure calculation) and the height.

Nut Material

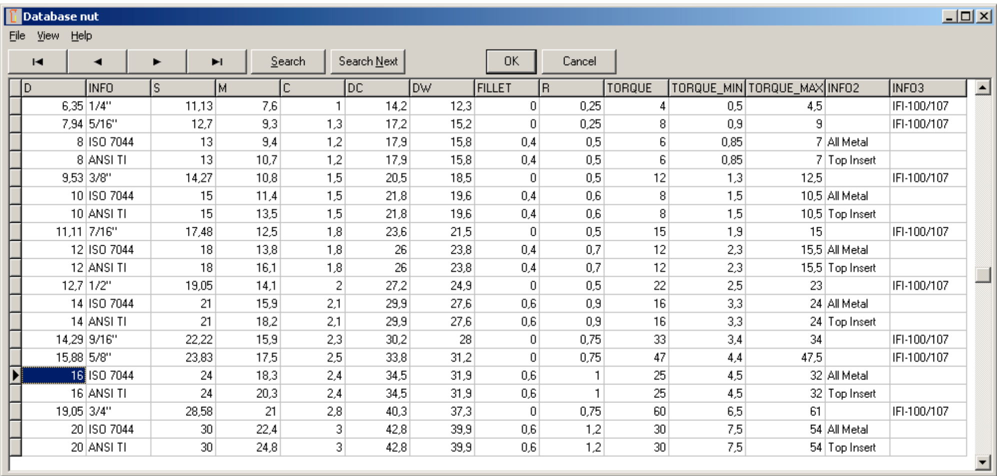
If you use bolt and nut material in an equivalent strength class, there is no need to calculate the nut. In this case there is no danger of stripping the nut thread. If you use different material for bolt and nut, the safety against stripping of the nut thread must be calculated



material	re	rm	pperm	beta_m	e_modul	alpha_t	info
QUAL. 4	300	500	500	0,577	206000	0,0000115	
QUAL. 5	380	580	580	0,577	206000	0,0000115	
QUAL. 6	480	680	680	0,577	206000	0,0000115	
QUAL. 8	640	850	850	0,577	206000	0,0000115	
QUAL.04	250	380	380	0,577	206000	0,0000115	
QUAL.05	300	500	500	0,577	206000	0,0000115	
QUAL.10	940	1040	1040	0,577	206000	0,0000115	
QUAL.12	1100	1150	1150	0,577	206000	0,0000115	
QUAL.3	190	330	330	0,577	206000	0,0000115	
SINT-D-10	210	300	250	0,577	155500	0,0000115	
St 37 (1.0037)	240	370	260	0,577	210000	0,0000115	
St 50 (1.0050)	320	500	420	0,577	210000	0,0000115	
Stainless steels,hardened	1100	1200	1000	0,577	205000	0,0000115	
Ti-6Al-4V	1000	1100	1000	0,577	116000	0,0000000	
Wrought Aluminum	370	450	370	0,440	72000	0,0000235	
X 5 CrNiMo 18 10	195	500	210	0,577	203000	0,0000115	
X10 CrNiMo 18 9	195	500	220	0,577	203000	0,0000000	

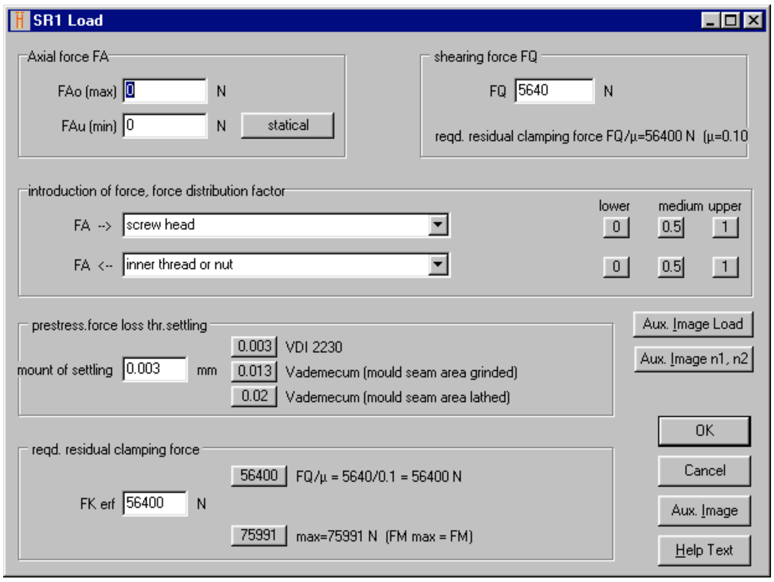
SR1 – Prevailing-Torque Type Nuts

If you use nuts with prevailing torque, additional torque by friction and additional shear stress has to be considered in this case. SR1 calculates higher tightening torque and reduced clamp load for equivalent stress. If you select a prevailing-torque type nut from database, friction torque (TORQUE) is set as MA pre, and MA pre option will be set. If you later use a standard nut without prevailing-torque, you have to reset MA pre to 0.



D	INFO	S	M	C	DC	DW	FILLET	R	TORQUE	TORQUE_MIN	TORQUE_MAX	INFO2	INFO3
6,35	1/4"	11,13	7,6	1	14,2	12,3	0	0,25	4	0,5	4,5		IFI-100/107
7,94	5/16"	12,7	9,3	1,3	17,2	15,2	0	0,25	8	0,9	9		IFI-100/107
8	ISO 7044	13	9,4	1,2	17,9	15,8	0,4	0,5	6	0,85	7	All Metal	
8	ANSI TI	13	10,7	1,2	17,9	15,8	0,4	0,5	6	0,85	7	Top Insert	
9,53	3/8"	14,27	10,8	1,5	20,5	18,5	0	0,5	12	1,3	12,5		IFI-100/107
10	ISO 7044	15	11,4	1,5	21,8	19,6	0,4	0,6	8	1,5	10,5	All Metal	
10	ANSI TI	15	13,5	1,5	21,8	19,6	0,4	0,6	8	1,5	10,5	Top Insert	
11,11	7/16"	17,48	12,5	1,8	23,6	21,5	0	0,5	15	1,9	15		IFI-100/107
12	ISO 7044	18	13,8	1,8	26	23,8	0,4	0,7	12	2,3	15,5	All Metal	
12	ANSI TI	18	16,1	1,8	26	23,8	0,4	0,7	12	2,3	15,5	Top Insert	
12,7	1/2"	19,05	14,1	2	27,2	24,9	0	0,5	22	2,5	23		IFI-100/107
14	ISO 7044	21	15,9	2,1	29,9	27,6	0,6	0,9	16	3,3	24	All Metal	
14	ANSI TI	21	18,2	2,1	29,9	27,6	0,6	0,9	16	3,3	24	Top Insert	
14,29	9/16"	22,22	15,9	2,3	30,2	28	0	0,75	33	3,4	34		IFI-100/107
15,88	5/8"	23,83	17,5	2,5	33,8	31,2	0	0,75	47	4,4	47,5		IFI-100/107
16	ISO 7044	24	18,3	2,4	34,5	31,9	0,6	1	25	4,5	32	All Metal	
16	ANSI TI	24	20,3	2,4	34,5	31,9	0,6	1	25	4,5	32	Top Insert	
19,05	3/4"	28,58	21	2,8	40,3	37,3	0	0,75	60	6,5	61		IFI-100/107
20	ISO 7044	30	22,4	3	42,8	39,9	0,6	1,2	30	7,5	54	All Metal	
20	ANSI TI	30	24,8	3	42,8	39,9	0,6	1,2	30	7,5	54	Top Insert	

5.3.6. Edit Load



The load is made up of the following:

- upper and lower tension force FAo and Fau
- Location of the force introduction of FA
- Shearing Force FQ
- Residual clamping force FKR

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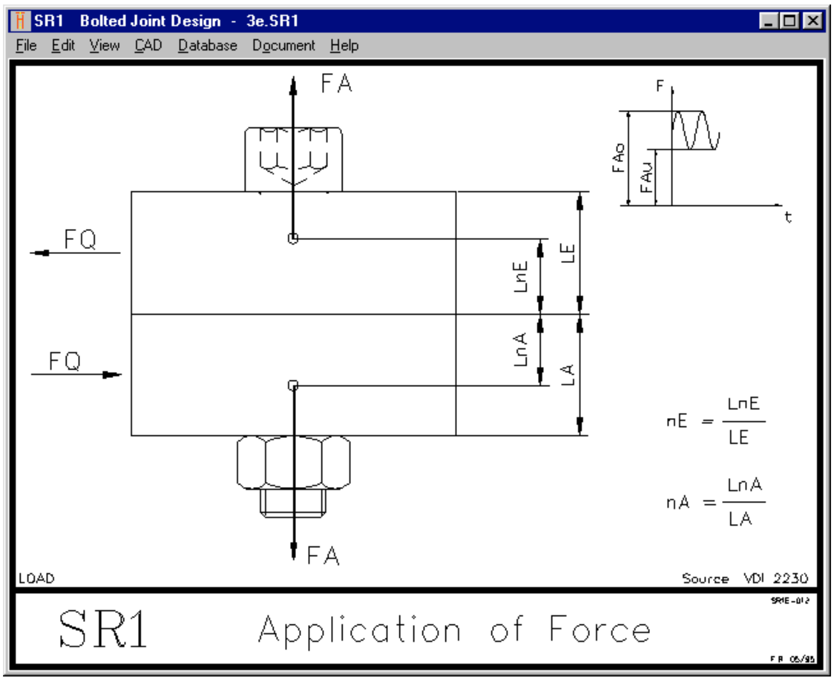
Axial Force FA

SR1 calculates the vibration stress for dynamic load between the forces FAo and FAu. For static load is FAu=FAo, for alternating load is FAu=-FAo, and for dynamic pulsating load the lower value is FAu = 0.

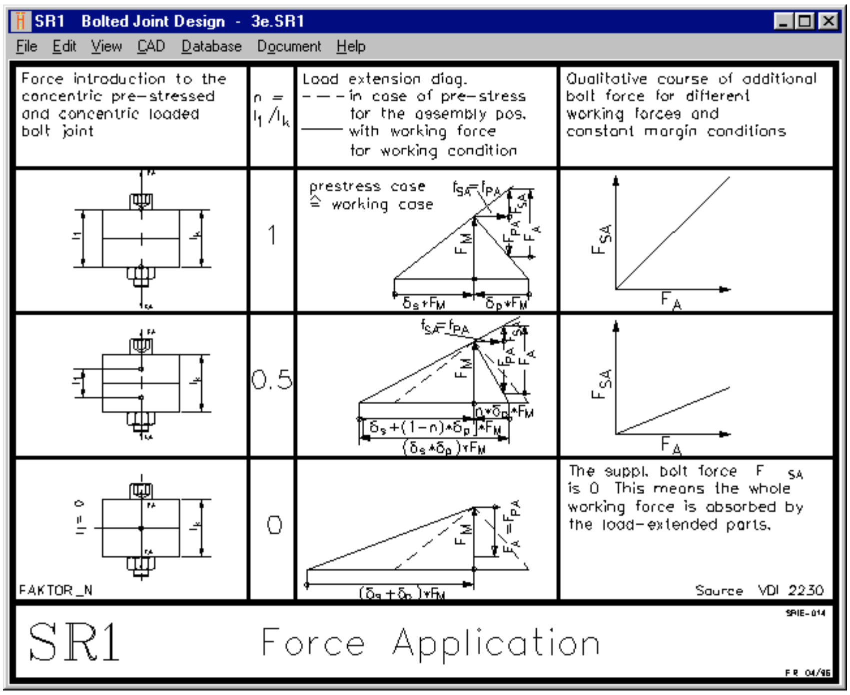


Axial Preload FA pre

Compared with FA, the statical preload FApre is applies already at the assembly procedure (i.e. clevis joint). FA pre is added to Fao and Fau, and also increases the assemly torque MA (MA pre = FApre * dkm/2 * μK). Locations of force introduction for Fapre are assumed to be the same than for axial load FA.

Force Introduction

The effect of the attacking force FA is highly influenced by the location of the force introduction. Use of a distancing sleeve under the bolt head greatly reduces the effect of the additional bolt force FSA. The force introduction factor is n = 1 for force introduction at the bolt head and force reduction at the nut thread. The force introduction factors nE for the upper clamping piece and nA for the lower clamping piece are entered separately in the program. No factor is required for force introduction on the bolt head or nut.
The force introduction factor n is the ratio of the length L1 to the whole length of the clamping piece LK.



Load-extension diagram for different force introduction heights (see also VDI 2230).

Shearing Force FQ

When entering the residual clamping force you should take into account whether or not a shearing force FQ attacks the clamping plates.

Residual Clamping Force F KR

The residual clamping force between the fixed plates must be at least FK req. = FQ / µTr for attack of shearing force. The residual clamping force must be greater than the clearing force for eccentric load.

Settling Amount

Leveling off of surface unevenness on a bolt causes appearance of settling, which means the assembly tension must be reduced by Fz. SR1 makes suggestions for the settling amount according to the VDI 2230 of 1986, Bauer & Schaurte Vademecum, and VDI 2230 draft of 1998.

Preload F pre, FA pre and MA

Preload F pre, FA pre and MA pre are not defined in VDI 2230. It must be activated at Edit->Calculation Method.

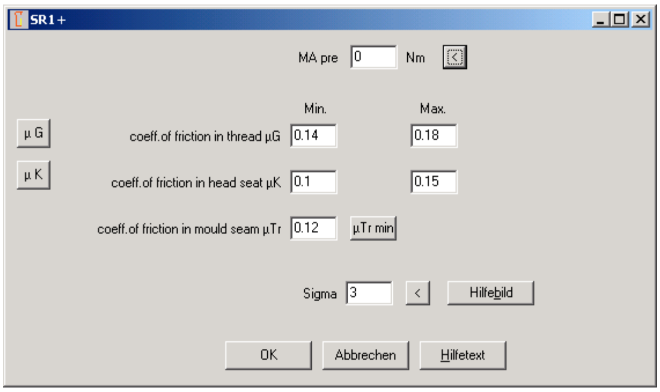
Preload Fpre and FApre

Fpre is the bolt preload required to bend plates that does not contribute to clamp load.
FKmin is reduced by the value of Fpre, and FMmax,req is increased by the value of Fpre.
Set Fpre=0 for standard joints to VDI 2230.
FApre is similar than Fpre, but FApre raises tightening torque (by FApre/µK). Load introduction of FA pre is like defined for FA. Load introduction of Fpre is between screw head and nut thread.

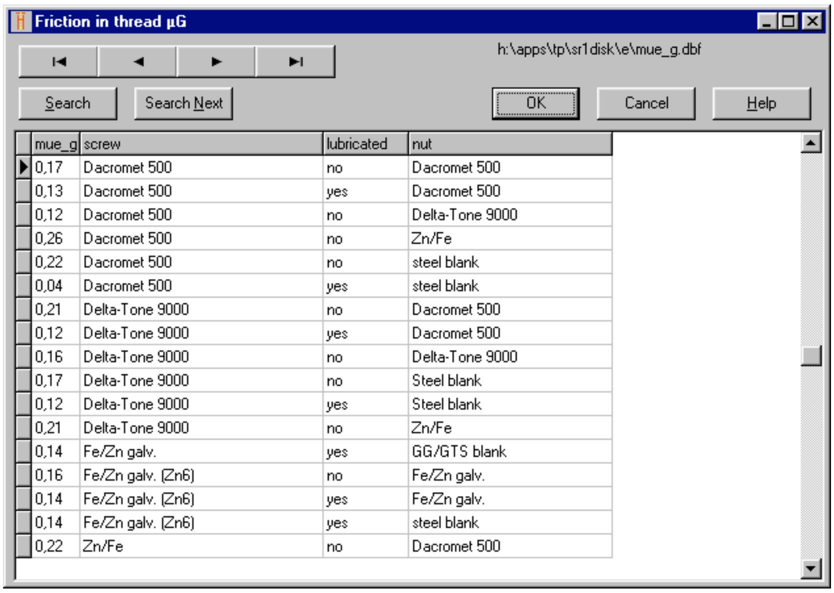
Prevailing Torque MApre

For self-locking screws and self-tapping screws you can define torque MApre caused by thread friction.
MApre increases tightening torque MA, but on the other side it also reduces maximum tightening torque because of higher torsion stress.

5.3.7. Input Friction



The friction values for the head seat and thread are required in order to calculate the tightening moment. The friction between the seam areas is required for the calculation of the necessary residual clamping force with shearing forces.



mue_g	screw	lubricated	nut
0,17	Dacromet 500	no	Dacromet 500
0,13	Dacromet 500	yes	Dacromet 500
0,12	Dacromet 500	no	Delta-Tone 9000
0,26	Dacromet 500	no	Zn/Fe
0,22	Dacromet 500	no	steel blank
0,04	Dacromet 500	yes	steel blank
0,21	Delta-Tone 9000	no	Dacromet 500
0,12	Delta-Tone 9000	yes	Dacromet 500
0,16	Delta-Tone 9000	no	Delta-Tone 9000
0,17	Delta-Tone 9000	no	Steel blank
0,12	Delta-Tone 9000	yes	Steel blank
0,21	Delta-Tone 9000	no	Zn/Fe
0,14	Fe/Zn galv.	yes	GG/GTS blank
0,16	Fe/Zn galv. (Zn6)	no	Fe/Zn galv.
0,14	Fe/Zn galv. (Zn6)	yes	Fe/Zn galv.
0,14	Fe/Zn galv. (Zn6)	yes	steel blank
0,22	Zn/Fe	no	Dacromet 500

The friction coefficients for the most important pairs can be selected from the database delivered with the program. The database values can be modified and appended as required.

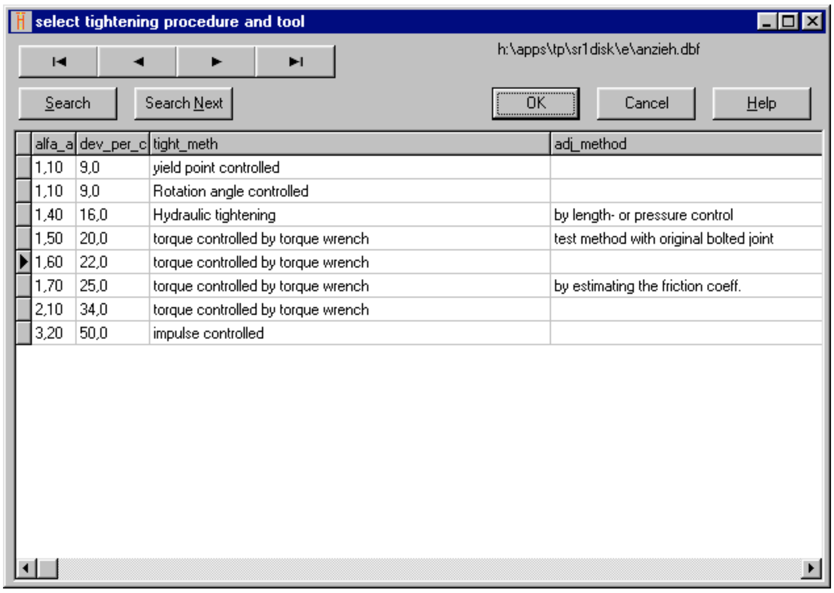
With newer versions of SR1 (V11.0) you can enter maximum friction values. SR1 calculates minimum torque MAmin from alphaA and friction tolerance. By entering Sigma coefficient, SR1+ calculates Gaussian distribution of FM and reject rate from statistically added tolerances.

If you use prevailing torque bolts or nuts, enter the prevailing torque at MApre.

At “Edit->Calculation Method”, you can set input of min. Friction coefficients or min/max.

5.3.8. Tightening Method

The tolerance between minimum and maximum pre-stress force depends upon the selected tightening method choosen from the database.



alfa_a	dev_per_c	tight_meth	adj_method
1,10	9,0	yield point controlled	
1,10	9,0	Rotation angle controlled	
1,40	16,0	Hydraulic tightening	by length- or pressure control
1,50	20,0	torque controlled by torque wrench	test method with original bolted joint
1,60	22,0	torque controlled by torque wrench	
1,70	25,0	torque controlled by torque wrench	by estimating the friction coeff.
2,10	34,0	torque controlled by torque wrench	
3,20	50,0	impulse controlled	

This database can of course be appended as required. The abbreviations have the following meanings:

sign	**meaning**
ALFA_A	tightening factor alphaA
dev_per_c	deviation +/- percent
ANZ_METHOD	tightening method
EINST_METH	setting method
BEMERK	remark

The tightening factor and scattering are related directly to each other, the program uses only the tightening factor alphaA. Scattering has been included in the database as this value generally has more meaning. The values can be converted with the following formula:

$$\text{deviation [\%]} = \left(\frac{2 \quad \text{alphaA}}{1 + \text{alphaA}} - 1 \right) * 100$$

$$\text{alphaA} = \frac{100\% + \text{deviation[\%]}}{100\% - \text{deviation[\%]}}$$

Instead of alphaA, you can input FMmin, MAmin, or MA tolerance.

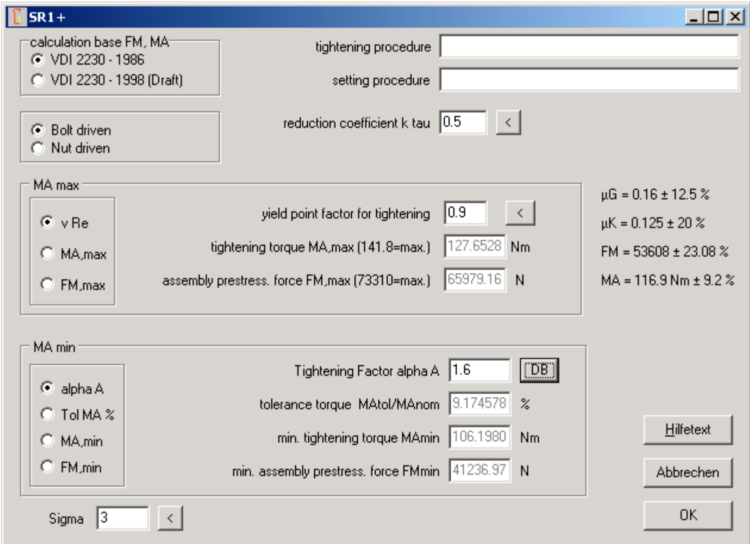
Reduction coefficient torsion k tau

When tightening the bolted joint, the bolt is stressed with tension and torque from thread friction as well. After tightening, a rest of torque remains. VDI 2230 recommends to calculate with 50%. Reduction coefficient depends on the tightening method. For hydraulic tightening with pressure to the clamping plates you can get tau k=0, the best case.

Reference stress Sigma red,B = $(\sigma_z^2 + 3(k_\tau * \tau_{max})^2)^{0.5}$

Yield Point Factor and Tightening Torque

How strongly the bolt needs to be tightened can be defined from the tightening torque MA or the yield point factor nüRp. A yield point factor of 1 means that the bolt is tightened until the tightening tension has reached the yield point. Usually a value of 0.9 is used for torque controlled tightening tools. SR1 calculates and displays the marginal torque at which the yield point is reached when you enter the tightening torque. Usually one tries to reach the point where the bolt is tightened to a maximum (approx. 90% of the yield point). Should such a high clamping force not be required or the surface pressure becomes too great then check whether or not a cheaper bolt with lower strength, or the next smaller size would be suitable for the application before you reduce the tightening moment or yield point factor.



Alternatively, you can enter the tightening torque MA or the assembly prestressing force FM, then SR1 calculates the yield point factor.

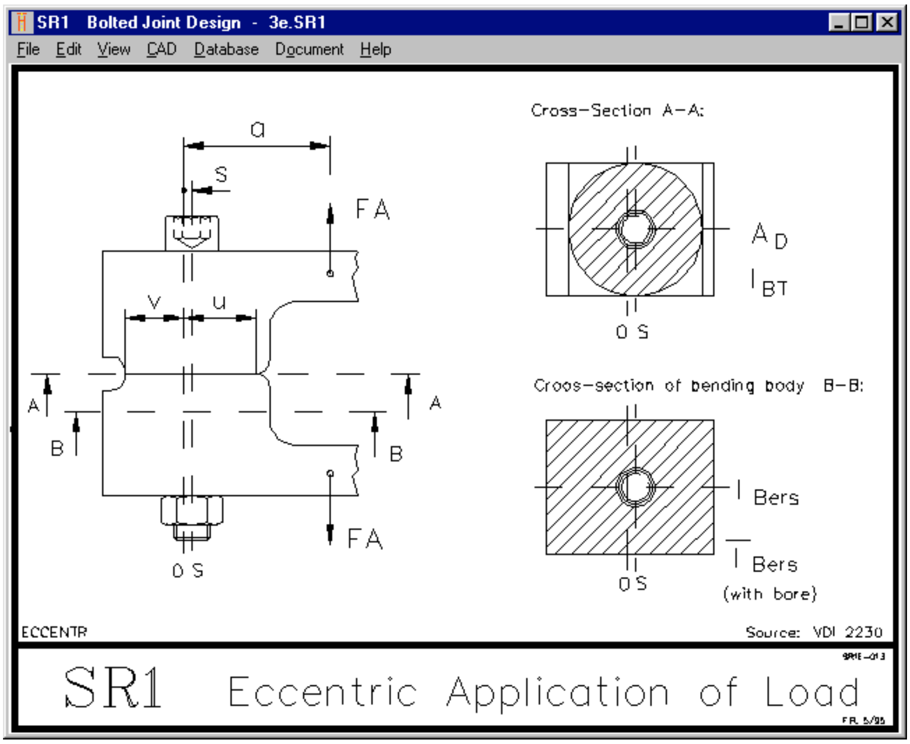
Calculation Base

The VDI2230 draft of 1998 uses another equation for tightening torque, this results in a higher value for MA.

Bolt/Nut driven

For nut-driven joints, SR1 uses the friction diameter between last plate and nut. The friction coeffient µK means the friction between nut and last plate for this case.

5.3.9. Eccentric Load Introduction



The non-central tension of a bolt joint causes, in addition to the longitudinal deformation, also a bending deformation of the clamped pieces, which also cause additional longitudinal deformation. Several additional entries are required when calculating with eccentrics.

Whereas when calculating with concentric load it is sufficient to enter an equivalent diameter for the cross-section of the clamping piece, with eccentric load the exact measurements are required, namely:
1. Geometry of the seam area
2. Geometry of the bending body

In the most simple case, the cross-section of the seam area and the bending body is identical. In the most difficult case, the bending body has several steps so that a substitute bending body must be used in order to calculate the cross-section and surface moment of inertia.

The eccentricity s is obtained from the position of the centre of gravity of the bending body in relation to bolt axis. The centre of gravity axis is also the datum axis for the input of the distance in relation to force effect line a and rim distance u and v. The eccentricity s is negative when the force effect line and bolt axis are on opposite sides of the centre of gravity axis.

AD is the seam area surface of the bending body minus the surface of the through-hole for the bolt (A BT - A H). Entering 0 is only correct for cylindrical, non-stepped clamping pieces.
I BT is the moment of inertia of the seam area surface which is to be calculated for the individual geometry. By entering 0 the surface moment of inertia of a hollow cylinder with the cross-section AD will be suggested for use.

IBers is the substitute moment of inertia which should be selected for stepped bending bodies. IBers is the same as the moment of inertia IB from the surface of the bending body AB for cross-sections which remain the same. The program suggests the moment of inertia of a cylinder with the cross-section AD for calculation.

íBers is the substitute moment of inertia with drilling. By entering 0 the moment of inertia will be calculated as the difference between IBers minus the drilling moment of inertia.

When more than two clamping pieces are defined, you will be asked between which two pieces the bending body calculation should be carried out.

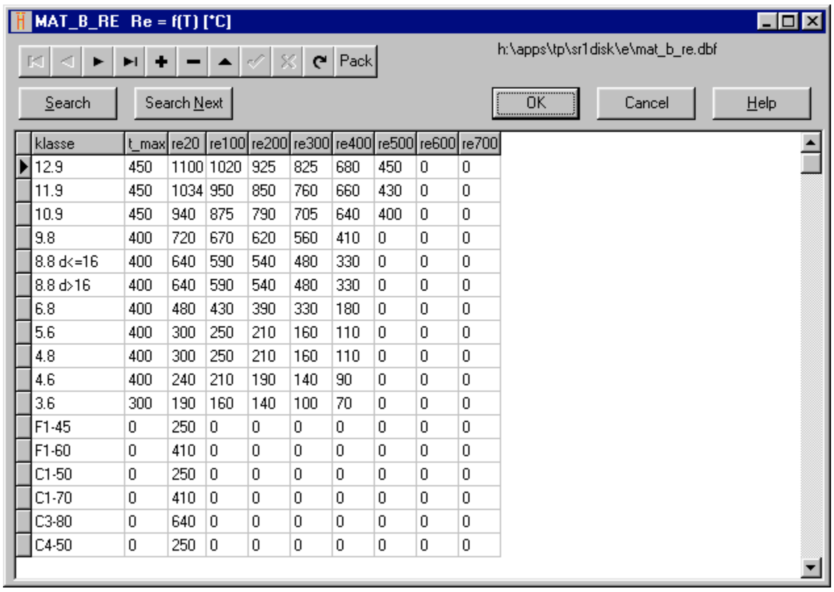
5.3.10. Temperature

The clamping force will increase or decrease at working temperature, if you use different materials for bolt and clamping plates. The length difference is calculated with:

delta L = L * alpha

The temperature coefficient alpha is loaded from the material databases MAT_BOLT (bolt) and PRESSUNG (clamping plates). The reference temperature (room temperature) was international standardized to 20øC and should never be changed. Yield point and e modulus of materials are temperature-dependent as well, data are loaded from following data bases:

MAT_B_RE.DBF: yield point of bolt, dependent from temperature in °C



klasse	t_max	re20	re100	re200	re300	re400	re500	re600	re700
12.9	450	1100	1020	925	825	680	450	0	0
11.9	450	1034	950	850	760	660	430	0	0
10.9	450	940	875	790	705	640	400	0	0
9.8	400	720	670	620	560	410	0	0	0
8.8 d<=16	400	640	590	540	480	330	0	0	0
8.8 d>16	400	640	590	540	480	330	0	0	0
6.8	400	480	430	390	330	180	0	0	0
5.6	400	300	250	210	160	110	0	0	0
4.8	400	300	250	210	160	110	0	0	0
4.6	400	240	210	190	140	90	0	0	0
3.6	300	190	160	140	100	70	0	0	0
F1-45	0	250	0	0	0	0	0	0	0
F1-60	0	410	0	0	0	0	0	0	0
C1-50	0	250	0	0	0	0	0	0	0
C1-70	0	410	0	0	0	0	0	0	0
C3-80	0	640	0	0	0	0	0	0	0
C4-50	0	250	0	0	0	0	0	0	0

MAT_B_E.DBF: E module of bolt, dependent from temperature in °C

MAT_P_E.DBF: E module of plates, dependent from temperature in °C
If no E-modulus was found in the database (E=0), SR1 uses an approximate calculation:

$$E = \frac{E20 - T * 72.5}{E20 - 20 * 72.5}$$

```
E20 = E-Module at 20°C
T   = Temperature in °C
```

If no database values are available for the warm yield point, SR1 uses another approximation formula:

```
Re = Re20 * (1.018 - T/1120)

Re20 = yield point at 20°C
T    = temperature in °C
```

If no database values are available, SR1 generates a warning.

A temperature calculation page is added to the printout, if reference temperature and working temperature differ.

Room temperature	T0	°C	20
Working temperature	T	°C	300
Length change, screw	delta LS	mm	0.515
Elasticity modulus, screw	ES	N/mm²	206000
Elasticity modulus, screw 300	ES300	N/mm²	185000

CLAMPING PIECE (T = 300°C)

i	l20 [mm]	l300 mm	E N/mm²	E 300	d20 mm/N	d300 mm/N
1	60.000	60.193	210000	185000	0.218E-6	0.247E-6
2	50.000	50.364	44000	23008	0.601E-6	1.150E-6
3	50.000	50.126	125000	104462	0.212E-6	0.253E-6

Length change, clamping piece	delta LP	mm	0.683
Elast.compliance, screw	delta St	mm/N	2.464E-6
Elast.compliance, plate	delta Pt	mm/N	1.65E-6
Yield point, screw	Re	N/mm²	940
Yield point, screw 300øC	Re300	N/mm²	705
Clamping force loss, work.temp.	delta FM	N	-40831
Mounting pre-stress force 300øC	FM 300	N	290196

5.4. Output

The calculation results can be printed out as text or displayed on screen, in addition it is possible to display or printout a hardcopy of the load-extension diagram of the calculated bolt joint as a graphic.

5.4.1. Printout

All input and calculated data can be displayed on screen, printed out or saved to file. The printout design (separating line *** or ====) can be configured under Edit->Settings->Printout.

Output to Printer

The printer interface (LPT1 thru 4) can be configured (see Chapter 4). The configured printer type is irrelevant for text output. The printer character set should be configured for PC so that special language characters and special signs can be printed out. For printers with manual individual page loading, the printout can be stopped after each page (pause after each page).

Output to File

The output can be diverted to file, if for example no printer is currently free or installed. A file name must be entered (e.g. SR1.OUT). The file will then be stored in the SR1 directory.

Printout Description

```
 ====================================================================»
º                                                                    º
º    SR1 V4.6  calc. of bolted joints to VDI 2230          page  1  º
º                                                                    º
º    R S TECHNOLOGIES  Farmington Hills                              º
º                                                                    º
º    User: TRAIN         File: 1E                        11/10/1996  º
º                                                                    º
Ì====================================================================¹
º                                                                    º
º    bolted joint in a hydraulic cylinder                            º
º    application example 1                                           º
º    from VDI 2230                                                   º
º                                                                    º
È====================================================================¼

BOLT:  DIN 912 - M12 x  60 - 10.9
=====================================================================
i   de [mm]   di [mm]   l [mm]    A [mm²]     x[mm]     delta [mm/N]
=====================================================================
 1    12.0       0.0      30.0      113.1      30.0     1.288E-6
---------------------------------------------------------------------
G3     9.9       0.0      12.0       76.2      42.0     0.764E-6
---------------------------------------------------------------------
```

The bolt part-cylinders are numbered with the index i. The index G3 characterises the part-cylinder with the non-screwed in thread part of the bolt. The entered diameter and lengths are da, di and l. A stands for the cross-section of the part-cylinder. The core cross-section Ad3 is relevant for the calculation of the elastic compliance in the thread free part G3. x is a consecutive coordinate for the end of the respective part-cylinder, commencing with x=0 at the bolt head. ë stands for the elastic compliance of the part-cylinder, this is in proportion to the screw extension.

```
---------------------------------------------------------------------
rated diameter of thread          M        mm              12.00
---------------------------------------------------------------------
thread pitch                      P        mm               1.75
---------------------------------------------------------------------
stress cross-section              As       mm              84.30
---------------------------------------------------------------------
diameter to As                    ds       mm              10.36
                                                                 --------
```

core diameter	d3	mm	9.85
edge diameter	d2	mm	10.87
minimum outside diameter	d0	mm	10.36
minimum cross-section	A0	mm²	84.30
yield point	Rp0,2	N/mm²	940
max. tensile stress (at FM)	Sigma 0	N/mm²	680
Young`s modulus	ES	N/mm²	206000
bolt length up to head	l	mm	60.00
thread length	lG	mm	30.00
head diameter	DK	mm	18.00
min. dia. of head seat	dw	mm	17.23
grip of bolt	lk	mm	42.00
equivalent length	lequ	mm	33.82

The index 0 of the smallest outer diameter and its cross-section is necessary for the calculation of the greatest occuring tensile stress. For DIN shaft bolts this is the stress cross-section, for special bolts this can also be the smallest diameter of the part-cylinder.

The clamping length lK is the total height of the clamped piece. l ers is the substitute length for a bolt with thread along its whole length with the same elastic compliance as the bolt used. The substitute length is necessary for eccentric load.

CLAMPING COMPONENTS (DIMENSIONS)

i	de [mm]	di [mm]	l [mm]	x [mm]	A equ[mm²]	d equ[mm]
1	80.0	13.5	42.0	42.0	525.1	29.2

CLAMPING COMPONENTS (MATERIAL AND LOAD)

i	material	E [N/mm²]	p zul	p max	delta [mm/N]
1	C 45	210000	700	636	0.38E-6

da, di and l are the entered diameter and lengths. x is the consecutive coordiante for the end of the clamping piece from the bolt head.
A ers is decisive cross-section for the calculation of the elastic compliance. For large "da" the cross-section used to calculate the elastic compliance is composed of a substitute pressure part with the diameter "ders".

Material, E modulus and p adm. are values from the material database.

A maximum occuring surface pressure in relation to the next clamping piece, head or nut seat is calculated for each clamping piece. The greatest surface pressure value in relation to the neighbouring piece is output.

delta is the elastic compliance of the clamping piece.

BOLTED JOINT: termin. bolted joint

thread depth	tG	mm	20.0
bore depth	t	mm	25.0

ELASTICITY

Elasticity bolt sect.	delta is	mm/N	1.288E-6
Elasticity free thread	delta G3	mm/N	0.764E-6
Elasticity head	delta K	mm/N	0.206E-6
Elasticity thread	delta G	mm/N	0.382E-6
Elasticity nut	delta M	mm/N	0.206E-6
Elasticity screw	delta S	mm/N	2.846E-6
Elasticity plates	delta P	mm/N	0.38E-6

SPRING RATE

Spring rate screw	R S	N/mm	351.4E3
Spring rate plates	R P	N/mm	2.625E6

ELONGATION

Elongation screw	fSM	mm	0.16
Shortening plates	fPM	mm	0.0215

FLEXURAL ELASTICITY

bolt grip ratio	lk/d		3.50
flexural elasticity screw	beta S	1/Nmm	0.355E-6

The elastic compliance deltaS of the bolt is the sum of part-cylinder compliance, with the addition of the bolt head, thread and nut compliance.

The elastic compliance deltaP of the plate is the sum of the compliance of all clamping pieces. The elastic bending compliance ßS of the bolt is necessary with eccentric load.

LOAD

max. tensile force	FAo	N	24900
min. tensile force	FAu	N	0
shearing force	FQ	N	0

reqd. residual clamping force	FKR	N	1000
min. residual clamping force	FKmin	N	9672
theor.prestressing force for Rp0.2	FM-Rp	N	62670
assembly prestress. force	FM	N	56403
max.req.assembly prestress. force	FMmax	N	42527
min.req.assembly prestress. force	FMmin	N	26579
total amount of settling	fz	mm	0.00504
prestress.force loss thr.settling	Fz	N	1561
req.prestressing force	Fv	N	25018
min.prestressing force	Fv min	N	33691
max.prestressing force	Fv max	N	54842
suppl. bolt force from FA	FSAo	N	881.9
suppl. plate force from FA	FPAo	N	24018

For an explanation of the calculated forces please see under Load Extension Diagram.

DISTRIBUTION OF FORCE

introduction of force: to the clamping piece 1

force distribution factor	n1	0.30
share of elastic.on introd.force	delta1	0.267E-6

application of force: at the nut thread

force ratio	phi K	0.118
force ratio	phi n	0.035
force distribution factor	n	0.30

Force distribution factor and force ratio are calculated from the locations of the force introduction and the elastic compliance of the bolt and clamping pieces.

VIBRATORY STRESS

perm.vibr.stress f.heat-tr.bolt	sigma A	N/mm²	+/-	50
vibratory stress of bolt (concen.)	sigma a	N/mm²	+/-	6

Permanent breakage when sigmaa becomes greater than sigmaA !

FRICTION

coeff.of friction in thread	μG		0.140
coeff.of friction in head seat	μK		0.100
coeff.of friction in mould seam	μTr		0.120

ASSEMBLY

tightening procedure: torque controlled by torque wrench			
setting procedure:			
yield point tightening factor	nue Rp		0.90
tightening factor	alpha A		1.60
dispersion of assembly force		%	23.1
tightening torque screw	MA	Nm	110.2
tightening torque f yield point	MA Rp	Nm	122.5
tightening angle	alpha M	deg	37.44

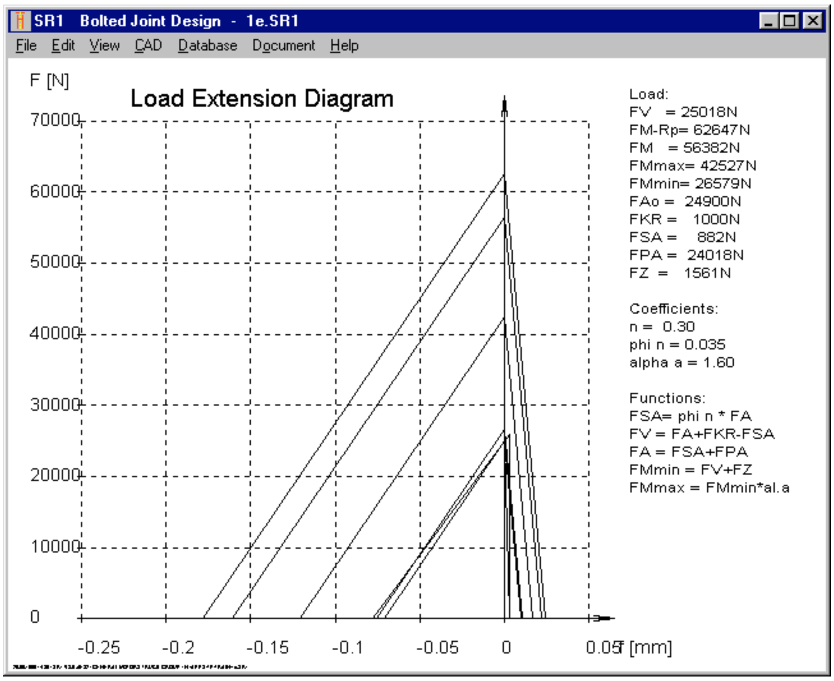
MA is the tightening torque representing a tensile stress in the bolt which is 90% (nue Rp) of the yield point.

FACTORS OF SAFETY

safety against loosening	FM/FMmax	1.33
safety against overelongation	Rp/sig.0	1.38
safety ag.fract. (stat.)	Rp*A0/(Fvmax+FSA)	1.42
safety ag.fatigue fract.(concen.)	sigmaaperm/sigmaa	8.69
safety plate surface pressure	pperm/p	1.10

All Safety factors must be higher than 1.0 !

5.4.2. Load Extension Diagrams



Load extension diagrams can be graphically displayed on screen. It is also possible to output to CAD or desk top publishing via DXF or IGES files. With the supplementary software DXFPLOT, you can output scale graphics and drawings to plotter or laser printer.

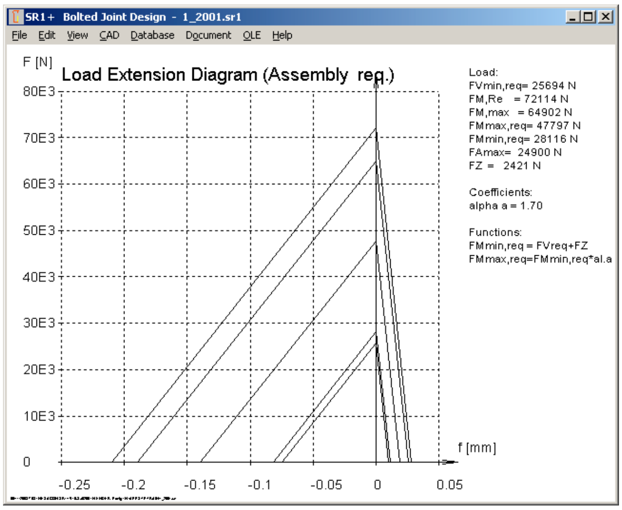
All forces and extensions from the calculation are shown in the load extension diagram.

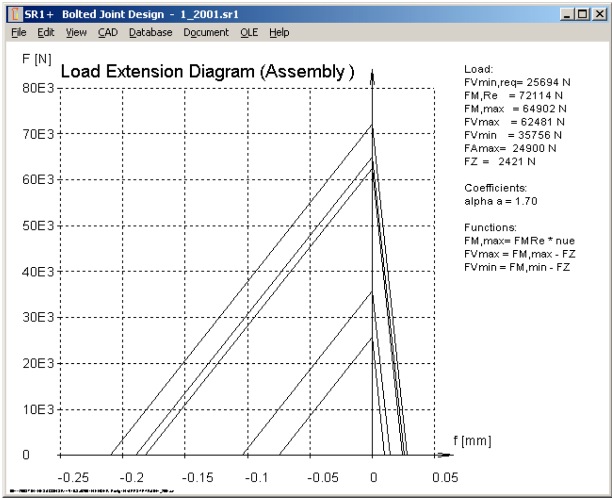
FV is the necessary pre-stress force calculated from the residual clamping force and tensile force. Fmmin,req and Fmmax,req are the calculated necessary assembly forces. The actual maximum assembly force is FM. FM-Re is the theoretical assembly force in case the bolt is to be tightened up to its yield point.

FMmin,req is the lowest necessary assembly pre-stress force and results from the sum of the necessary pre-stress forces FV and the settling force loss FZ. FMmax,req results from the tolerance due to scattering from the tightening method.

With the keys "+" and "-" you can enlarge or scale down the diagram, or zoom window by left mouse key. You can move the diagram in all four directions with the cursor keys. The right mouse button will return you to the original diagram. A copy of the diagram can be printed out with "File-Print".

Load Extension Diagram (Assembly Condition)

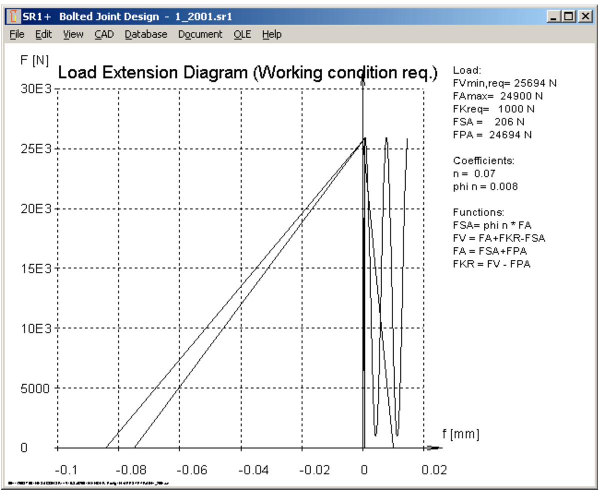


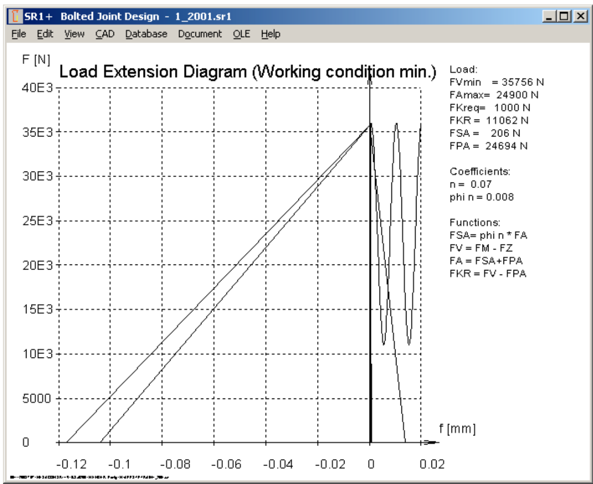


These diagrams shows the forces in assembled unloaded state.
FM,max is the assembly force which occurs when the bolt is tightened a tension of 90% of the yield point (Factor nue).
FZ is the settling force loss which results from evening of the surface irregularities.
FVmin and FVmax are the smallest and greatest pre-stress forces affecting the bolt.
FV is the required pre-stress force which is dependent on the amount of the attacking tensile force, the force introduction factor and the necessary residual clamping force.

Load Extension Diagram in Working Condition

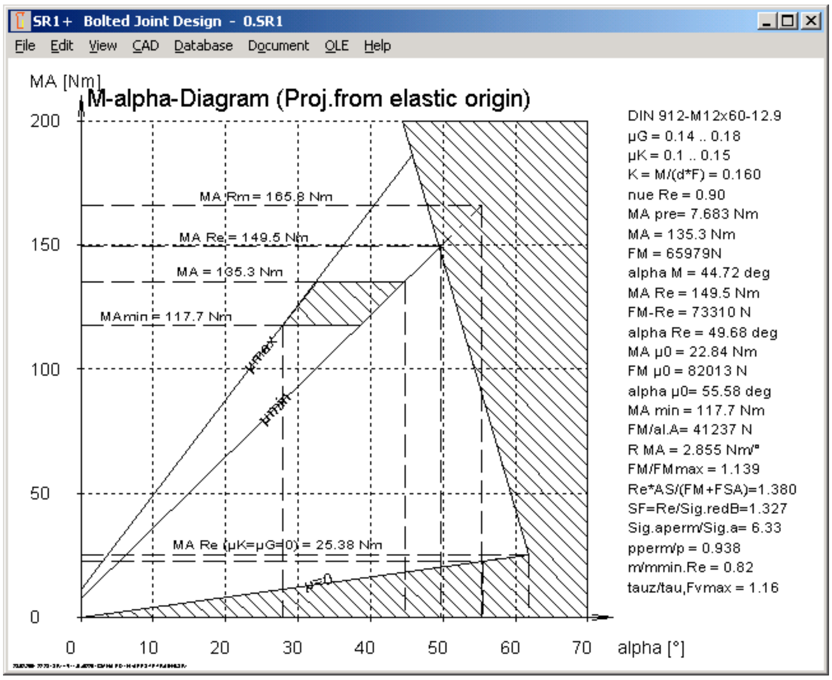
The diagram shows clearly how the influencing tensile force FA affects the joint. For dimensioning, the external axial force FA is used together with the necessary pre-stress force FV or otherwise with the maximum and minimum occurring pre-stress force Fvmax and FVmin. This diagram shows only the forces which occur in connection with the load on the bolt joint due to the axial force FA.





FV is the necessary pre-stress force which is dependent on the at external tensile force FA, the force introduction factor n and the required residual clamping force FKR.
The additional bolt force FSA is dependent on the size of the axial force FA and factor n resulting from the force introduction positions. It is the part of the axial force FA with which the bolt is additional loaded.
The additional plate force FPA results as the difference between the axial force FA and the additional bolt force FSA. It is the part of the axial force FA which removes the load from the clamping pieces.

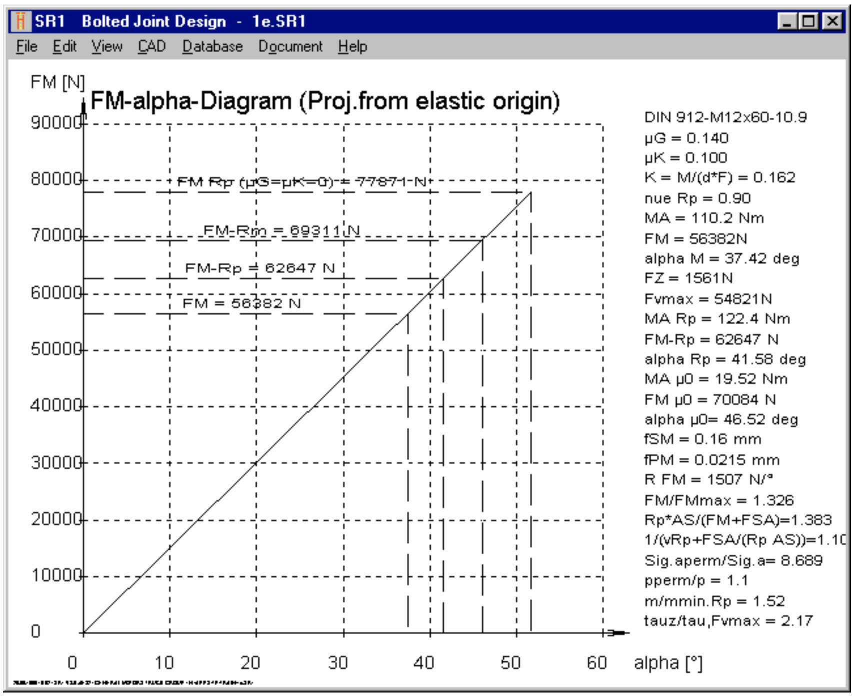
5.4.3. M-alpha Diagram



The M-alpha diagram shows the tightening torque as function of the bolt assembly angle (Proj.from elastic origin). MA is the torque according to the entered values. MA Rp is the Torque until yield point of the bolt, and MA Rm until tensile strength. Also there are marked the torque without head friction (MG), and the theoretical torque MA Rp (μ=0) without friction. Yield zone and tolerance zone (friction and alphaA) are hatched at the diagram.

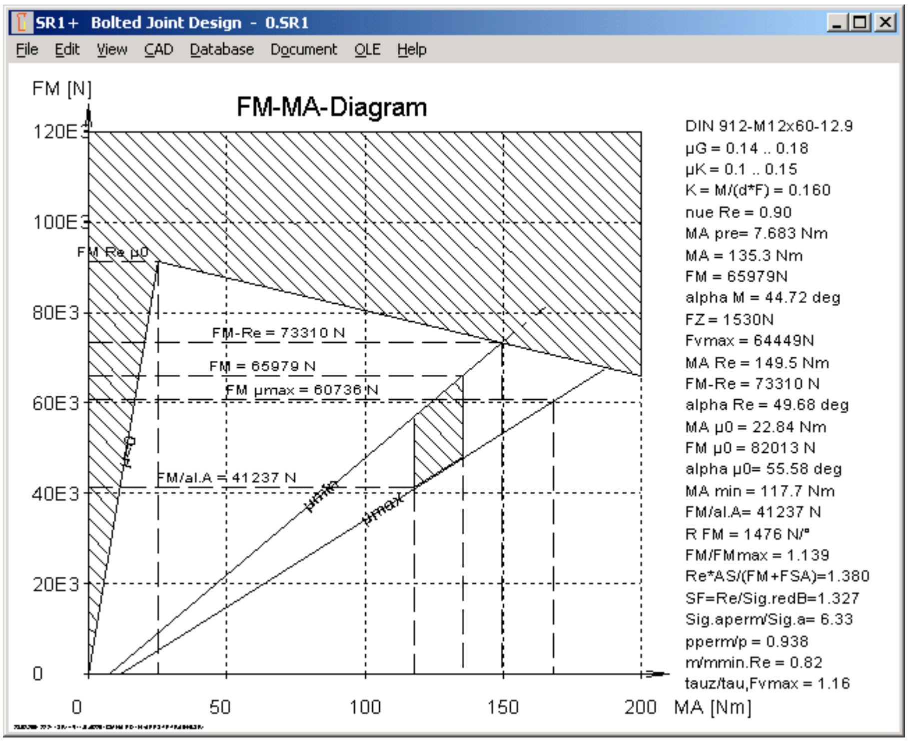
F-alpha-Diagram

The F-alpha diagram shows the assembly prestressing force FM as function of the bolt assembly angle (Proj.from elastic origin).



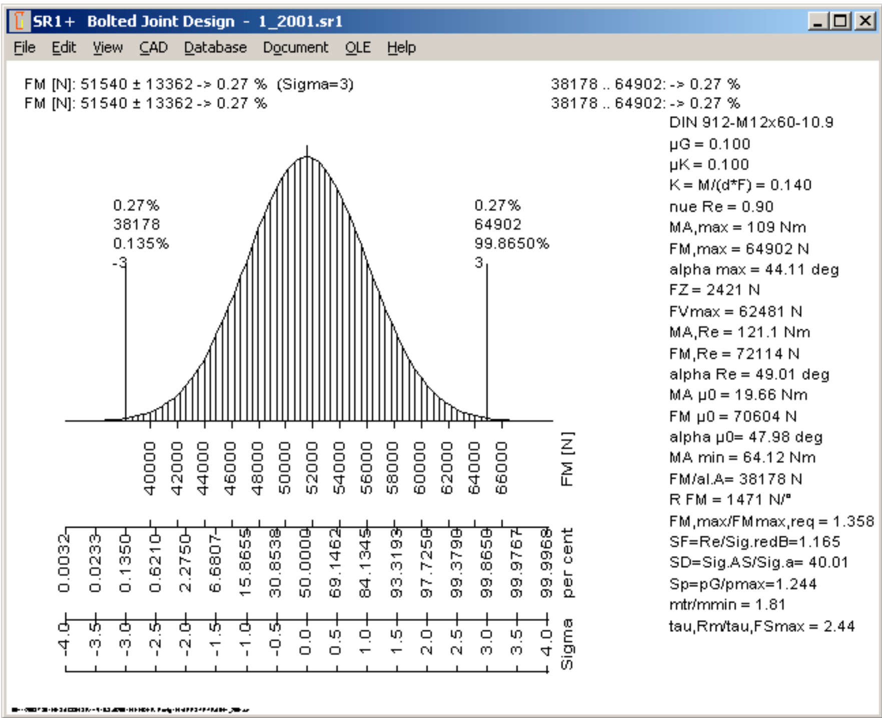
5.4.4. FM-MA-Diagram

The FM-MA diagram shows the dependency of the pre-stressing force from the tightening torque. FM-Rp µ0 is the theoretical line without friction. FM is the pre-stressing force according to the entered nü Rp, FM-Rp at yield point, and FM-Rm at tensile strength of the bolt.



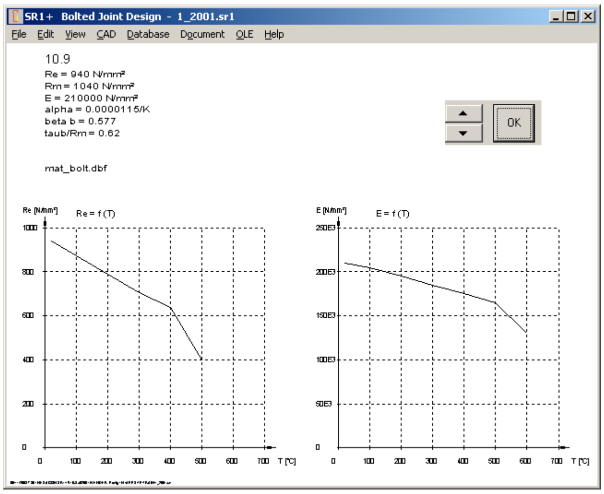
5.4.5. FM Statist.

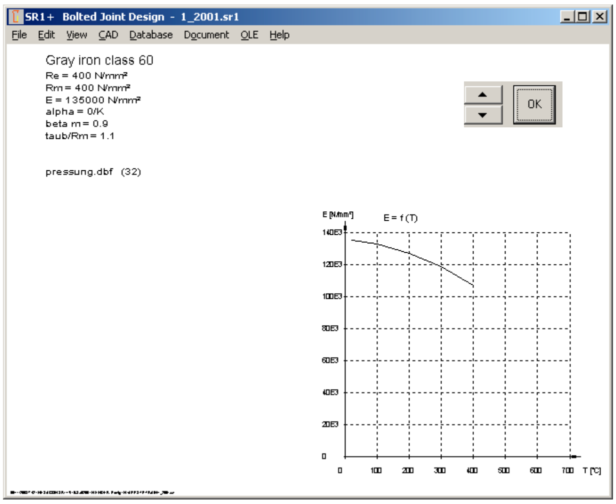
This chart shows the statistical distribution of the clamping load FM. It depends on FM,min and FM,max and the Sigma coefficient entered at “Edit->Tightening”.



5.4.6. View Material

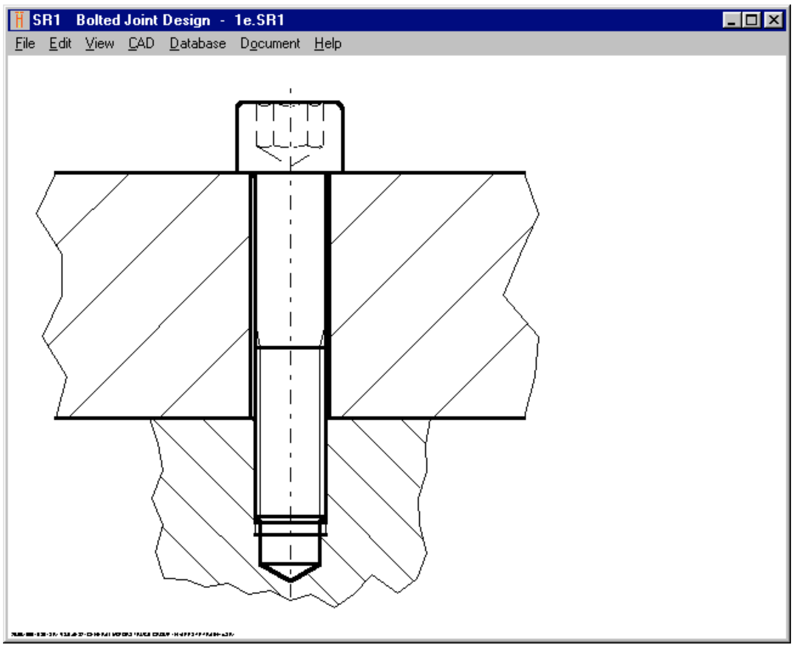
Here you can list the material data included in the databases mat_bolt.dbf, pressung.dbf and mat_p_1.dbf. Temperature-dependent curves of yield point Re and modulus of elasticity E are drawn only if data available from databases mat_b_re.dbf, mat_b_e.dbf, mat_p_re.dbf, mat_p_e.dbf.
Click into buttons “<” and “>” to show previous/next record and “OK” to return to menu.





View Drawing

You can have a diagram of the calculated bolt displayed. Under "CAD" you can have the file exported to CAD via the DXF or IGES files.



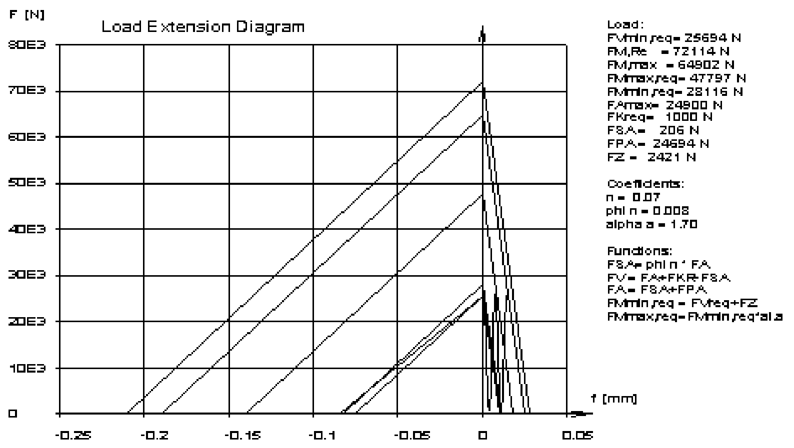
View Load

Load-Extension diagram and tables with load data and formulas, sorted for input data, required load and real load.

SR1+ Bolted Joint Design - 1E.sr1

File Edit View CAD Database Document OLE Help

HEXAGON SR1+ Bolted Joint Design to VDI 2230 V15.8



input			
tensile load max.	FAmax	N	24900
tensile load min.	FAmin	N	0
shearing force	FQ	N	0
reqd.residual clamp.load	FKR	N	1000
amount of settling	fz	mm	0.008
settling load	Fz	N	2421
tightening factor	alpha A	N	1.7
tightening torque (max.)	MA	Nm	109

Load Extension Diagram			
FSA / FA	phi n		0.00827
suppl.bolt load from FA	FSAmax	N	205.9
suppl.plate load from FA	FPAmax	N	24694

Load, required			
req. preload	FV= FKR + FA - FSA	N	25694
req. assembly preload min.	FM min = FV+ Fz	N	28116
req. assembly preload max.	FM max = FM min * alpha A	N	47797

Load, real			
real assembly preload (max)	FM (zul,max)	N	64902
assembly preload at Rp	FM 0.2	N	72114
real assembly preload max.	FVmax = FM - Fz	N	62481
real assembly preload min.	FVmin = FM / alphaA - Fz	N	35756
real residual clamp.load	FK min = FVmin - FPA	N	11062
bolt load max.	FS max = FVmax + FSA	N	65108
bolt fracture load	F Rm	N	87637
yield load, bolt	F Rp	N	79211

					Date	Name
				Compl	19.01.1997	Ruoss
				Check		
				Stand.		
a	nach VDI 2230:2003	03/14/2003	Ruoss			
Cond.	Modification	Date	Name	FLENDER Penig		

Example 1

VDI 2230 (2003)

1_2001

Page

Pg.

H:\APPS\TP\TRAIN\1E.sr1

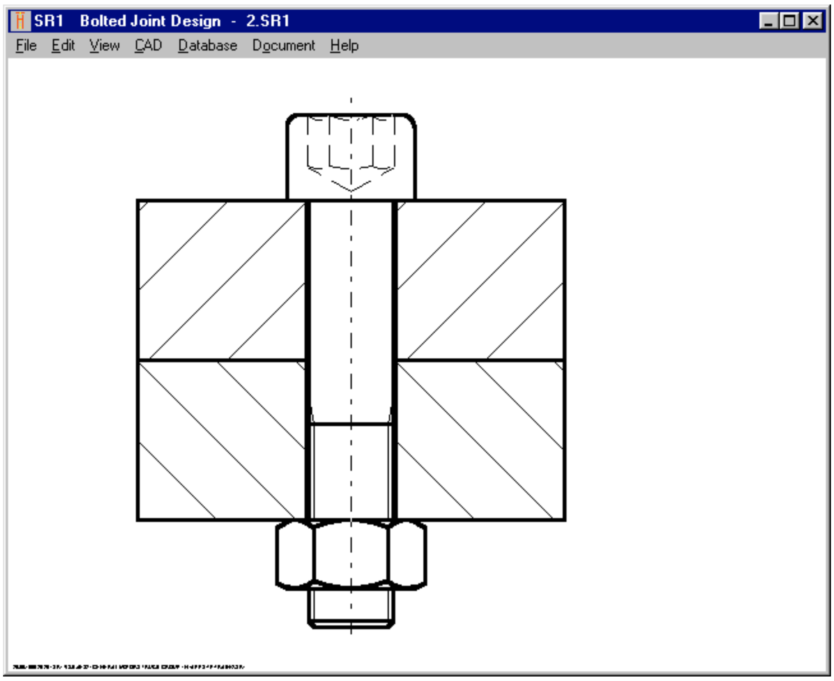
03/11/2003 7:47 - HEXAGON SR1+ V15.8 #0200 - FLENDER Penig - H:\APPS\TP\TRAIN\1E.sr1

5.5. CAD

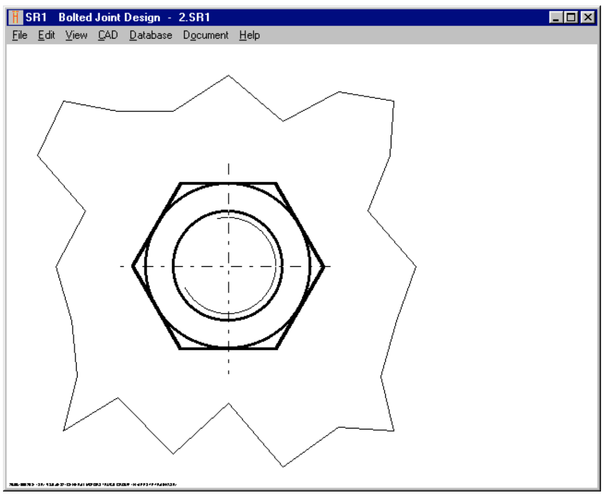
The calculated bolt joint can be created as a drawing via DXF or IGES files, output to screen is also possible. The drawing files can then be loaded, edited, plotted or included in construction and combination drawings with CAD systems which have the appropriate interface.

When you choose to create DXF or IGES files the file swill be stored in the SR1 directory if no other CAD directory has been configured (see Chapter 4: Configuration). We recommend that you first display the drawing on screen to see if it is in order. When outputting as a CAD file you have to give the file a name (without the ending DXF or IGS)

You can display a front or side elevation, however the only difference is in the bolt head and the nut. The top elevation shows the bolt head, the bottom elevation shows the nut.



Top elevation bolt joint



Bottom elevation bolt joing

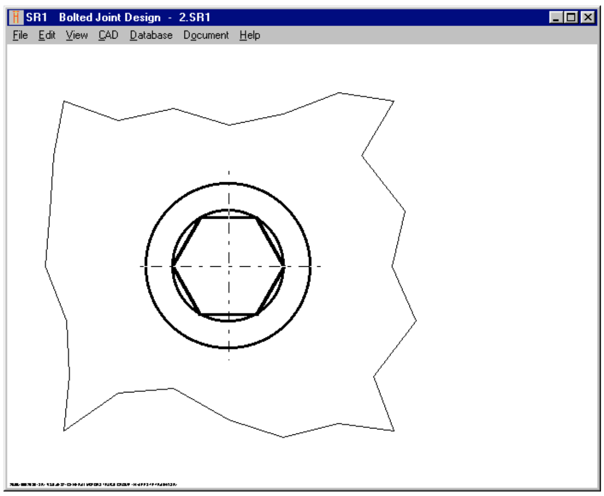
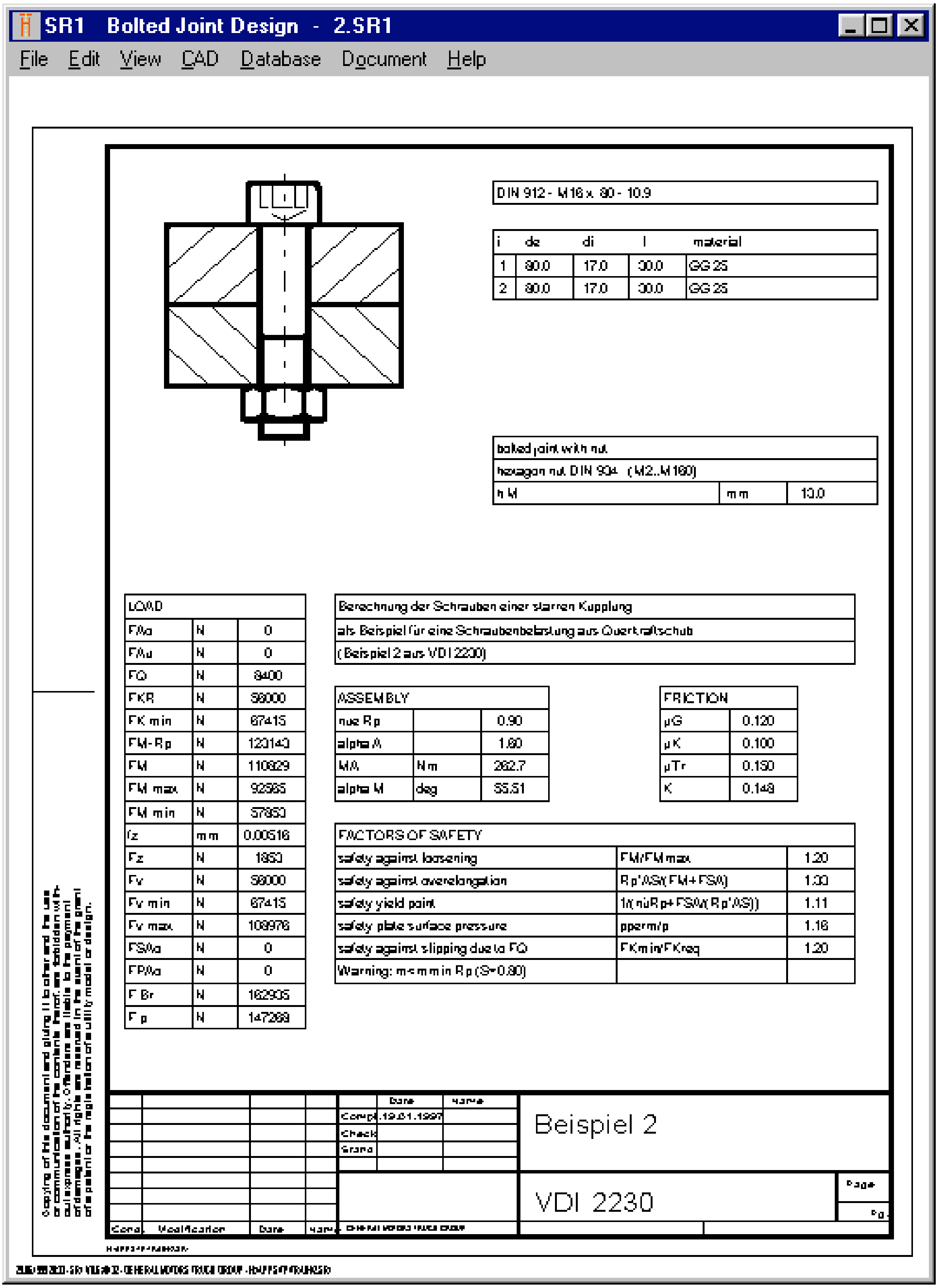


Table Drawing

The drawing contains tables with the most essential data and results of the bolted joint.



DIN 912 - M16 x 80 - 10.9

i	da	di	l	material
1	80.0	17.0	30.0	GG 25
2	80.0	17.0	30.0	GG 25

bolted joint with nut		
hexagon nut DIN 934 (M2..M160)		
h M	mm	13.0

LOAD		
FAo	N	0
FAu	N	0
FQ	N	8400
FKR	N	58000
FK min	N	67415
FM-Rp	N	120143
FM	N	110829
FM max	N	92585
FM min	N	57853
fz	mm	0.00516
Fz	N	1853
Fv	N	58000
Fv min	N	67415
Fv max	N	108976
FSAo	N	0
FPAo	N	0
F Br	N	162905
F p	N	147268

Berechnung der Schrauben einer starren Kupplung
als Beispiel für eine Schraubenbelastung aus Querkraftschub
(Beispiel 2 aus VDI 2230)

ASSEMBLY		
nue Rp		0.90
alpha A		1.60
MA	Nm	262.7
alpha M	deg	55.51

FRICTION	
µG	0.120
µK	0.100
µTr	0.150
K	0.148

FACTORS OF SAFETY		
safety against loosening	FM/FM max	1.20
safety against overelongation	Rp*AS/(FM+FSA)	1.00
safety yield point	1/(nüRp+FSA/(Rp*AS))	1.11
safety plate surface pressure	pperm/p	1.16
safety against slipping due to FQ	FKmin/FKreq	1.20
Warning: m<mmin Rp (S=0.80)		

Beispiel 2

VDI 2230

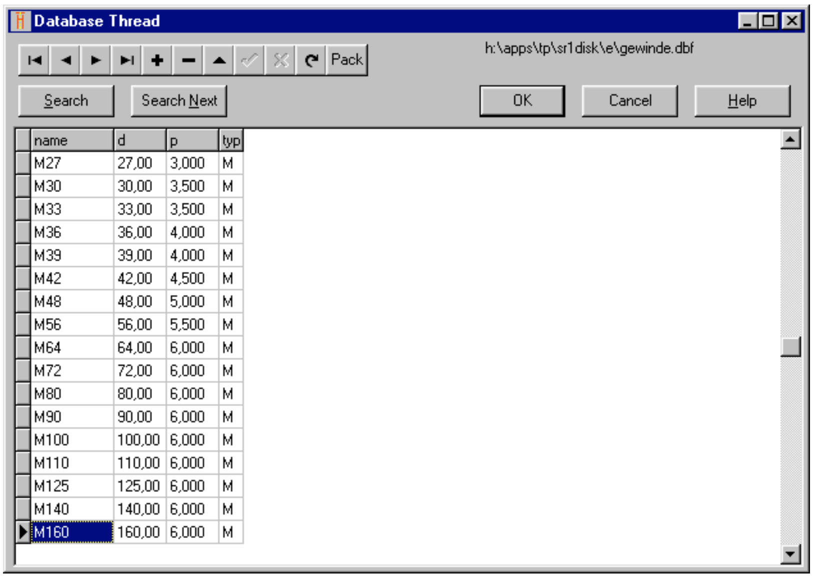
5.6. Database

Most of the data for for input, calculation and drawing of the bolt joint is taken from the database delivered with the program. You can alter individual data fields or append with new data records, e.g. for a thread M15.

The SR1 database fields will be explained shortly.

For database input, please also read the explanations on pages 5-4 and 5.5.

5.6.1. Thread Database



name	d	p	typ
M27	27,00	3,000	M
M30	30,00	3,500	M
M33	33,00	3,500	M
M36	36,00	4,000	M
M39	39,00	4,000	M
M42	42,00	4,500	M
M48	48,00	5,000	M
M56	56,00	5,500	M
M64	64,00	6,000	M
M72	72,00	6,000	M
M80	80,00	6,000	M
M90	90,00	6,000	M
M100	100,00	6,000	M
M110	110,00	6,000	M
M125	125,00	6,000	M
M140	140,00	6,000	M
M160	160,00	6,000	M

The abbreviations have the following meanings:

sign	meaning	unit
D	nominal diameter of thread	mm
P	pitch	mm
AS	stress cross-section of thread	mm^2
D3	core diameter	mm^2
TYP	thread type(M=metric N=metr.fine)	"M","N"

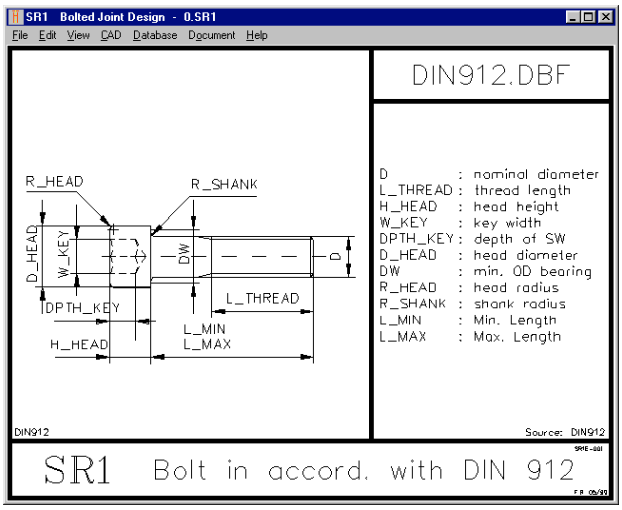
5.6.2. Bolt Head Database

The most common bolt head shapes are available in the SR1 database. The field descriptions are stored in the matching help pictures.

Database for Hexagon Socket Head Screw

hexagon socket head screw (C:\VOL3\APPS\TP\sr1disk\e\din912.dbf)

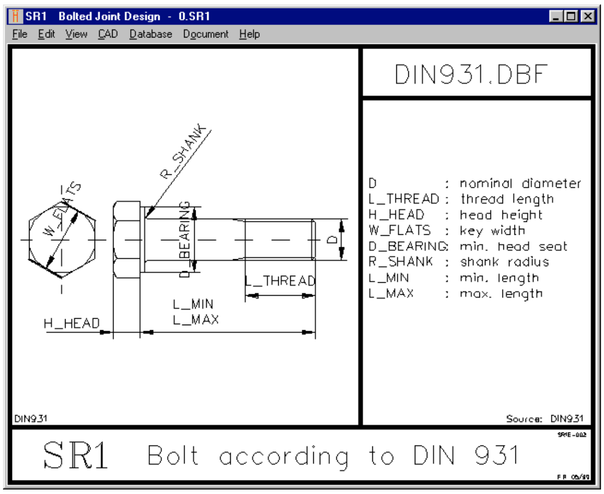
D	INFO1	L_THREAD	W_KEY	H_HEAD	DPTH_KEY	D_HEAD	DW	R_HEAD
1,85	ANSI B18.3	8	1,57	1,85	0,79	3	2,51	0,15
2,18	ANSI B18.3	9	1,98	2,18	0,96	3,55	3,32	0,2
2,51	ANSI B18.3	10	1,98	2,51	1,12	4,09	3,83	0,2
2,84	ANSI B18.3	11	2,38	2,84	1,29	4,64	4,34	0,2
3	DIN 912	18	2,5	3	1,7	5,5	5,07	0,2
3	DIN 7984	12	2	2	1,5	5,5	4,84	0,2
3	ISO 4762	18	2,5	3	1,3	5,5	5,07	0,3
3,18	ANSI B18.3	18	2,38	3,17	1,45	5,21	4,9	0,25
3,5	DIN 912	18	2,5	3,5	2,05	6,25	5,8	0,3
3,51	ANSI B18.3	18	2,76	3,51	1,63	5,74	5,4	0,3
4	DIN 912	20	3	4	2,4	7	6,53	0,4
4	DIN 6912	14	3	2,8	1,6	7	6,2	0,4
4	DIN 7984	14	2,5	2,8	2,3	7	6,2	0,4
4	ISO 4762	20	3	4	2	7	6,53	0,4
4,17	ANSI B18.3	20	3,58	4,16	1,96	6,86	6,52	0,4
4,83	ANSI B18.3	20	3,96	4,83	2,29	7,92	7,57	0,4
5	DIN 912	22	4	5	3,1	8,5	8,03	0,4
5	DIN 6912	16	4	3,5	2	8,5	7,7	0,4
5	DIN 7984	16	3	3,5	2,7	8,5	7,7	0,4



Database for Hexagon Head Bolt Heads

hexagon head bolt (C:\VOL3\APPS\TP\sr1disk\e\din931.dbf)

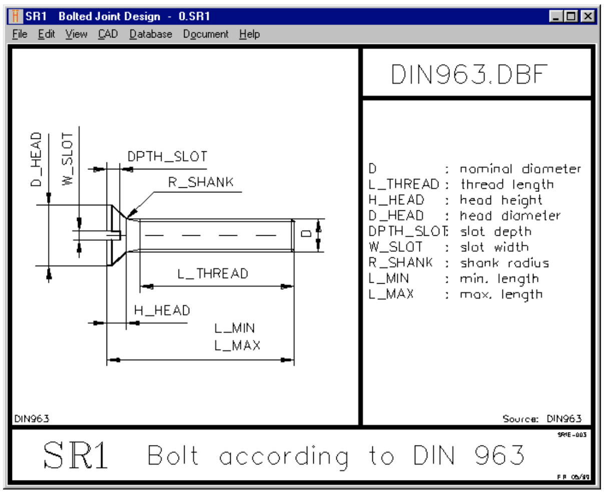
D	INFO1	L_THREAD	W_FLATS	H_HEAD	H_BEARING	DW	R_SHANK	L_MIN
3	ISO 4014	12	5,5	2	0,15	4,6	0,1	20
4	ISO 4014	14	7	2,8	0,15	5,9	0,2	25
5	ISO 4014	16	8	3,5	0,15	6,9	0,2	25
6	ISO 4014	18	10	4	0,15	8,9	0,25	30
6,35	ANSI HEX	19,05	11,13	4,78	0	10,79	0,76	0
7		20	11	4,8	0,15	9,6	0,25	30
7,94	ANSI HEX	22,23	12,7	5,97	0,4	12,29	0,76	0
8	ISO 4014	22	13	5,5	0,15	11,6	0,4	35
9,53	ANSI HEX	25,4	14,27	6,81	0,4	13,82	0,76	0
10	DIN 931	32	17	7	0,15	15,6	0,4	40
10	ISO 4014	32	16	6,4	0,15	14,5	0,4	40
10		32	15	6,4	0,45	13,6	0,4	0
11,11	ANSI HEX	28,57	15,88	8,03	0,4	15,32	0,76	0
12	DIN 931	36	19	8	0,15	17,4	0,6	45
12	ISO 4014	36	18	7,5	0,45	16,6	0,6	45
12,7	ANSI HEAVY	31,75	22,22	8,2	0,4	20	0	0
12,7	ANSI HEX	31,75	19,05	9,25	0,4	18,41	0,76	0
14		40	22	8,8	0,15	20,5	0,6	50
14	ISO	40	21	8,8	0,45	19,6	0,6	50



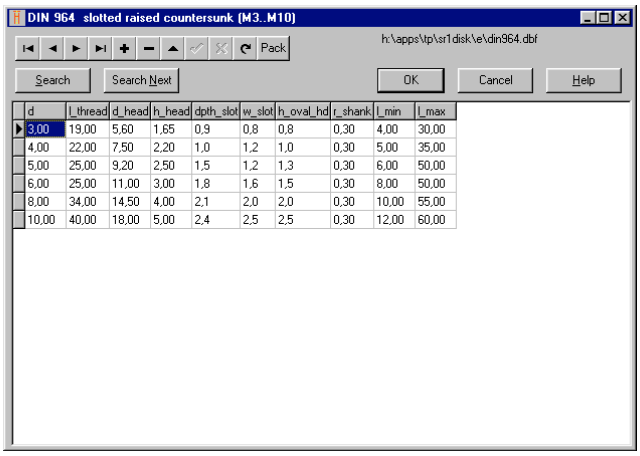
Database for Slotted Countersunk Screws (DIN 963)

DIN 963 slotted countersunk (M3..M20) — h:\apps\tp\sr1disk\e\din963.dbf

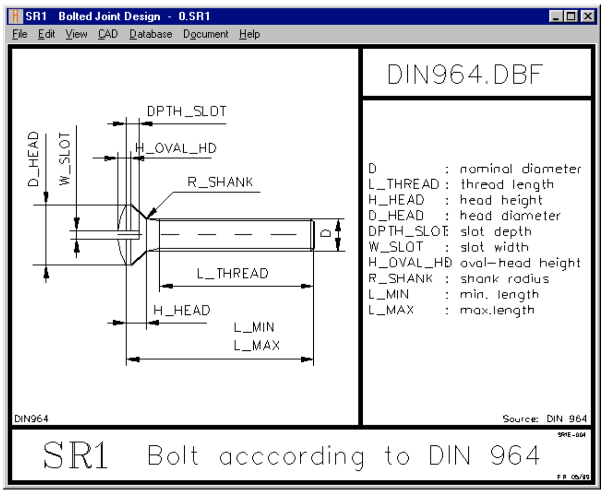
d	l_thread	d_head	h_head	dpth_slot	w_slot	r_shank	l_min	l_max
3,00	19,00	5,60	1,65	0,6	0,8	0,30	4,00	30,00
4,00	22,00	7,50	2,20	1,2	1,0	0,30	4,00	30,00
5,00	25,00	9,20	2,50	1,5	1,2	0,30	6,00	50,00
6,00	28,00	11,00	3,00	1,8	1,6	0,30	8,00	50,00
8,00	34,00	14,50	4,00	2,1	2,0	0,30	10,00	55,00
10,00	46,00	18,00	5,00	2,6	2,5	0,30	12,00	60,00
12,00	46,00	22,00	6,00	2,4	3,0	1,20	20,00	80,00
14,00	52,00	25,00	7,00	2,8	3,0	1,40	22,00	80,00
16,00	58,00	29,00	8,00	3,2	4,0	1,60	25,00	100,00
18,00	64,00	33,00	9,00	3,6	4,0	1,80	28,00	100,00
20,00	70,00	36,00	10,00	4,0	5,0	2,00	30,00	100,00



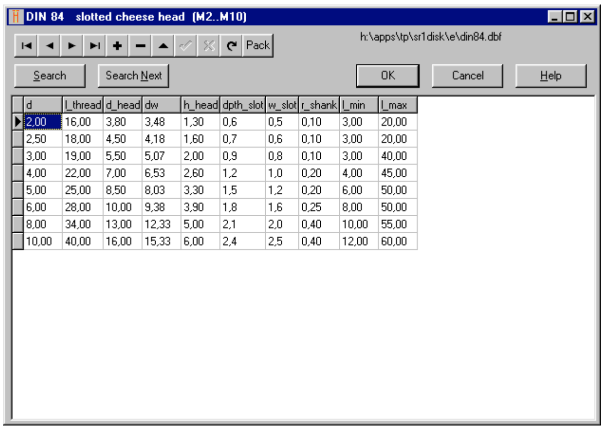
Database for Slotted Raised Countersunk Screws (DIN 964)



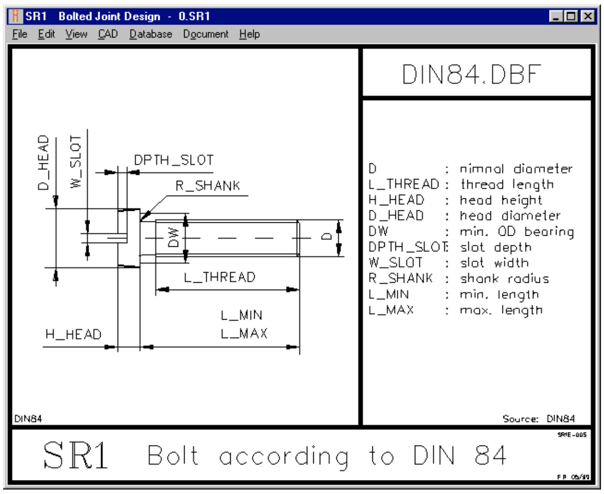
d	l_thread	d_head	h_head	dpth_slot	w_slot	h_oval_hd	r_shank	l_min	l_max
3,00	19,00	5,60	1,65	0,9	0,8	0,8	0,30	4,00	30,00
4,00	22,00	7,50	2,20	1,0	1,2	1,0	0,30	5,00	35,00
5,00	25,00	9,20	2,50	1,5	1,2	1,3	0,30	6,00	50,00
6,00	25,00	11,00	3,00	1,8	1,6	1,5	0,30	8,00	50,00
8,00	34,00	14,50	4,00	2,1	2,0	2,0	0,30	10,00	55,00
10,00	40,00	18,00	5,00	2,4	2,5	2,5	0,30	12,00	60,00



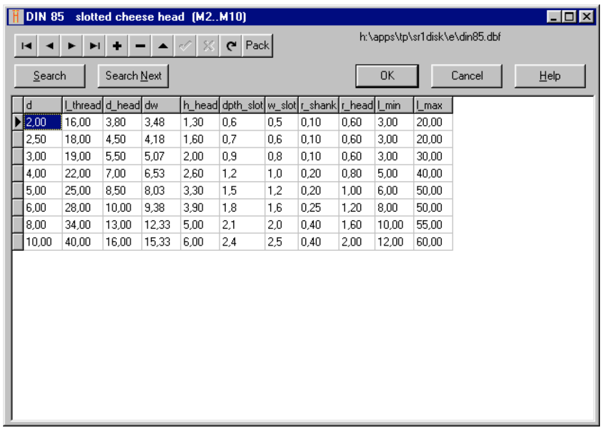
Database for Slotted Cheese Head Screw (DIN 84)



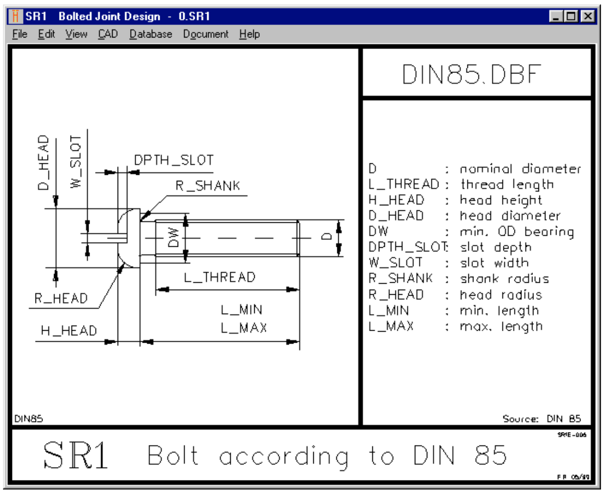
d	l_thread	d_head	dw	h_head	dpth_slot	w_slot	r_shank	l_min	l_max
2,00	16,00	3,80	3,48	1,30	0,6	0,5	0,10	3,00	20,00
2,50	18,00	4,50	4,18	1,60	0,7	0,6	0,10	3,00	20,00
3,00	19,00	5,50	5,07	2,00	0,9	0,8	0,10	3,00	40,00
4,00	22,00	7,00	6,53	2,60	1,2	1,0	0,20	4,00	45,00
5,00	25,00	8,50	8,03	3,30	1,5	1,2	0,20	6,00	50,00
6,00	28,00	10,00	9,38	3,90	1,8	1,6	0,25	8,00	50,00
8,00	34,00	13,00	12,33	5,00	2,1	2,0	0,40	10,00	55,00
10,00	40,00	16,00	15,33	6,00	2,4	2,5	0,40	12,00	60,00



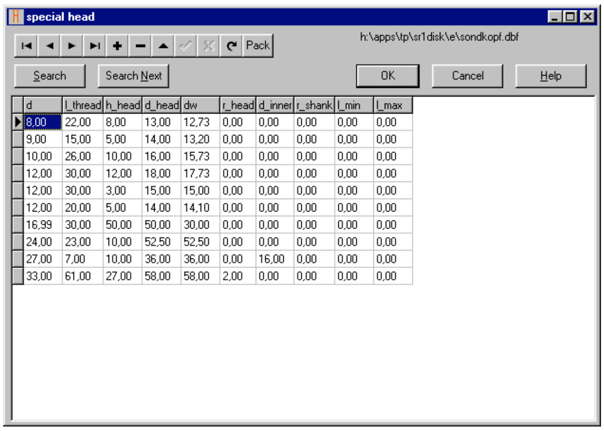
Database for Slotted Cheese Head Screw (DIN 85)



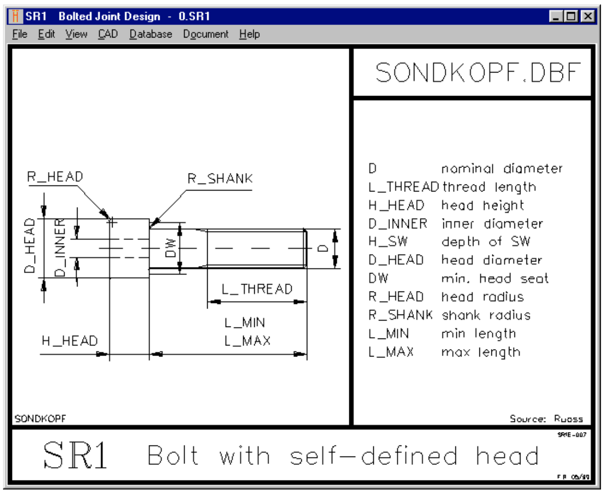
d	l_thread	d_head	dw	h_head	dpth_slot	w_slot	r_shank	r_head	l_min	l_max
2,00	16,00	3,80	3,48	1,30	0,6	0,5	0,10	0,60	3,00	20,00
2,50	18,00	4,50	4,18	1,60	0,7	0,6	0,10	0,60	3,00	20,00
3,00	19,00	5,50	5,07	2,00	0,9	0,8	0,10	0,60	3,00	30,00
4,00	22,00	7,00	6,53	2,60	1,2	1,0	0,20	0,80	5,00	40,00
5,00	25,00	8,50	8,03	3,30	1,5	1,2	0,20	1,00	6,00	50,00
6,00	28,00	10,00	9,38	3,90	1,8	1,6	0,25	1,20	8,00	50,00
8,00	34,00	13,00	12,33	5,00	2,1	2,0	0,40	1,60	10,00	55,00
10,00	40,00	16,00	15,33	6,00	2,4	2,5	0,40	2,00	12,00	60,00



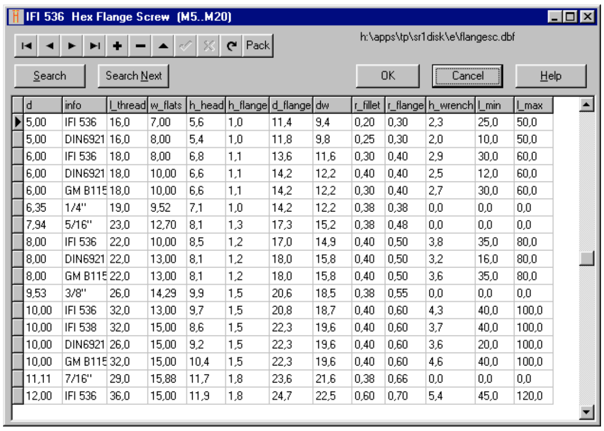
Database for self-defined head



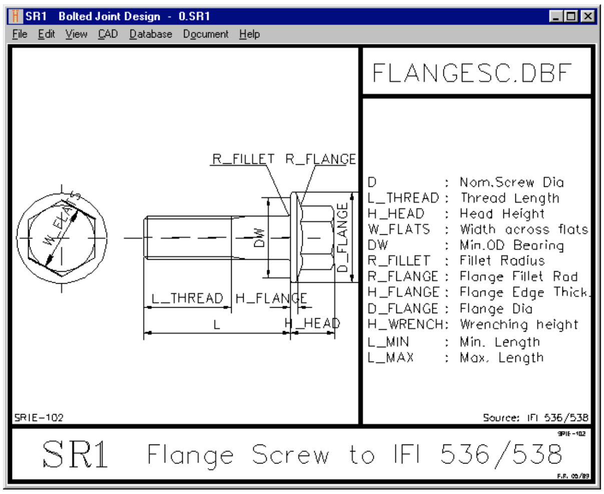
d	l_thread	h_head	d_head	dw	r_head	d_inner	r_shank	l_min	l_max
8,00	22,00	8,00	13,00	12,73	0,00	0,00	0,00	0,00	0,00
9,00	15,00	5,00	14,00	13,20	0,00	0,00	0,00	0,00	0,00
10,00	26,00	10,00	16,00	15,73	0,00	0,00	0,00	0,00	0,00
12,00	30,00	12,00	18,00	17,73	0,00	0,00	0,00	0,00	0,00
12,00	30,00	3,00	15,00	15,00	0,00	0,00	0,00	0,00	0,00
12,00	20,00	5,00	14,00	14,10	0,00	0,00	0,00	0,00	0,00
16,99	30,00	50,00	50,00	30,00	0,00	0,00	0,00	0,00	0,00
24,00	23,00	10,00	52,50	52,50	0,00	0,00	0,00	0,00	0,00
27,00	7,00	10,00	36,00	36,00	0,00	16,00	0,00	0,00	0,00
33,00	61,00	27,00	58,00	58,00	2,00	0,00	0,00	0,00	0,00



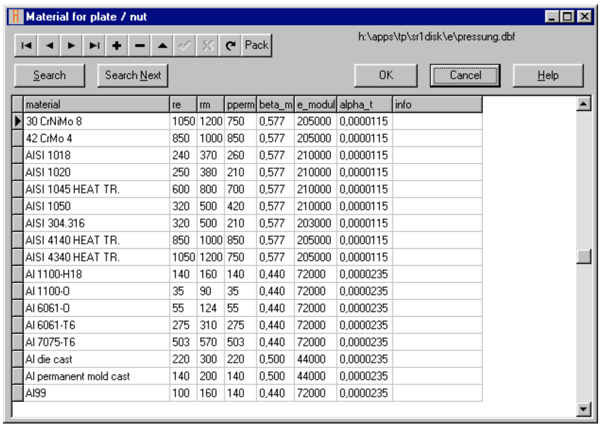
Database for Hex Flange Screw



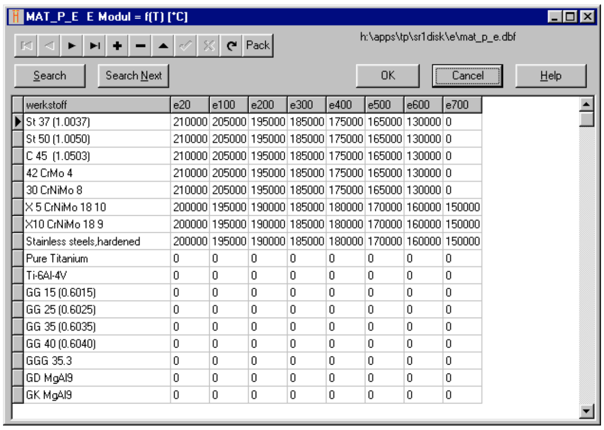
d	info	l_thread	w_flats	h_head	h_flange	d_flange	dw	r_fillet	r_flange	h_wrench	l_min	l_max
5,00	IFI 536	16,0	7,00	5,6	1,0	11,4	9,4	0,20	0,30	2,3	25,0	50,0
5,00	DIN6921	16,0	8,00	5,4	1,0	11,8	9,8	0,25	0,30	2,0	10,0	50,0
6,00	IFI 536	18,0	8,00	6,8	1,1	13,6	11,6	0,30	0,40	2,9	30,0	60,0
6,00	DIN6921	18,0	10,00	6,6	1,1	14,2	12,2	0,40	0,40	2,5	12,0	60,0
6,00	GM B115	18,0	10,00	6,6	1,1	14,2	12,2	0,30	0,40	2,7	30,0	60,0
6,35	1/4''	19,0	9,52	7,1	1,0	14,2	12,2	0,38	0,38	0,0	0,0	0,0
7,94	5/16''	23,0	12,70	8,1	1,3	17,3	15,2	0,38	0,48	0,0	0,0	0,0
8,00	IFI 536	22,0	10,00	8,5	1,2	17,0	14,9	0,40	0,50	3,8	35,0	80,0
8,00	DIN6921	22,0	13,00	8,1	1,2	18,0	15,8	0,40	0,50	3,2	16,0	80,0
8,00	GM B115	22,0	13,00	8,1	1,2	18,0	15,8	0,40	0,50	3,6	35,0	80,0
9,53	3/8''	26,0	14,29	9,9	1,5	20,6	18,5	0,38	0,55	0,0	0,0	0,0
10,00	IFI 536	32,0	13,00	9,7	1,5	20,8	18,7	0,40	0,60	4,3	40,0	100,0
10,00	IFI 538	32,0	15,00	8,6	1,5	22,3	19,6	0,40	0,60	3,7	40,0	100,0
10,00	DIN6921	26,0	15,00	9,2	1,5	22,3	19,6	0,40	0,60	3,6	20,0	100,0
10,00	GM B115	32,0	15,00	10,4	1,5	22,3	19,6	0,40	0,60	4,6	40,0	100,0
11,11	7/16''	29,0	15,88	11,7	1,8	23,6	21,6	0,38	0,66	0,0	0,0	0,0
12,00	IFI 536	36,0	15,00	11,9	1,8	24,7	22,5	0,60	0,70	5,4	45,0	120,0



5.6.3. Database Material (for clamping plates)



material	re	rm	pperm	beta_m	e_modul	alpha_t	info
30 CrNiMo 8	1050	1200	750	0,577	205000	0,0000115	
42 CrMo 4	850	1000	850	0,577	205000	0,0000115	
AISI 1018	240	370	260	0,577	210000	0,0000115	
AISI 1020	250	380	210	0,577	210000	0,0000115	
AISI 1045 HEAT TR.	600	800	700	0,577	210000	0,0000115	
AISI 1050	320	500	420	0,577	210000	0,0000115	
AISI 304.316	320	500	210	0,577	203000	0,0000115	
AISI 4140 HEAT TR.	850	1000	850	0,577	205000	0,0000115	
AISI 4340 HEAT TR.	1050	1200	750	0,577	205000	0,0000115	
Al 1100-H18	140	160	140	0,440	72000	0,0000235	
Al 1100-O	35	90	35	0,440	72000	0,0000235	
Al 6061-O	55	124	55	0,440	72000	0,0000235	
Al 6061-T6	275	310	275	0,440	72000	0,0000235	
Al 7075-T6	503	570	503	0,440	72000	0,0000235	
Al die cast	220	300	220	0,500	44000	0,0000235	
Al permanent mold cast	140	200	140	0,500	44000	0,0000235	
Al99	100	160	140	0,440	72000	0,0000235	



werkstoff	e20	e100	e200	e300	e400	e500	e600	e700
St 37 (1.0037)	210000	205000	195000	185000	175000	165000	130000	0
St 50 (1.0050)	210000	205000	195000	185000	175000	165000	130000	0
C 45 (1.0503)	210000	205000	195000	185000	175000	165000	130000	0
42 CrMo 4	210000	205000	195000	185000	175000	165000	130000	0
30 CrNiMo 8	210000	205000	195000	185000	175000	165000	130000	0
X 5 CrNiMo 18 10	200000	195000	190000	185000	180000	170000	160000	150000
X10 CrNiMo 18 9	200000	195000	190000	185000	180000	170000	160000	150000
Stainless steels,hardened	200000	195000	190000	185000	180000	170000	160000	150000
Pure Titanium	0	0	0	0	0	0	0	0
Ti-6Al-4V	0	0	0	0	0	0	0	0
GG 15 (0.6015)	0	0	0	0	0	0	0	0
GG 25 (0.6025)	0	0	0	0	0	0	0	0
GG 35 (0.6035)	0	0	0	0	0	0	0	0
GG 40 (0.6040)	0	0	0	0	0	0	0	0
GGG 35.3	0	0	0	0	0	0	0	0
GD MgAl9	0	0	0	0	0	0	0	0
GK MgAl9	0	0	0	0	0	0	0	0

Sign	Meaning	Unit
MATERIAL	Material name	
RE	Yield point	N/mm^2
RM	Tensile strength	N/mm^2
P_PERM	Ultimate pressure	N/mm^2
BETA_B	shear factor (0.577 for steel)	
E_MODUL	Modulus of elasticity	N/mm^2
ALPHA_T	Temperature coefficient	mm/K

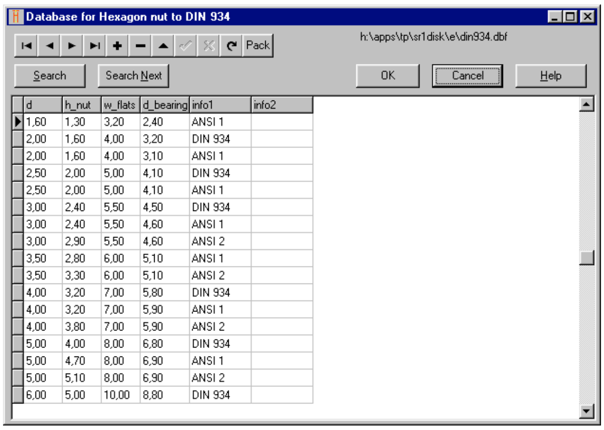
Temperature-dependancy of E-Modulus

The MAT_P_RE database is linked with PRESSUNG.DBF via the MATERIAL field. Therefore, MATERIAL name in the two databases must be exactly the same.

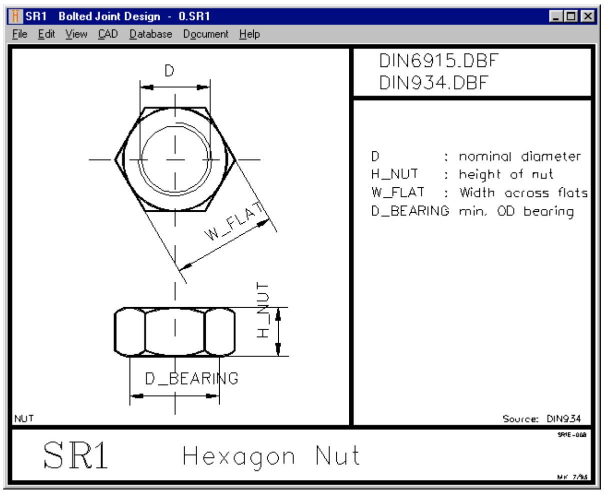
Sign	Meaning	Unit
MATERIAL	Material name	
E20	E module at 20=C	N/mm^2
E100	E module at 100=C	N/mm^2
E200	E module at 200=C	N/mm^2
E300	E module at 300=C	N/mm^2
E400	E module at 400=C	N/mm^2
E500	E module at 500=C	N/mm^2
E600	E module at 600=C	N/mm^2
E700	E module at 700=C	N/mm^2

5.6.4. Database Nut

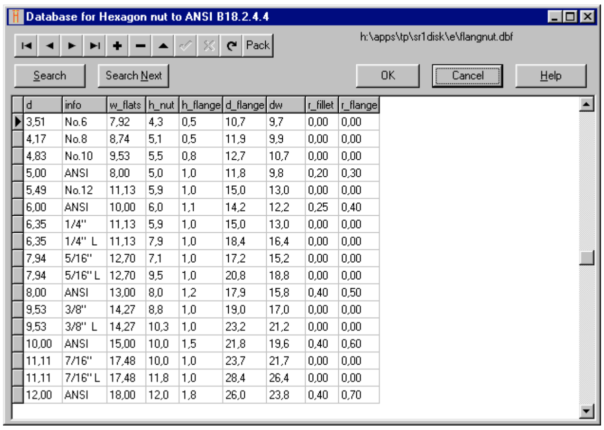
The Database structure for hexagon nuts to DIN 934 and to DIN 6915 are identical.



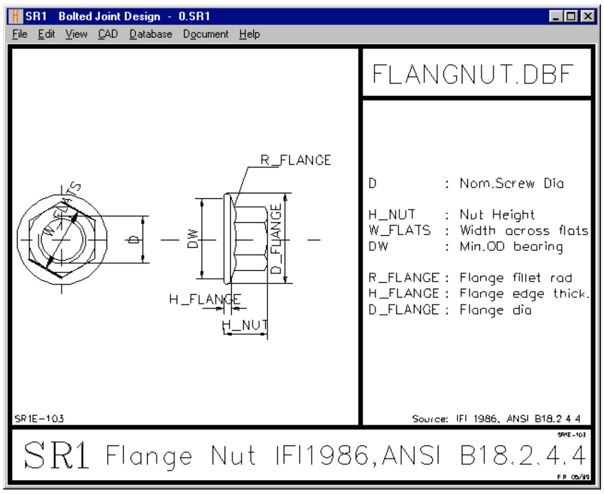
d	h_nut	w_flats	d_bearing	info1	info2
1,60	1,30	3,20	2,40	ANSI 1	
2,00	1,60	4,00	3,20	DIN 934	
2,00	1,60	4,00	3,10	ANSI 1	
2,50	2,00	5,00	4,10	DIN 934	
2,50	2,00	5,00	4,10	ANSI 1	
3,00	2,40	5,50	4,50	DIN 934	
3,00	2,40	5,50	4,60	ANSI 1	
3,00	2,90	5,50	4,60	ANSI 2	
3,50	2,80	6,00	5,10	ANSI 1	
3,50	3,30	6,00	5,10	ANSI 2	
4,00	3,20	7,00	5,80	DIN 934	
4,00	3,20	7,00	5,90	ANSI 1	
4,00	3,80	7,00	5,90	ANSI 2	
5,00	4,00	8,00	6,80	DIN 934	
5,00	4,70	8,00	6,90	ANSI 1	
5,00	5,10	8,00	6,90	ANSI 2	
6,00	5,00	10,00	8,80	DIN 934	



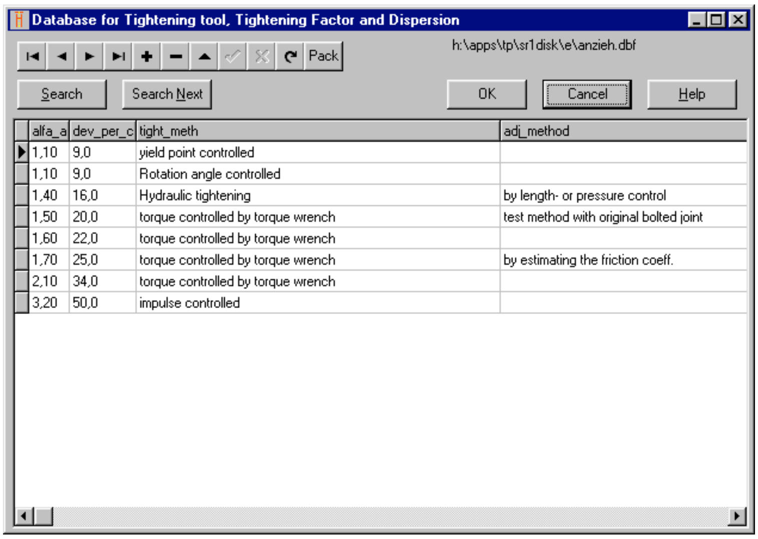
Hexagon Flange Nut



d	info	w_flats	h_nut	h_flange	d_flange	dw	r_fillet	r_flange
3,51	No.6	7,92	4,3	0,5	10,7	9,7	0,00	0,00
4,17	No.8	8,74	5,1	0,5	11,9	9,9	0,00	0,00
4,83	No.10	9,53	5,5	0,8	12,7	10,7	0,00	0,00
5,00	ANSI	8,00	5,0	1,0	11,8	9,8	0,20	0,30
5,49	No.12	11,13	5,9	1,0	15,0	13,0	0,00	0,00
6,00	ANSI	10,00	6,0	1,1	14,2	12,2	0,25	0,40
6,35	1/4''	11,13	5,9	1,0	15,0	13,0	0,00	0,00
6,35	1/4'' L	11,13	7,9	1,0	18,4	16,4	0,00	0,00
7,94	5/16''	12,70	7,1	1,0	17,2	15,2	0,00	0,00
7,94	5/16'' L	12,70	9,5	1,0	20,8	18,8	0,00	0,00
8,00	ANSI	13,00	8,0	1,2	17,9	15,8	0,40	0,50
9,53	3/8''	14,27	8,8	1,0	19,0	17,0	0,00	0,00
9,53	3/8'' L	14,27	10,3	1,0	23,2	21,2	0,00	0,00
10,00	ANSI	15,00	10,0	1,5	21,8	19,6	0,40	0,60
11,11	7/16''	17,48	10,0	1,0	23,7	21,7	0,00	0,00
11,11	7/16'' L	17,48	11,8	1,0	28,4	26,4	0,00	0,00
12,00	ANSI	18,00	12,0	1,8	26,0	23,8	0,40	0,70



5.6.5. Database tightening tool



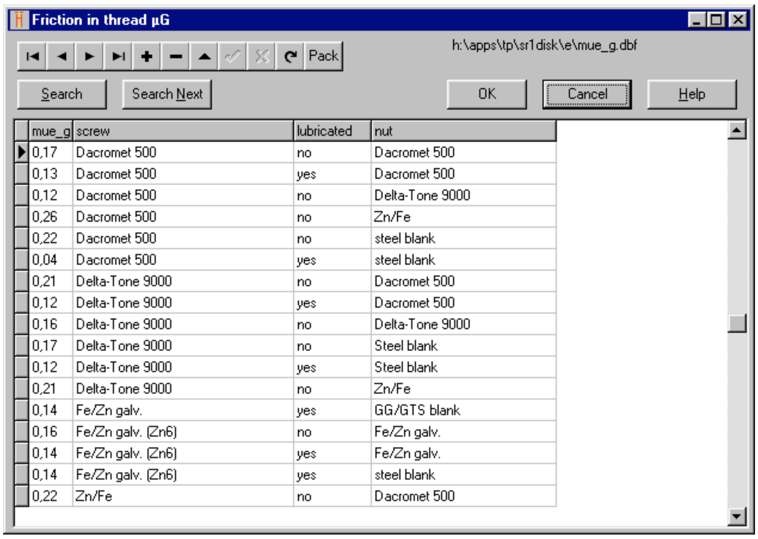
Sign	Meaning
ALFA_A	Tightening factor alpha a
DEV_PER_C	Dispersion of assembly force
TIGHT_METH	Tightening method
ADJ_METHOD	Adjustment method
INFO	Remarks

The tightening factor and scattering are related directly to each other, the program uses only the tightening factor alphaA. Scattering has been included in the database as this value generally has more meaning. The values can be converted with the following formula:

$$\text{dispers. [\%]} = \left(\frac{2 \ \text{alphaA}}{1 + \text{alphaA}} - 1 \right) * 100$$

$$\text{alphaA} = \frac{100\% + \text{dispers.[\%]}}{100\% - \text{dispers.[\%]}}$$

5.6.6. Database Friction



mue_g	screw	lubricated	nut
0,17	Dacromet 500	no	Dacromet 500
0,13	Dacromet 500	yes	Dacromet 500
0,12	Dacromet 500	no	Delta-Tone 9000
0,26	Dacromet 500	no	Zn/Fe
0,22	Dacromet 500	no	steel blank
0,04	Dacromet 500	yes	steel blank
0,21	Delta-Tone 9000	no	Dacromet 500
0,12	Delta-Tone 9000	yes	Dacromet 500
0,16	Delta-Tone 9000	no	Delta-Tone 9000
0,17	Delta-Tone 9000	no	Steel blank
0,12	Delta-Tone 9000	yes	Steel blank
0,21	Delta-Tone 9000	no	Zn/Fe
0,14	Fe/Zn galv.	yes	GG/GTS blank
0,16	Fe/Zn galv. (Zn6)	no	Fe/Zn galv.
0,14	Fe/Zn galv. (Zn6)	yes	Fe/Zn galv.
0,14	Fe/Zn galv. (Zn6)	yes	steel blank
0,22	Zn/Fe	no	Dacromet 500

Thread friction

Sign	Meaning
MUE_G	Friction coefficient thread
SCREW	Material/Surface of screw
GREASE	Lubrication for bolted joint
NUT	Material/Surface of Nut thread

Screw head friction:

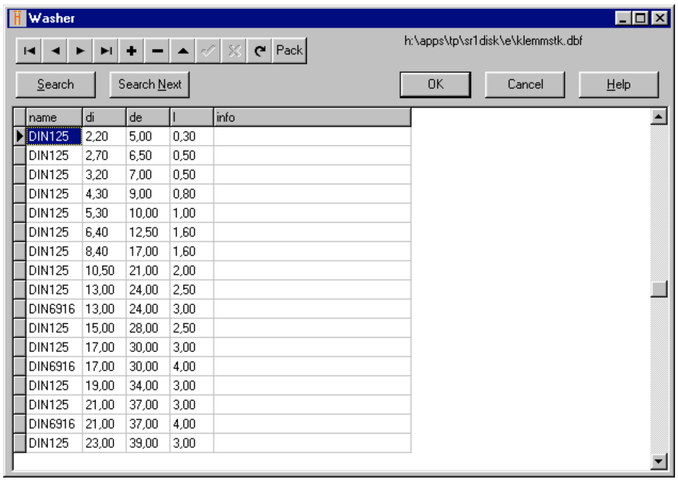
Sign	Meaning
MUE_K	Friction coefficient for srew head
SCREW	Material/Surface of screw
GREASE	Lubrication of bolted joint
COMPONENT	Material of the 1st clamping plate

Friction in the Mould Seam:

Sign	Meaning
MUE_TR	Mould seam friction
KLEMMST_1	Material of clamping plate 1
SCHMIERUNG	Lubrication of the bolted joint ?
KLEMMST_2	Material of clamping plate 2

5.6.7. Database Washers/clamping plates

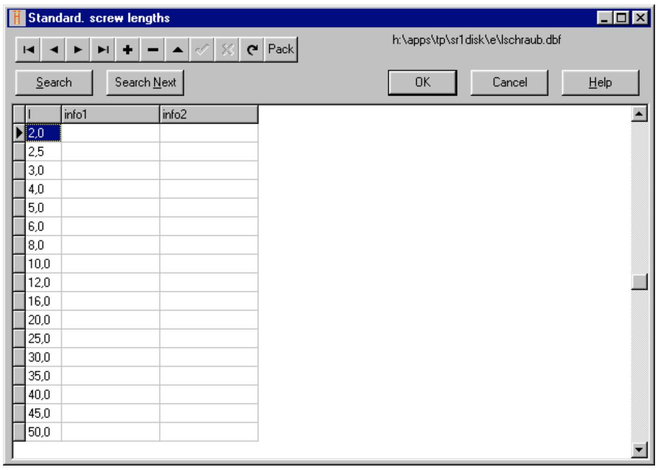
You can acces this database from the clamping plates input window.



Sign	Meaning
NAME	Info to washer or clamping plate
DI	Bore diameter
DE	Outside diameter
S	thickness of washer/clamping plate
INFO	Additional information

5.6.8. Database Bolt length

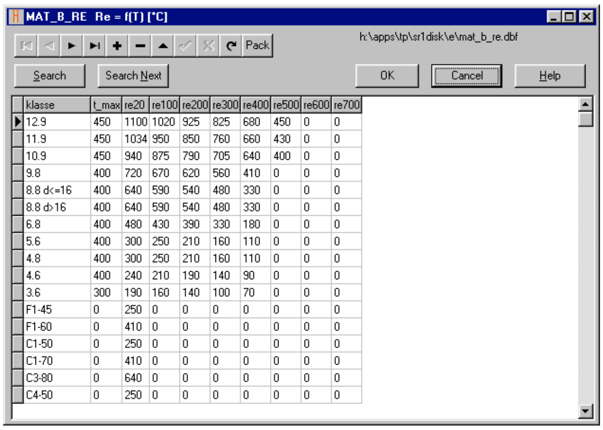
When clicking “<” at bolt length input, SR1 gets a suitable value from the database



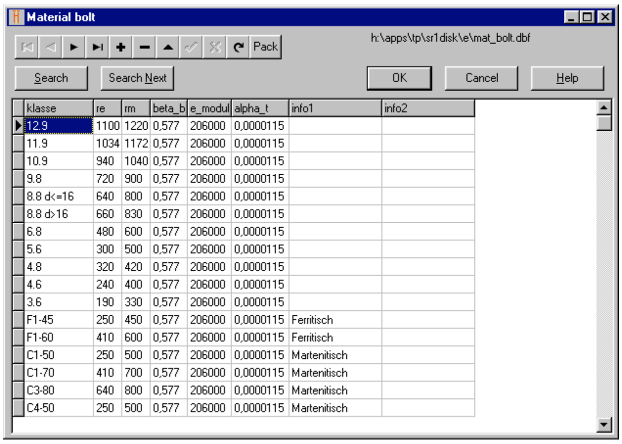
Sign	Meaning
L	Bolt length in mm
INFO1	remarks
INFO2	remarks

5.6.9. Database Bolt Material

MAT_B_RE and MAT_B_E are linked to MAT_BOLT via KLASSE field. Therefore, the text string in the KLASSE fields must be exactly the same.



klasse	t_max	re20	re100	re200	re300	re400	re500	re600	re700
12.9	450	1100	1020	925	825	680	450	0	0
11.9	450	1034	950	850	760	660	430	0	0
10.9	450	940	875	790	705	640	400	0	0
9.8	400	720	670	620	560	410	0	0	0
8.8 d<=16	400	640	590	540	480	330	0	0	0
8.8 d>16	400	640	590	540	480	330	0	0	0
6.8	400	480	430	390	330	180	0	0	0
5.6	400	300	250	210	160	110	0	0	0
4.8	400	300	250	210	160	110	0	0	0
4.6	400	240	210	190	140	90	0	0	0
3.6	300	190	160	140	100	70	0	0	0
F1-45	0	250	0	0	0	0	0	0	0
F1-60	0	410	0	0	0	0	0	0	0
C1-50	0	250	0	0	0	0	0	0	0
C1-70	0	410	0	0	0	0	0	0	0
C3-80	0	640	0	0	0	0	0	0	0
C4-50	0	250	0	0	0	0	0	0	0



klasse	re	rm	beta_b	e_modul	alpha_t	info1	info2
12.9	1100	1220	0,577	206000	0,0000115		
11.9	1034	1172	0,577	206000	0,0000115		
10.9	940	1040	0,577	206000	0,0000115		
9.8	720	900	0,577	206000	0,0000115		
8.8 d<=16	640	800	0,577	206000	0,0000115		
8.8 d>16	660	830	0,577	206000	0,0000115		
6.8	480	600	0,577	206000	0,0000115		
5.6	300	500	0,577	206000	0,0000115		
4.8	320	420	0,577	206000	0,0000115		
4.6	240	400	0,577	206000	0,0000115		
3.6	190	330	0,577	206000	0,0000115		
F1-45	250	450	0,577	206000	0,0000115	Ferritisch	
F1-60	410	600	0,577	206000	0,0000115	Ferritisch	
C1-50	250	500	0,577	206000	0,0000115	Martenitisch	
C1-70	410	700	0,577	206000	0,0000115	Martenitisch	
C3-80	640	800	0,577	206000	0,0000115	Martenitisch	
C4-50	250	500	0,577	206000	0,0000115	Martenitisch	

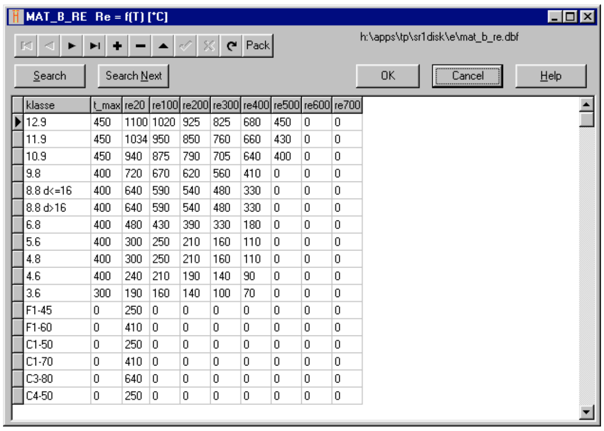
MAT_BOLT.DBF - Basic data of bolt materials.

Sign	Meaning	Unit
KLASSE	Material or material class	
RE	Yield point	N/mm²
RM	Tensile strength	N/mm²
BETA_B	shear coefficient (0.577 for steel)	
E_MODUL	Modulus of elasticity	N/mm²
ALPHA_T	Temperature coefficient	mm/K

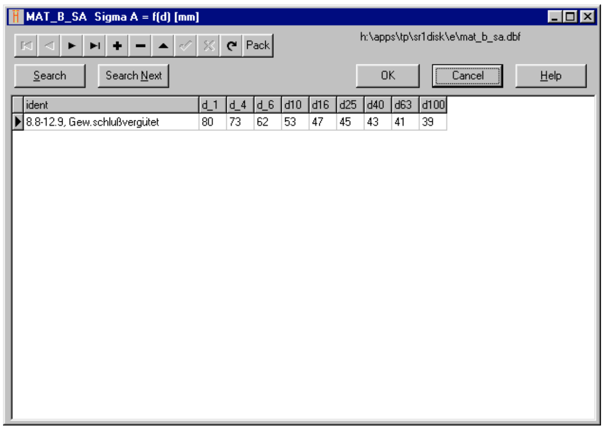
MAT_B_RE.DBF - Dependancy of the yield point from working temperature.

Sign	Meaning	Unit
CLASS	Material class, material name	
T_MAX	max. working temperature	°C
RE20	yield point at 20=C	N/mm²
RE100	yield point at 100=C	N/mm²
RE200	yield point at 200=C	N/mm²
RE300	yield point at 300=C	N/mm²
RE400	yield point at 400=C	N/mm²
RE500	yield point at 500=C	N/mm²
RE600	yield point at 600=C	N/mm²
RE700	yield point at 700=C	N/mm²

Databases Bolt Material



klasse	t_max	re20	re100	re200	re300	re400	re500	re600	re700
12.9	450	1100	1020	925	825	680	450	0	0
11.9	450	1034	950	850	760	660	430	0	0
10.9	450	940	875	790	705	640	400	0	0
9.8	400	720	670	620	560	410	0	0	0
8.8 d<=16	400	640	590	540	480	330	0	0	0
8.8 d>16	400	640	590	540	480	330	0	0	0
6.8	400	480	430	390	330	180	0	0	0
5.6	400	300	250	210	160	110	0	0	0
4.8	400	300	250	210	160	110	0	0	0
4.6	400	240	210	190	140	90	0	0	0
3.6	300	190	160	140	100	70	0	0	0
F1-45	0	250	0	0	0	0	0	0	0
F1-60	0	410	0	0	0	0	0	0	0
C1-50	0	250	0	0	0	0	0	0	0
C1-70	0	410	0	0	0	0	0	0	0
C3-80	0	640	0	0	0	0	0	0	0
C4-50	0	250	0	0	0	0	0	0	0



ident	d_1	d_4	d_6	d10	d16	d25	d40	d63	d100
8.8-12.9, Gew.schlußvergütet	80	73	62	53	47	45	43	41	39

MAT_B_E.DBF

Modulus of elasticity, dependant from temperature. If values are 0, SR1 uses an approximation formula.

Sign	Meaning	Unit
KLASSE	Material name, class	
E20	E module at 20=C	N/mm^2
E100	E module at 100=C	N/mm^2
E200	E module at 200=C	N/mm^2
E300	E module at 300=C	N/mm^2
E400	E module at 400=C	N/mm^2
E500	E module at 500=C	N/mm^2
E600	E module at 600=C	N/mm^2
E700	E module at 700=C	N/mm^2

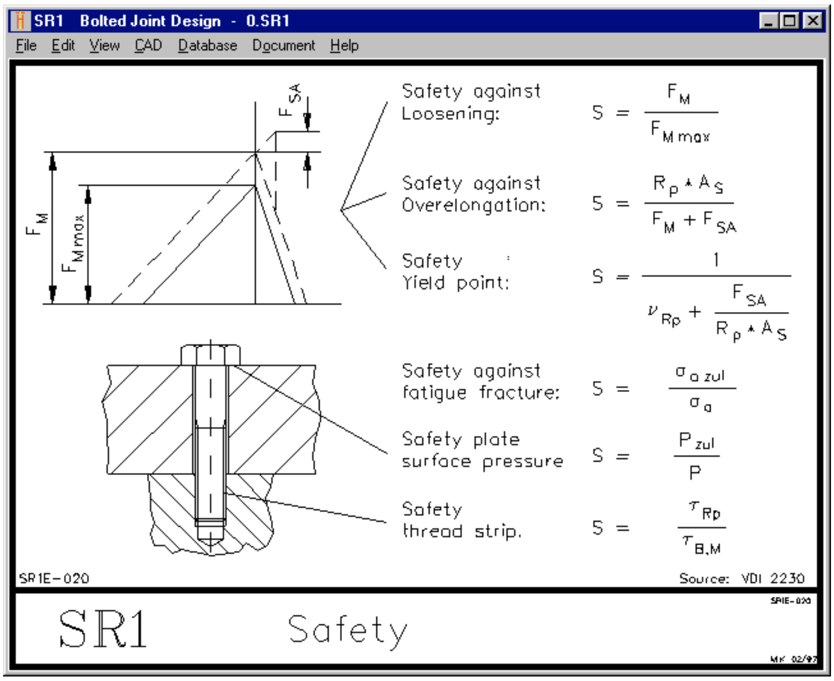
MAT_B_SA.DBF

Fatigue Strength Sigma A (alternating tension), dependent from thread size.

Sign	Meaning	Unit
IDENT	Material, Production method	
D_1	Sigma A for thread size 1 mm	N/mm^2
D_4	Sigma A for thread M4	N/mm^2
D_6	Sigma A for thread M6	N/mm^2
D_10	Sigma A for thread M10	N/mm^2
D_16	Sigma A for thread M16	N/mm^2
D_25	Sigma A for thread M25	N/mm^2
D_40	Sigma A for thread M40	N/mm^2
D_63	Sigma A for thread M63	N/mm^2
D_100	Sigma A for thread M100	N/mm^2

5.7. Help

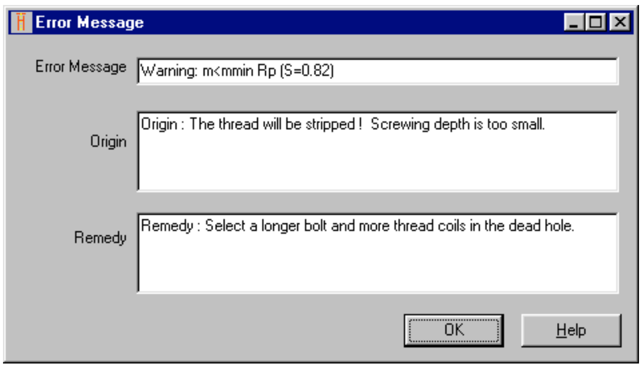
Auxiliary picture



Under this menu reference point you can obtain auxiliary screen drawings for the input of spring dimensions. The auxiliary illustrations are drawings in the plot Hewlett Packard HP/GL format. This means that you can complete them with your own graphics. You can design your own drawings via CAD or DTP and send the output to an HP-Plotter or to a file. In which case you will have to configure the HP7475 as plotter; the filename extension is PLT. The drawing size should be 160 x 120 mm, as these values are used as the drawing margin.

Error messages

If error messages occur, you can obtain explanation and help for each error message. The text is stored in the file SR1.ERR.



Quit

SR1 is ended at File->Exit. Before the program is quit the current data is automatically written to the File ACTUAL.SR1.