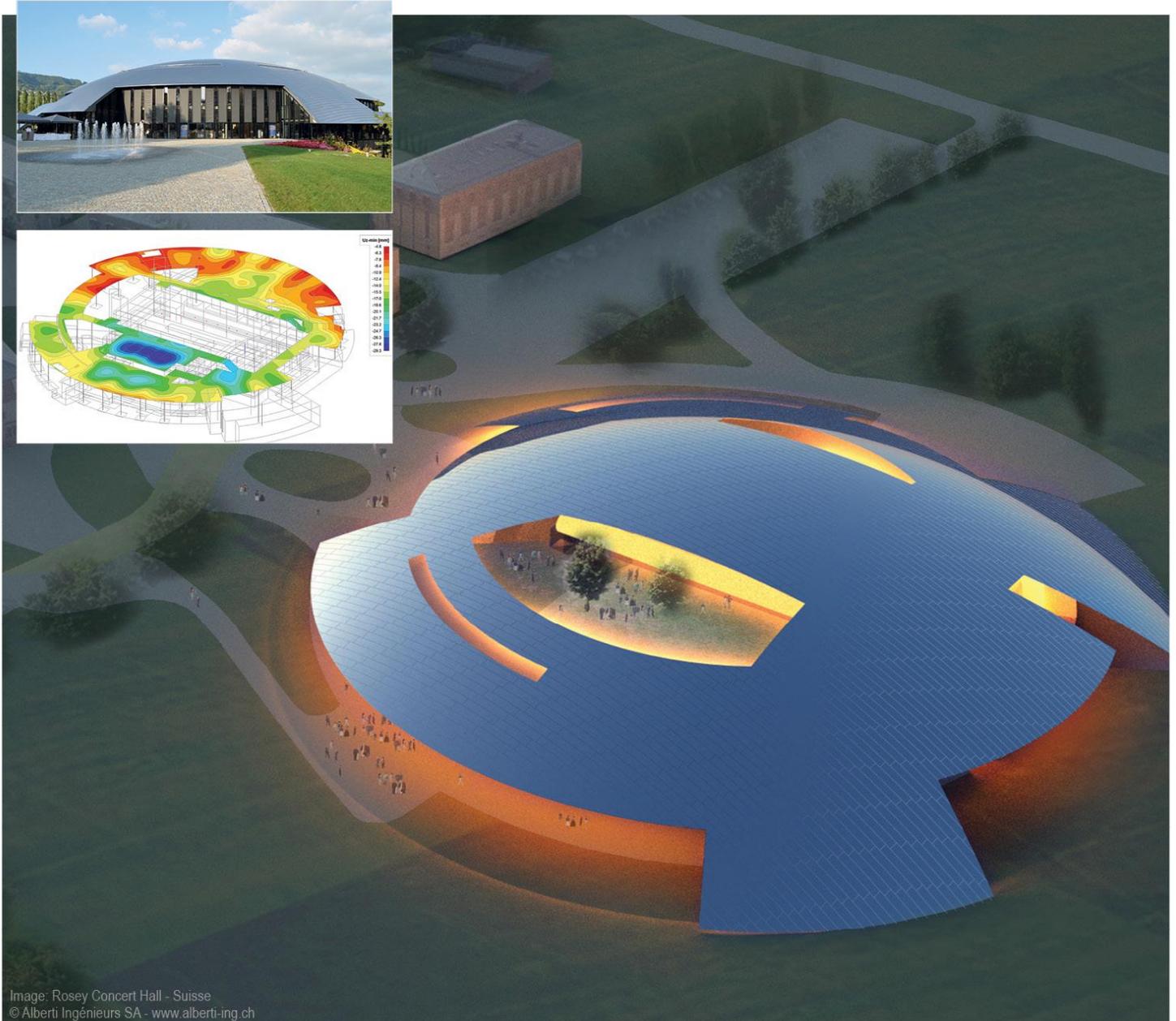


SCIENGINEER



Manual

Virtual Joists and Joist Girders

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Nemetschek Scia Offices

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Belgium Headquarters

Nemetschek Scia nv
 Industrieweg 1007
 B-3540 Herk-de-Stad
 Tel.: +32 13 55 17 75
 Fax: +32 13 55 41 75
 E-mail: info@scia-online.com

Support Phone
 CAE (Scia Engineer)
 Tel: +32 13 55 09 90

CAD (Allplan)
 Tel: +32 13 55 09 80

Support e-mail:
support@scia-online.com

Austria

Scia Datenservice Ges.m.b.H
 Dresdnerstrasse 68/2/6/9
 A-1200 Wien
 Tel.: +43 1 7433232-11
 Fax: +43 1 7433232-20
info@scia.at

Support
 Tel: +43 1 7433232-12
 E-mail: support@scia-online.com

Brazil

Nemetschek Scia do Brasil
 Rua Dr. Luiz Migliano, 1896 – sala
 702, CEP
 SP -05711-001 São Paulo
 Brasil
 Tel: +55 11 4314-5880
 E-mail: brasil@scia-online.com

Czech Republic

Nemetschek Scia s.r.o.
 Evropská 2591/33d
 160 00 Praha 6
 Tel.: +420 226 205 600
 Fax: +420 226 201 673
 E-mail: info.praha@scia.cz

Nemetschek Scia s.r.o.
 Slavickova 827/1a
 638 00 Brno
 Tel.: +420 530 501 570
 Fax: +420 226 201 673
 E-mail: info.brno@scia.cz

France

Nemetschek Scia sarl
 Centre d'Affaires
 29, Grand' Rue
 FR-59100 Roubaix
 France
 Tel.: +33 3.28.33.28.67
 Fax: +33 3.28.33.28.69
france@scia-online.com

Germany

Scia Software GmbH
 Emil-Figge-Strasse 76-80
 D-44227 Dortmund
 Tel.: +49 231/9742586
 Fax: +49 231/9742587
info@scia.de

Netherlands

Nemetschek Scia bv
 Wassenaarweg 40
 NL- 6843 NW Arnhem
 Tel.: +31 26 320 12 30
 Fax: +31 26 320 12 39
info@scia.nl

Slovakia

Nemetschek Scia s.r.o.
 Murgašova 1298/16
 SK - 010 01 Žilina
 Tel.: +421 415 003 070-1
 Fax: +421 415 003 072
info@scia.sk

Switzerland

Nemetschek Scia Switzerland
 Dürenbergstr. 24
 CH-3212 Gurmels
 Tel.: +41 26 341 74 11
 Fax: +41 26 341 74 13
info@scia.ch

USA

Nemetschek Scia North America
 7150 Riverwood Drive
 Columbia, MD (USA)
 Tel.: +1 443-542-0638
 Fax: +1 410-290-8050
usa@scia-online.com

GENERAL INFORMATION

Scia Engineer Support

If you need assistance with the software, you can contact the Scia Engineer support service in the following manners:

By e-mail

Send an e-mail to support@scia-online.com with a description of the problem and the concerning *.esa file, and mention the number of the version you are currently working with.

By telephone

From Belgium: +32 13 350310

From the Netherlands: +31 26 3201230

From the USA: 443 542 0637

Via the Scia Support website

<http://www.Scia-online.com/en/online-support.html>

Helpful Links

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Link to eLearning

<http://www.Scia-online.com> > Support & Downloads > eLearning

Link to Demo version

<http://www.Scia-online.com> > Support & Downloads > Secured Downloads > input username and password > Service Packs > Scia Engineer > Setup – Scia Engineer

Link to User Interface Video

<http://www.youtube.com/watch?v=t6fgRJ90FE0&list=PL0OvQw2kgGq64GwSUbuzxwS9DyKGtUn3>

ABOUT VIRTUAL JOISTS

Background

Virtual joist and joist girder tables were created by the Steel Joist Institute (SJI) as a way to incorporate joists and joist girders into the analysis of building models. These tables include equivalent beam cross section properties so that the joists and joist girders can be checked for flexure, shear, axial and combined forces, by treating them like doubly symmetric I-shaped sections using the methods laid out in the 2010 Specification for Structural Steel Buildings (AISC 360-10).

Additionally, Scia Engineer's analysis engine utilizes a stiffness matrix to determine a structures stability and to distribute loads. As a result, the virtual joist and joist girder tables allow for joist member stiffness to be accounted for in the overall model, making the analysis of the overall building system more accurate.

While virtual joist properties are needed to create and analyze a building model, the name of the virtual joist member used in the model is not a sufficient way to designate what type of joist should be used by the joist manufacturer. For this reason, the Virtual Joist Designation component of Scia Engineer will output a joist designation that depends on how the joist or joist girder is loaded.

Joist and joist girder designations are based on the "Code of Standard Practice for Steel Joists and Joist Girders" (Steel Joist Institute - SJI-COSP-2010).

Terminology

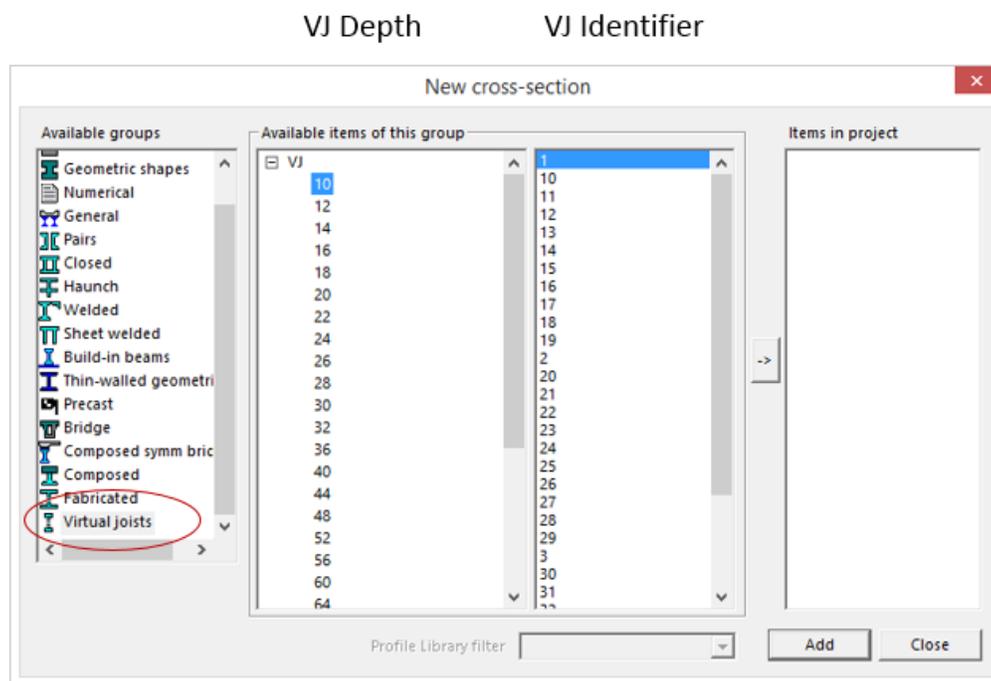
Both "joist" and "joist girder" refer to open web steel joist members. The term "joist" is used to refer to a joist member used to directly support floor and roof systems. The term "joist girder" is used to refer to a primary structural load-carrying joist which supports concentrated loads acting at panel points. Generally, joist girders are used to support joist members.

Virtual Joist Model Requirements

The Virtual Joist Designation component will only work for members with virtual joist (VJ) or virtual joist girder (VJG) cross sections. The national code must be set to **IBC** and a steel with a yield stress (F_y) of **50 ksi** must be used.

SELECTING VIRTUAL JOIST CROSS-SECTIONS

To insert a joist member into a model, a VJ or VJG cross-section must first be selected. To do this, in the **New Cross-Section** window, select **Virtual Joist** as the group and open either the **VJ** or **VJG** tree for virtual joist sections or virtual joist girder sections, respectively. The number in the first column is the depth of the virtual joist, and the number in the second is an identifier. The depth and identifier together make up the VJ or VJG section name. In the image below, for example, a VJ10-1 is selected.

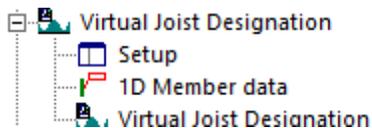


When adding VJ and VJG cross-sections to a model, the user may wish to select a depth for a joist that will be inserted into the initial model, but the identifier may be selected arbitrarily as it does not represent a physical property of the joist, in the same way that, for example, a W8x21 represents an I-Section that has a depth of 8 inches and a weight of 21 lb/ft. The complete name of the joist correlates to cross-sectional properties specified by the Steel Joist Institute and thus the name of the virtual joist section may not be helpful for intuitively selecting initial sections for the model. Furthermore, once the model is complete, these original virtual joist (and joist girder) members must be checked for flexure, shear and axial forces and will likely be replaced in the Auto-Design process with optimized sections that pass the check.

SETTINGS FOR THE VIRTUAL JOIST DESIGNATION

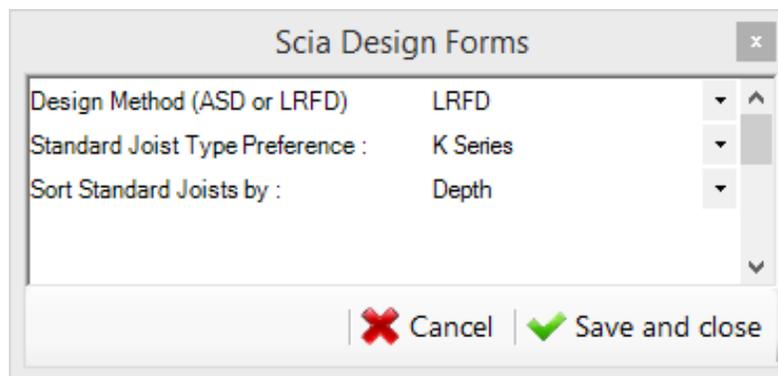
Overview:

Setup data is used for all joists in the model. **1D Member data** settings are applied to individual members as needed.



Setup:

- Design Method: ASD or LRFD
- Standard joist series preference: K only, LH only, DLH only, or Allow Any
- Sort standard joists by: depth or weight



Member Data:

- Option to allow member to be a KCS series joist - by default a KCS is not allowed unless box is checked.
- If member is allowed to be a KCS joist, option to sort KCS by weight, depth, moment capacity, shear capacity, or moment of inertia.

Scia Design Forms

Allow a KCS Series Joist To Be Used For This Member

Sort KCS Joists by: Moment of Inertia

|

JOIST AND JOIST GIRDER DESIGNATION METHODOLOGY

Designation for Joists

The designation of a joist in Scia Engineer depends on how the joist is loaded. Joists with uniform loading can be designated with a standard joist designation while joists with a non-uniform loading and/or concentrated point loads receive a special or a KCS joist designation. The **Virtual Joist Designation** component in Scia Engineer can determine how the joist is loaded and gives a designation which can then be given to the joist manufacturer in order to design the joist.

Joists with Uniform Loading

If a joist is uniformly loaded and there are no concentrated point loads higher than 100 lbs., a standard joist designation will be used. Standard designations are taken from the K, LH, and DLH series tables based on the joist's span and uniform load. As part of the model setup, the user can specify if they would like to limit the series of joists used in the model to only use a K, LH, or DLH series joist, or they can allow the program to mix and match joist series. If the user selects to limit the joist designation to a specific series and a joist cannot be found which meets the requirements, a joist from another series will be selected and a message will be displayed to the user. The uniform load used to look up a standard joist designation is a calculated equivalent uniform loading which is based on the maximum moment or maximum shear in the joist. The higher of these loadings (the equivalent uniform loading based on maximum moment and the equivalent uniform loading based on maximum shear) is used as the equivalent uniform loading. Maximum moment and shear values are then calculated using this equivalent uniform loading. If these calculated moment and shear values are not within 10% of the actual maximum moment and shear values, the joist will receive a special designation.

Joists with Non-Uniform Loading

If the joist has a point load or the calculated equivalent uniform loading results in moment or shear values not within 10% to the actual values, then a "special" designation or a KCS series joist designation will be used. By default, the joist will be designated as "special" unless the user specifies to allow a KCS joists to be used for a member (in the 1D Member Data). KCS series joists have constant shear and flexural strength along their span and are well suited for joists that have a large concentrated load. Alternatively, when a joist has a

"special" designation, all loads on the joist must be given to the joist manufacturer so that joist can be specifically manufactured with the capacity to handle the loads. Generally, using the "special" designation and allowing the joist manufacture to account for the specific loads is the more cost effective of the two options. However, if the loading on the joist may change position and/or magnitude in the future, using a KCS series joist may offer greater flexibility and be a better option. (Note that any future loading must not exceed the shear and moment capacity of the KCS joist).

If a KCS joist is allowed by the user, a KCS series joist which meets the shear, moment, and uniform loading requirements will be chosen from the Standard LRFD or ASD Load Tables for KCS Joists. The maximum un-factored uniform loading allowed on any KCS joist is 550 lb/ft and the maximum factored uniform load is 825 lb/ft. If uniform load exceeds the capacity, then joist will be designated as special.

For joists determined to be "special", the depth of the virtual joist in the model, which has been auto-designed and meets design requirements, is given along with "SP*" for the designation. (For example, if the virtual joist in the model which passes the steel check is a VJ16-10, a designation of "16SP*" is given to the joist). The uniform and point loads on the joist will also be displayed along with a message to the user that the joist is to be designed by the joist manufacturer according to the loads shown. Although no standard joists series designation is given for special joists, as part of the output, a note will be displayed as to what series of joist should be used to specify seat dimensions, end anchorage, bridging, attachment tables, etc.

Designation for joist girders

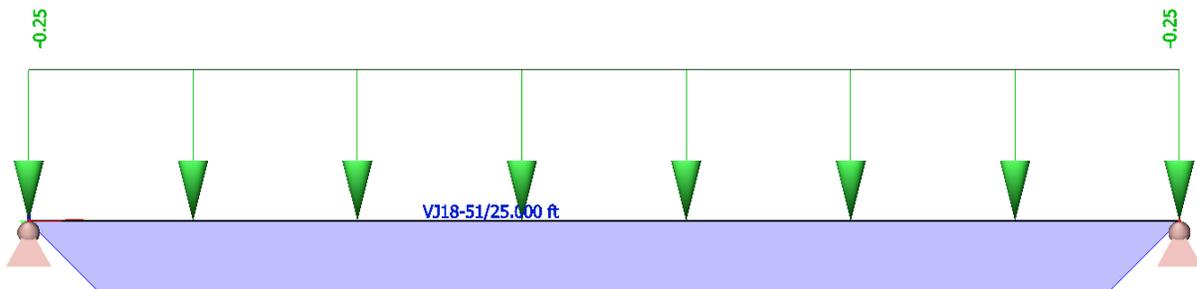
Joist girders are designated using the depth of the virtual joist girder, the letter "G" to signify the member is a girder, the number of spaces between the joists that the girder supports and the letter "N", followed by an "F" if the loads are factored (LRFD) or a "K" if the loads are not factored (ASD).

If there is any variation in the magnitude of the loads on the joist girder or any variation in the spacing between the loads on the joist girder, then a message will be displayed in the output that refers the user to the load diagram for the actual loading on the joist girder. If there is any variation in the magnitude of the loads, the lowest load value will be used in the designation.

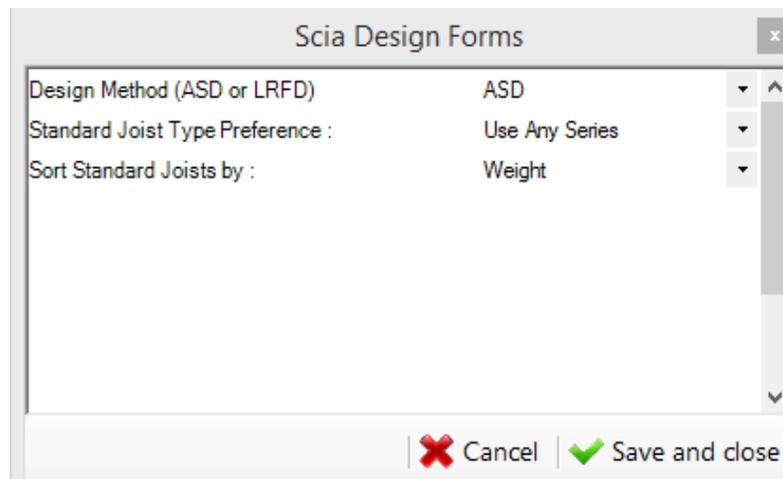
VIRTUAL JOIST DESIGNATION EXAMPLES

Example 1 - Uniformly loaded Joist

The following joist has a span of 25 feet and an un-factored uniform load of 250 lb/ft. Through auto-design, a virtual joist VJ18-51 was selected to meet the design requirements.



In the **Setup**, the following settings are used:



As part of the **Summary** output of the virtual joist designation component, a standard joist designation of 16K3 is given based on the uniform load and span along with the capacity of the 16K3 at 25 feet. (Note, that had the standard joists been sorted by height instead of weight, then a 14K4 would have been chosen).

Joist Designation

ID	VJ	VJ Target A _x	VJ Target I _x	Uni. Load	Span	Designation	Capacity
B1	VJ18-51	4.61 in ²	265 in ⁴	250 lb/ft	25 ft	16K3	260 lb/ft

Designation Method and Notes:

1. Uniform loading on joist
2. Standard joist used for designation
3. Depth of standard joist is different than depth of virtual joist

ASD K Series Joist Table:

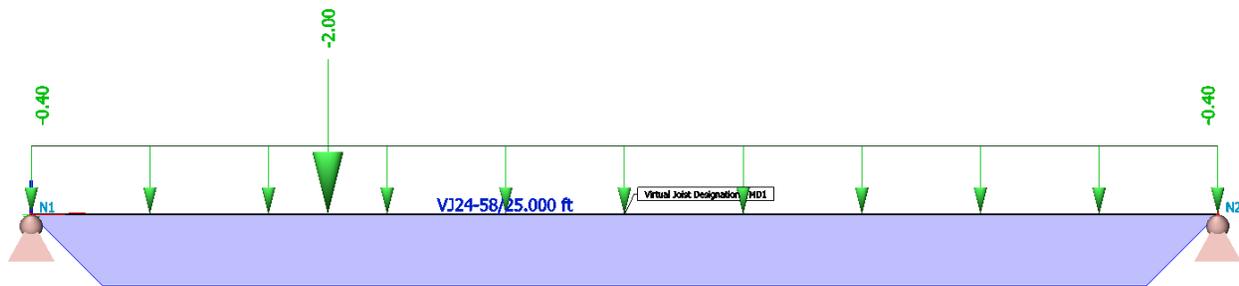
ASD

STANDARD LOAD TABLE FOR OPEN WEB STEEL JOISTS, K-SERIES
Based on a 50 ksi Maximum Yield Strength - Loads Shown In Pounds Per Linear Foot (plf)

Joist Designation	10K1	12K1	12K3	12K5	14K1	14K3	14K4	14K6	16K2	16K3	16K4	16K5	16K6	16K7	16K9
Depth (in.)	10	12	12	12	14	14	14	14	16	16	16	16	16	16	16
Approx. Wt (lbs./ft.)	5.0	5.0	5.7	7.1	5.2	6.0	6.7	7.7	5.5	6.3	7.0	7.5	8.1	8.6	10.0
Span (ft.)															
↓															
10	550														
11	550														
12	550	550	550	550											
13	479	550	550	550											
14	412	500	550	550	550	550	550	550							
15	358	434	543	550	511	550	550	550							
16	313	380	476	550	448	550	550	550	550	550	550	550	550	550	550
17	277	336	420	550	395	495	550	550	512	550	550	550	550	550	550
18	246	299	374	507	352	441	530	550	456	508	550	550	550	550	550
19	221	268	335	454	315	395	475	550	408	455	547	550	550	550	550
20	199	241	302	409	284	356	428	525	368	410	493	550	550	550	550
21	179	218	273	370	257	322	388	475	333	371	447	503	548	550	550
22	159	199	249	337	234	293	353	432	303	337	406	458	498	550	550
23	134	181	227	308	214	268	322	395	277	308	371	418	455	507	550
24	113	166	208	282	196	245	295	362	254	283	340	384	418	465	550
25	97	81	101	132	113	141	165	199	170	189	221	248	269	298	346
26					180	226	272	334	234	260	313	353	384	428	514
27					100	124	145	175	150	167	195	219	238	263	311
28					166	209	251	308	216	240	289	326	355	395	474
29					88	110	129	156	133	158	173	194	211	233	276
30					154	193	233	285	200	223	268	302	329	366	439
31					79	98	115	139	119	132	155	173	188	208	246
32					143	180	216	265	186	207	249	281	306	340	408
					70	88	103	124	106	118	138	155	168	186	220
									173	193	232	261	285	317	380
									95	106	124	139	151	167	198
									161	180	216	244	266	296	355
									86	96	112	126	137	151	178
									151	168	203	228	249	277	332
									78	87	101	114	124	137	161
									142	158	190	214	233	259	311
									71	79	92	103	112	124	147

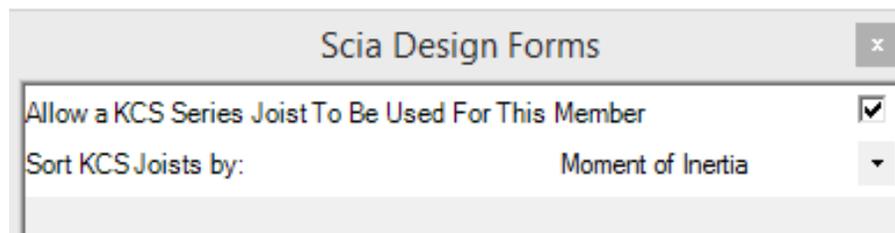
Example 2 – KCS Joist with Point Load

The following joist has a span of 25 feet, an un-factored uniform load of 400 lb/ft and a concentrated load of 2,000 lbs. at 6'-3" from one end of the joist. Through auto-design, a virtual joist VJ24-58 was selected to meet the design requirements.



The settings from Example 1 are used in the Setup. (Note that while the standard joist type preference and sorting method can be set in this example, they will not be used since the point load on the joist disqualifies the joist from receiving a standard joist designation).

In the **1D Member data**, the following settings are used to allow a KCS joist to be selected for the joist and to sort KCS joists by Moment of Inertia.



The **Summary** output of Virtual Joist Designation, shows the virtual joist name (VJ24-58), the area and moment of inertia of the virtual joist cross-section, as well as a KCS series joist designation which has a shear and moment capacity greater than or equal to the applied shear and moment applied to the joist. The **Designation Method and Notes** displays the reasoning for using a KCS series joists for this member – that there is a point load on the joist, the user has selected to allow a KCS joist to be used, and the uniform load does not exceed the maximum un-factored uniform load allowed on the KCS joist.

Joist Designation

ID	VJ	VJ Target A_x	VJ Target I_x	Span	KCS Size
B1	VJ24-58	5.25 in ²	573 in ³	25 ft	26KCS2

Designation Method and Notes:

1. Point loads are present on joist
2. KCS joist permitted by user & max uniform loading doesn't exceed max uniform load allowed for KCS
3. KCS Series joist used for designation
4. Depth of KCS joist is different than depth of virtual joist

In this example, the maximum moment and shear are 37.8 kip-ft (453.6 kip-in) and 6.5 kips (6500 lbs.), respectively.

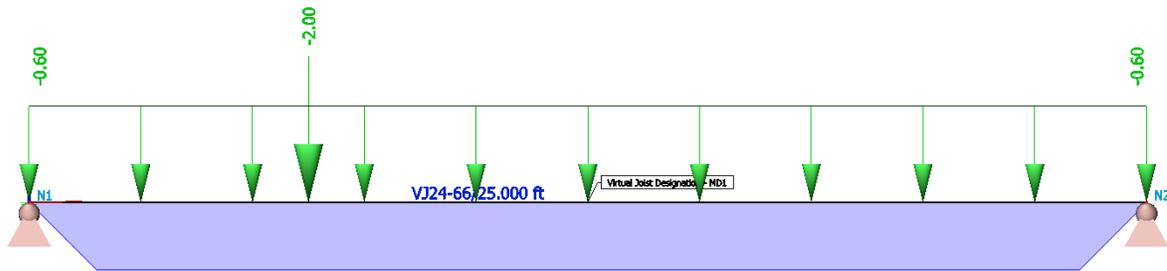
ASD KCS Series Joist Table:



STANDARD LOAD TABLE FOR KCS OPEN WEB STEEL JOISTS							
Based on a 50 ksi Maximum Yield Strength							
JOIST DESIGNATION	DEPTH (in.)	MOMENT CAPACITY (k-in.)	SHEAR CAPACITY* (lbs)	APPROX. WEIGHT** (lbs/ft.)	GROSS MOMENT OF INERTIA (in ⁴)	ERECTION STABILITY BRIDGING REQ'D (ft.)	BRIDGING TABLE SECTION NUMBER
10KCS1	10	172	2000	6.0	29	NA	1
10KCS2	10	225	2500	7.5	37	NA	1
10KCS3	10	296	3000	10.0	47	NA	1
12KCS1	12	209	2400	6.0	43	NA	3
12KCS2	12	274	3000	8.0	55	NA	5
12KCS3	12	362	3500	10.0	71	NA	5
14KCS1	14	247	2900	6.5	59	NA	4
14KCS2	14	324	3400	8.0	77	NA	6
14KCS3	14	428	3900	10.0	99	NA	6
16KCS2	16	349	4000	8.5	99	NA	6
16KCS3	16	470	4800	10.5	128	NA	9
16KCS4	16	720	5300	14.5	192	NA	9
16KCS5	16	934	5800	18.0	245	NA	9
18KCS2	18	395	4700	9.0	127	35-0	6
18KCS3	18	532	5200	11.0	164	NA	9
18KCS4	18	817	5700	15.0	247	NA	10
18KCS5	18	1062	6200	18.5	316	NA	10
20KCS2	20	442	5200	9.5	159	36-0	6
20KCS3	20	595	6000	11.5	205	39-0	9
20KCS4	20	914	7900	16.5	308	NA	10
20KCS5	20	1191	8400	20.0	396	NA	10
22KCS2	22	488	5900	10.0	194	36-0	6
22KCS3	22	658	6600	12.5	251	40-0	9
22KCS4	22	1012	7900	16.5	377	NA	11
22KCS5	22	1319	8600	20.5	485	NA	11
24KCS2	24	534	6300	10.0	232	39-0	6
24KCS3	24	720	7200	12.5	301	44-0	9
24KCS4	24	1108	8400	16.5	453	NA	12
24KCS5	24	1448	8900	20.5	584	NA	12
26KCS2	26	580	6600	10.0	274	39-0	6
26KCS3	26	783	7800	12.5	355	44-0	9
26KCS4	26	1206	8500	16.5	536	NA	12

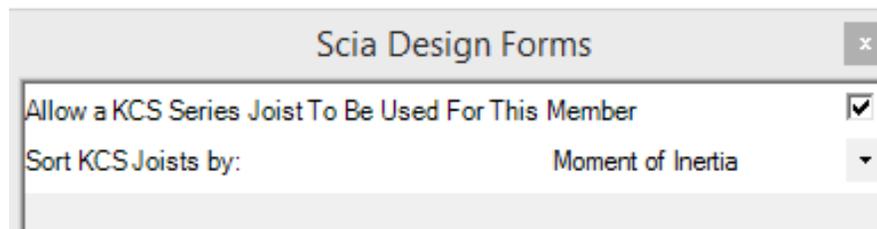
Example 3 – Special Joist with Point Load

Similar to Example 2, the following joist has a span of 25 feet and a concentrated load of 2,000 lbs. at 6'-3" from one end of the joist. However, this joist has an un-factored uniform load of 600 lb/ft.



The settings from Example 1 and 2 are again used in the **Setup**.

In the **1D Member data**, the following settings are used to allow a KCS joist to be selected for the joist and to sort KCS joists by Moment of Inertia.



The **Summary** output of Virtual Joist Designation, displays the virtual joist name (VJ24-66), the area and moment of inertia of the virtual joist cross-section. In this example, the uniform load of 600 lb/ft exceeds the maximum un-factored uniform load allowed on a KCS joist (550 lb/ft). For this reason, a KCS joist cannot be used and the joist will use the “special” designation. The joist is given a special designation of 24SP*. The **Designation Method and Notes** displays the reasoning for the special designation, the standard series joist which should be used for specifying seat dimensions, end anchorage, bridging, and attachment tables as well as a note to communicate to the joist manufacturer to design the joist according to the loads displayed.

Joist Designation

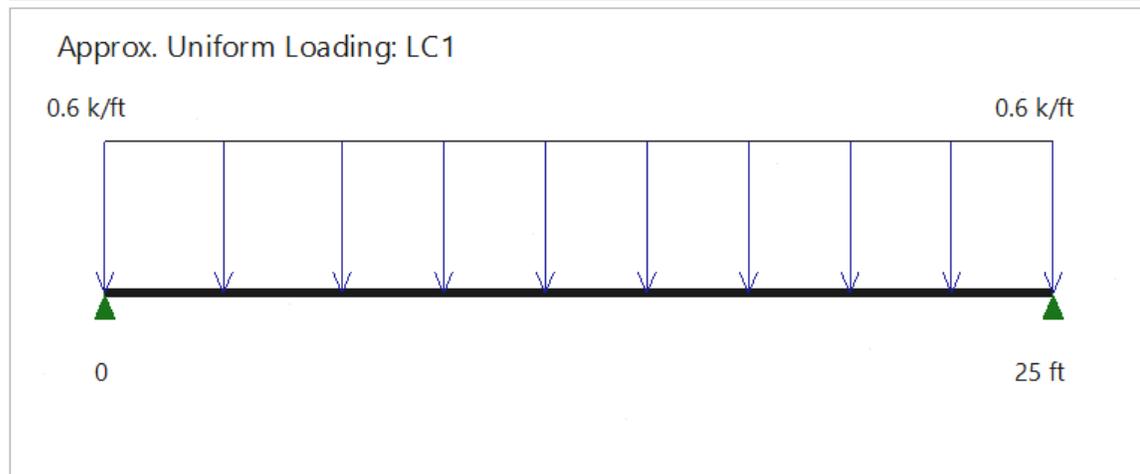
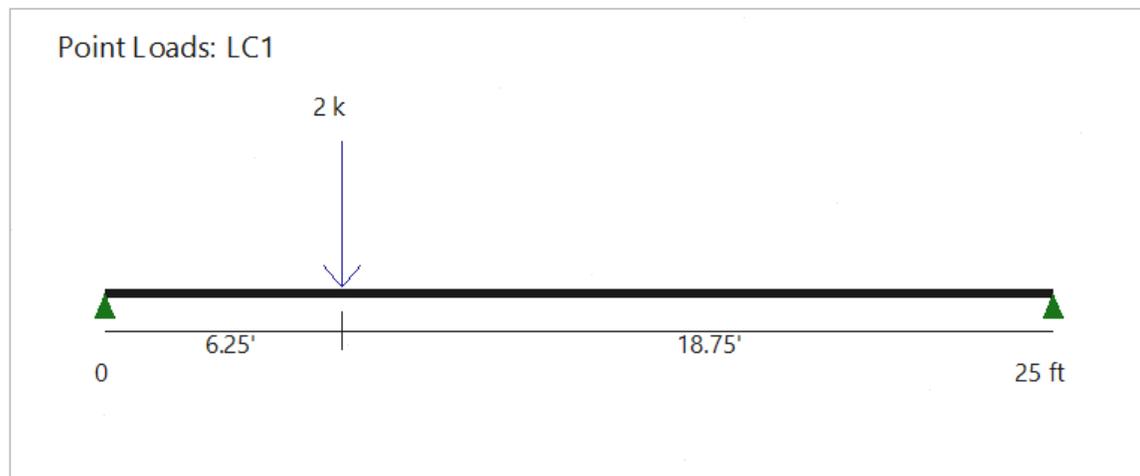
ID	VJ	VJ Target A_x	VJ Target I_x	Span	Designation
B1	VJ24-66	7.12 in ²	773 in ³	25 ft	24SP*

Designation Method and Notes:

1. Point loads are present on joist
2. KCS joist permitted by user, but the max uniform loading exceeds max uniform load allowed for KCS
3. Special joist used for designation
4. Use K series joist specifications for seat, end anchorage, bridging, attachment tables, etc.

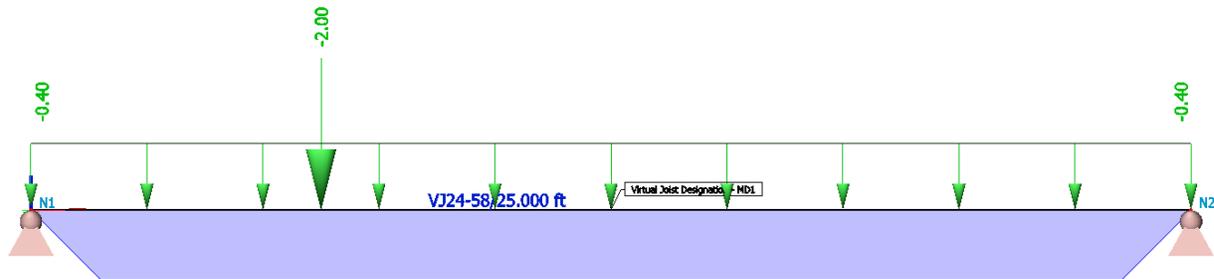
*Joist manufacturer to design joist to support loads as shown below

Load Diagrams



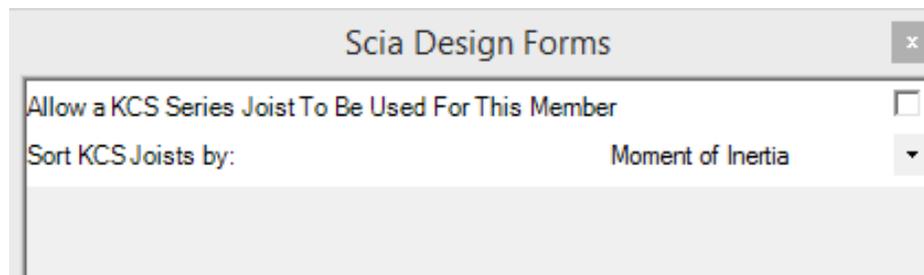
Example 4 – Special Joist with Point Load #2

Similar to Example 2, the following joist has a span of 25 feet, an un-factored uniform load of 400 lb/ft and a concentrated load of 2,000 lbs. at 6'-3" from one end of the joist. Through auto-design, a virtual joist VJ24-58 was selected to meet the design requirements.



The settings from Examples 1 & 2 are again used in the Setup.

In the **1D Member data**, the following settings are used to not allow a KCS joist to be selected for the joist.



Because there is a concentrated load with a magnitude greater than 100 lbs. on this joist and allowing a KCS joist was not selected, this joist receives a special designation. The **Summary** output of the Virtual Joist Designation displays the virtual joist name (VJ24-58), the area and moment of inertia of the virtual joist cross-section, and the special joist designation (24SP*). As in Example 3, the **Designation Method and Notes** displays the reasoning for the special designation, the standard series joist which should be used for specifying seat dimensions, end anchorage, bridging, and attachment tables as well as a note to communicate to the joist manufacturer to design the joist according to the loads displayed.

Joist Designation

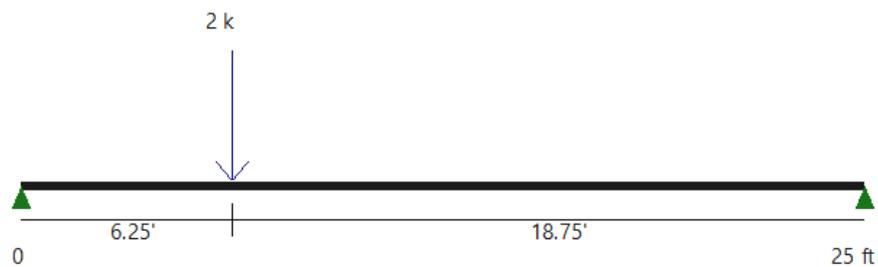
ID	VJ	VJ Target A_x	VJ Target I_x	Span	Designation
B1	VJ24-58	5.25 in ²	573 in ³	25 ft	24SP*

Designation Method and Notes:

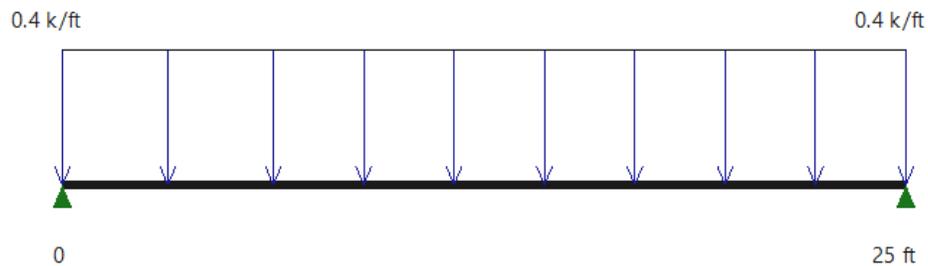
1. Point loads are present on joist
 2. KCS joist not permitted by user
 3. Special joist used for designation
 4. Use K series joist specifications for seat, end anchorage, bridging, attachment tables, etc.
- *Joist manufacturer to design joist to support loads as shown below

Load Diagrams

Point Loads: LC1



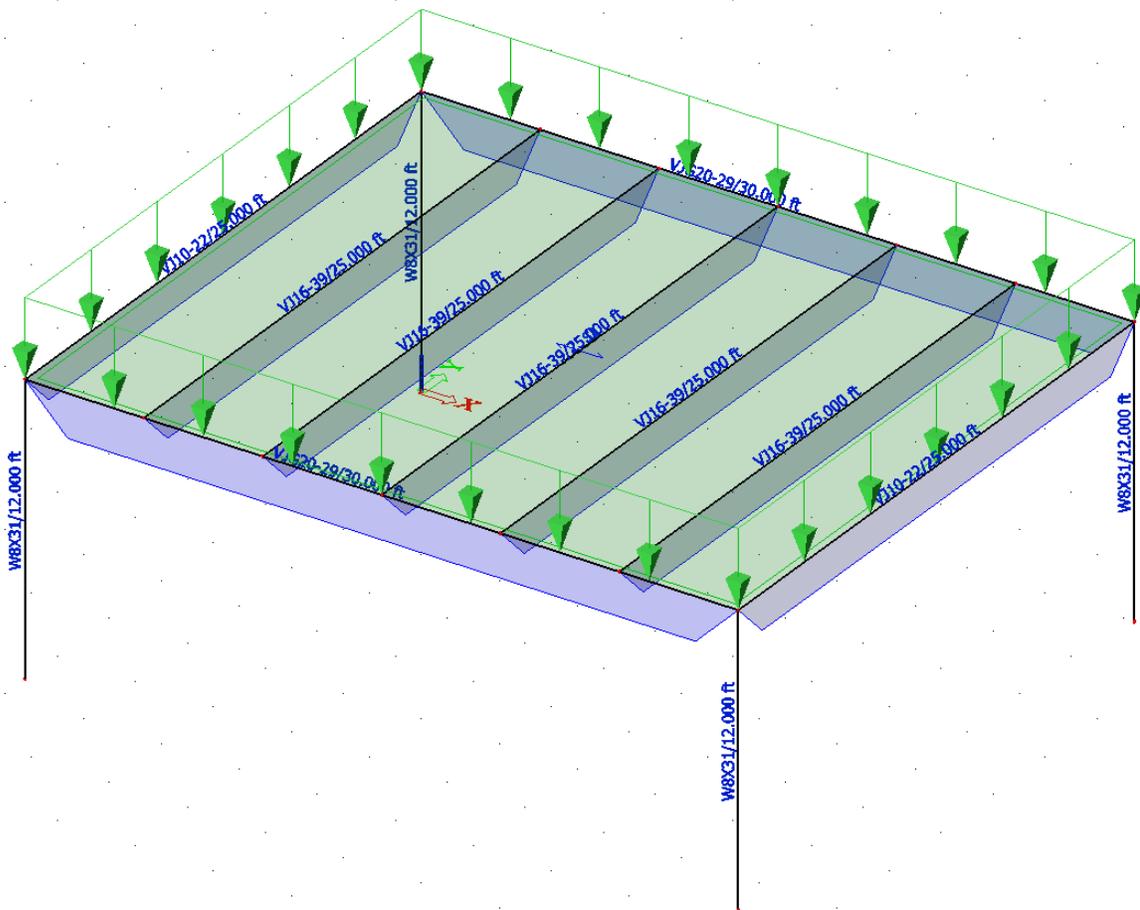
Approx. Uniform Loading: LC1



Example 5 – Joist and Joist Girder with Metal Deck

In the following example, there are two joist girders, which support five 25 ft long interior infill joists. The infill joists are spaced at 5 ft. apart and support a metal deck which has a dead load of 25 lb/ft². Through auto-design, the interior infill joists become VJ16-39s and the joist girders become VJ20-29s.

The settings from Examples 1-4 are used in the **Setup. 1-D Member Data** is not required for the joists or joist girders, since there are not point loads or not-uniform loading on the joists and the joist girders should not receive a KCS Series designation.



The **Summary** output is shown for one of the joists and one of the joist girders. For both, the ID of the joist, the cross-section name, area, and moment of inertia are displayed in the table.

For the joist, the uniform load and span are given as well as the standard joist designation and capacity of the standard joist.

For the joist girder, the designation consists of the member's depth (20 inches), the letter "G" to represent that this member is a girder, the number of spaces between joists (6), and the end reaction forces from the joists (5K). In addition, a load diagram illustrating the forces on the joist girder and their spacing is also shown. Note that while there are a total of seven joists on the joist girders, the end reactions forces from the exterior joists (VJ10-22s) are supported directly by the columns, and therefore, the forces are not shown on the load diagram.

Joist Results:

ID	VJ	VJ Target A_x	VJ Target I_x	Uni. Load	Span	Designation	Capacity
B9	VJ16-39	3.67 in ²	163 in ⁴	131 lb/ft	25 ft	14K1	180 lb/ft

Designation Method and Notes:

1. Uniform loading on joist
2. Standard joist used for designation
3. Depth of standard joist is different than depth of virtual joist

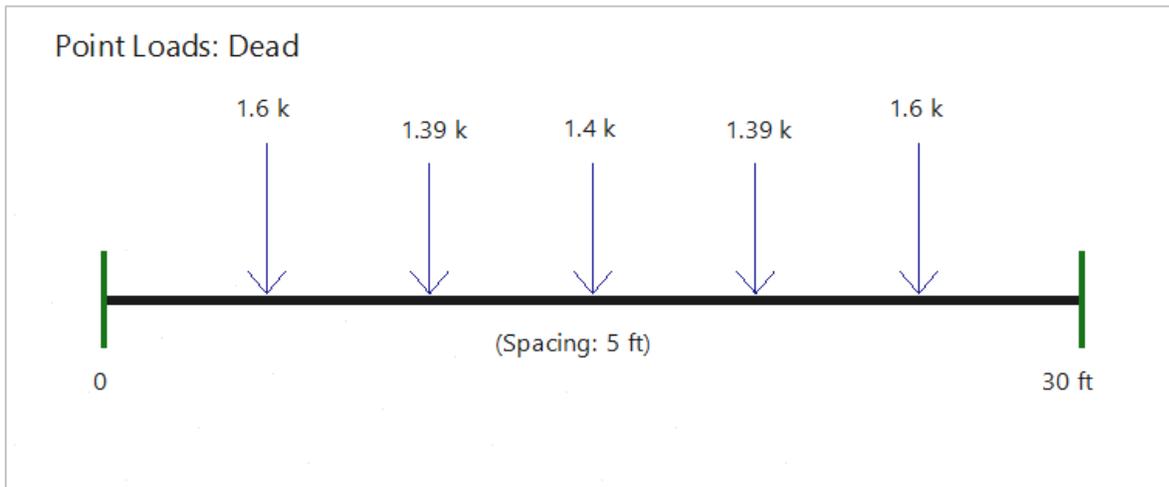
Joist Girder Results:

ID	VJG	VJG Target A_x	VJG Target* I_x	Span	Designation
B6	VJG20-29	6.09 in ²	447 in ³	30 ft	20G6N1.39K **

Designation Method and Notes:

*Joist manufacturer must notify the The Project Structural Engineer of Record if the final joist girder design moment of inertia varies by more than 10% from the "target"

** Loads on joist girder are not of equal magnitude and/or are not equally spaced. See load diagram:



NOTES ON LOADING JOISTS AND JOIST GIRDERS

- There are two primary way to load joists: 1) loading joists with uniform line loads and 2) putting a metal deck 2D member on the joists and loading the metal deck with an surface load. Loading the joists with uniform line loads will produce a more “idealized” result. When using uniform line loads, the resulting loads for the designation should be close to or exactly the magnitude of the applied load. When using an area load on a metal deck, the load values used for the designations may have some variation from the theoretical.
- Any point loads spaced less than the depth of the joist or spaced less than 24 inches, should be added together and considered as a single load by the user.
- Self-weight is taken into account in the model. There is no need to add self-weight of members.
- Joists with uplift will always be considered as “special” joists. Loading a joist with a completely uniform uplift is allowed. Any uplift other than completely uniform may not produce an accurate load diagram or may cause errors in the designation.
- The Virtual Joist Designation component will determine a designation for virtual joist girders based on the point loads and spacing on it. The dead, live, and axial loads as well as any end moments on the joist girder should be listed in the engineering report by the user.
- The Virtual Joist Designation component attempts to differentiate between uniform loading which is perfectly uniform (i.e. no variation) and uniform load that varies along the length of the joist. If a varying uniform load is applied to a joist, the maximum value of the load must be at least 50% greater than the average load value on that load segment, otherwise the uniform load will be plotted and considered as perfectly uniform using the average load value.

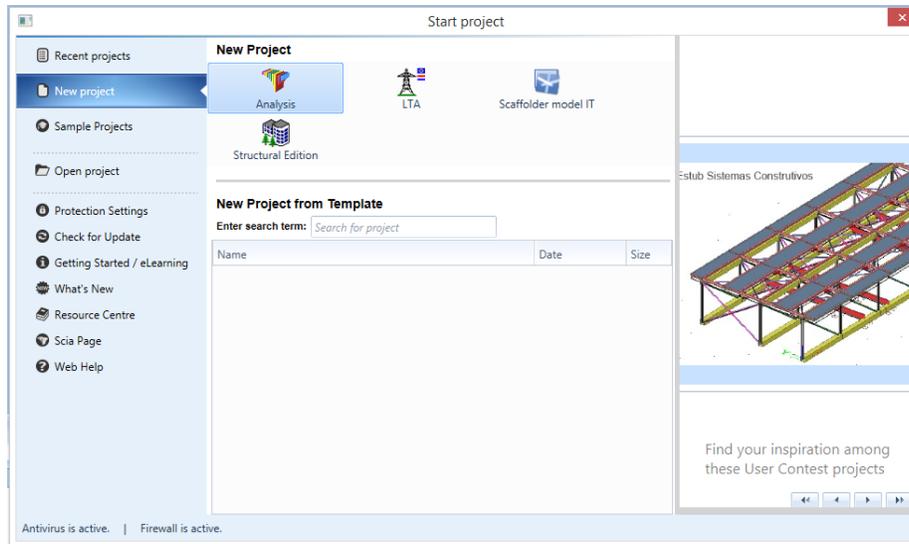
GENERAL NOTES

- Joists and joist girders can either have a simple span or be fixed-fixed. A joist with fixed end conditions will be designated as a "Special" joist. Having a fixed-pinned joist will produce unreliable results and/or errors in the Virtual Joist Designation.
- In some cases the depth of the virtual joist in the model may vary from the depth of the standard or KCS joist designation. This is due to the fact that virtual joist cross-sections do not have a one-to-one relationship with standard or KCS series joists. If the depth of the virtual joist and standard or KCS designation are different, a note is displayed in the **Designation Method and Notes**.
- When using a joist girder to support joists, the joists should be equally spaced when possible.

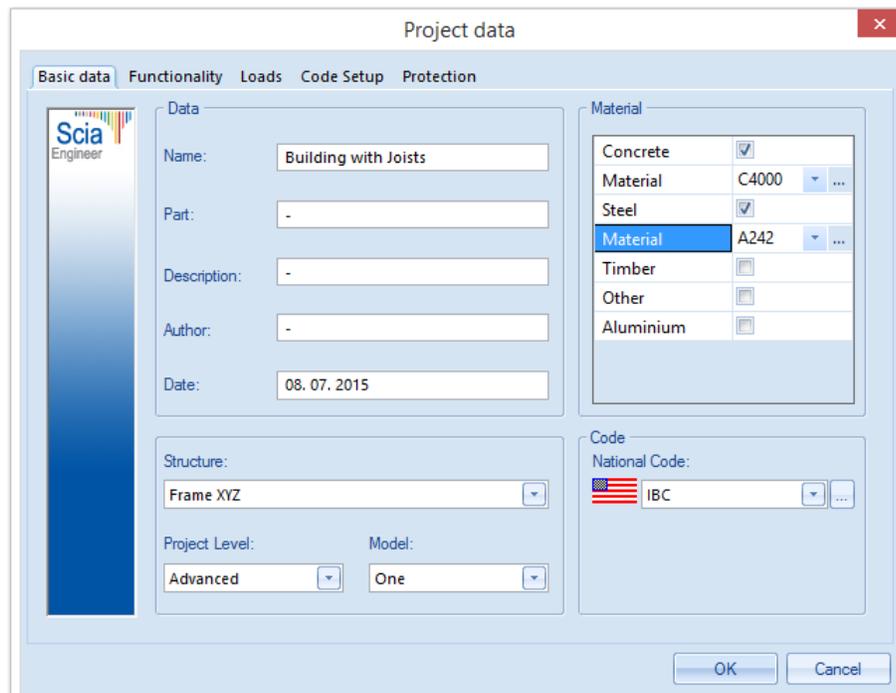
TYPICAL VIRTUAL JOIST WORKFLOW

Start a new analysis project:

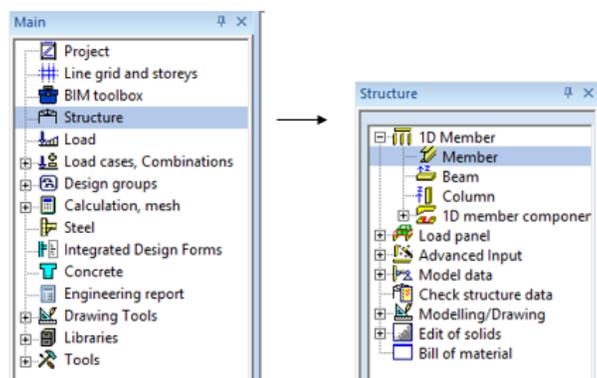
File > New Project > Analysis



In **Project Data**, ensure that National Code is set to **IBC**. Under **Materials** select the **Steel** checkbox and select a steel that has a yield stress of **50ksi**. If planning to use metal decking in the model, select the **Concrete** checkbox as well.

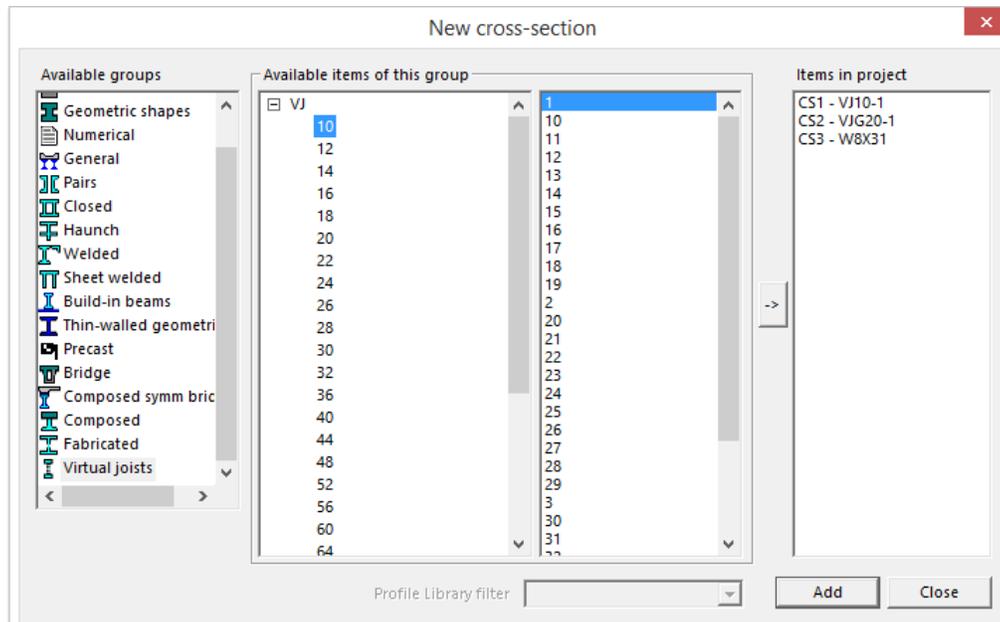


To add a virtual joist girder to the model, select the **Structure** component in the **Main** Project tree, and select **Member** under the **1D Member** options in the Structure tree.



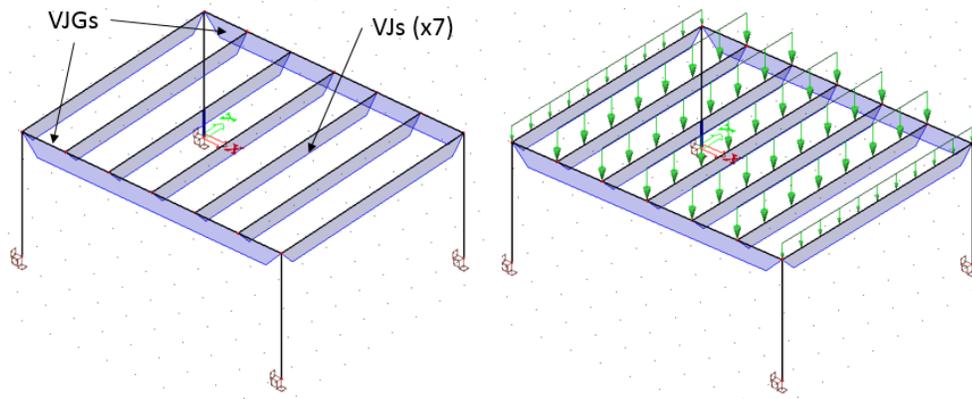
If no cross-sections have been added to the model, a window will open prompting the user to select a cross-section(s). The selection of virtual joists (VJ) and virtual joist girders (VJG) can be completed as needed. See “Selecting Virtual Joist Cross-Sections” above for more information on selecting the joist sections.

In this example, a virtual joist (VJ10-1) and virtual joist girder (VJG20-1) have been added as well as a W8x31 cross-section, which will be used for column members.

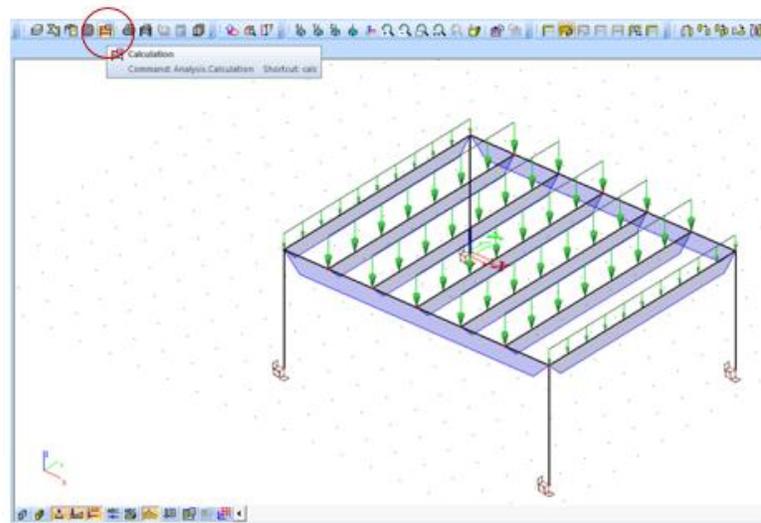


After adding the cross-sections, close the **New Cross-Section** window, place the members into the building model, and add load to the joists. In this illustration, the joists are loaded using uniform line loads. Alternatively, a metal deck (**2D Member**) can be added in order to load the joists using a surface force.

The image on the left shows the model and the placement of the joists and joist girders. The image on the right shows the model loaded using uniform line loads.

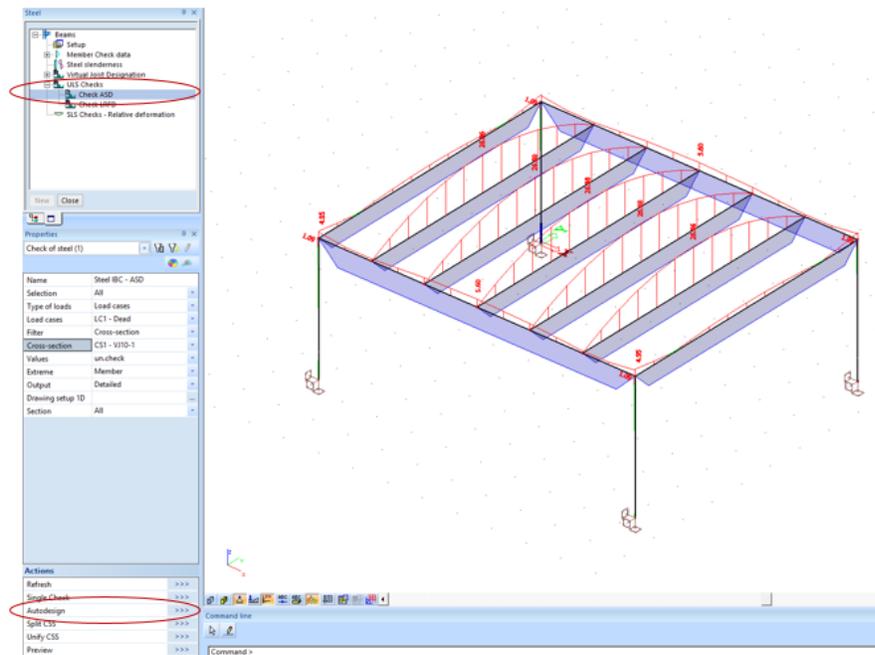


Run analysis on the model:

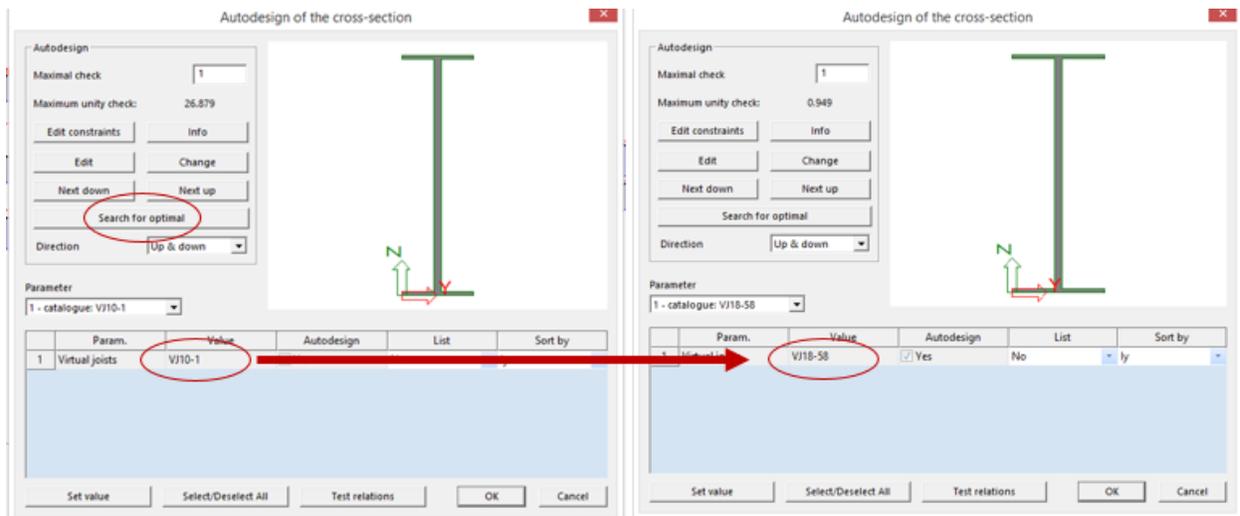


In the **Steel** service, check the joists by expanding **ULS Checks**. Select **Check ASD** for models with un-factored loads or **Check LRFD** for factored loads. Click the **Refresh** action button to show the unity check value for each member in the model. Values in red show members which have a unity greater than 1.0, while values in green show members that pass the check with a value less than 1.0.

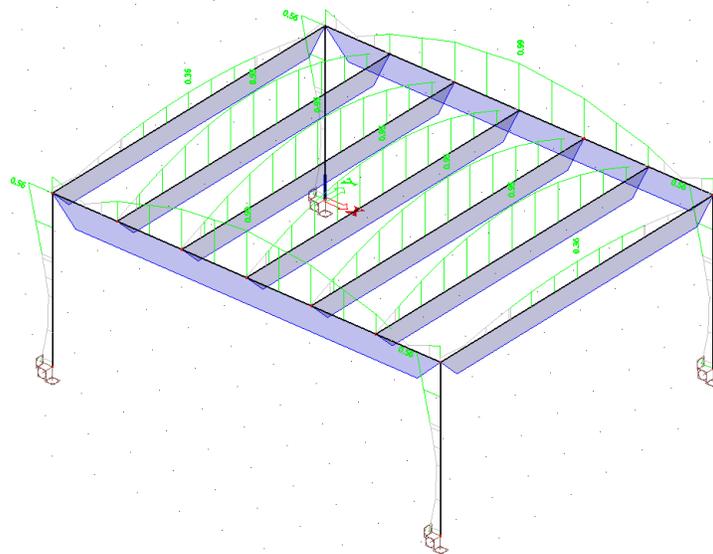
Next, select the action **Autodesign** to replace the initial joist cross-sections with the optimal cross-sections that pass the code check. Note that the **filter** should be set to **cross-section** and each cross-section will be auto-designed individually.



In the **Autodesign of Cross-Section** window, select a method to sort cross-sections (height, area, or moment of inertia), and then press **Search for Optimal**. A cross-section which passes the steel check based on the current model data will be selected. Select **OK** to replace the current joist cross-sections with this new one. In the example shown, the VJ10-1 joists are replaced with VJ18-58 joists. Repeat this process for all cross-sections in the model. The Autodesign replaces all members of a particular cross-section based on the worst-case member. Therefore, it is advised to assign similarly loaded joists the same cross-section and uniquely loaded joists their own cross-section as needed. For example, if a joist has a large concentrated load, giving it a cross-section different from joists that only have a uniform load will prevent the uniformly loaded joists from being auto-designed along with the point load joist.



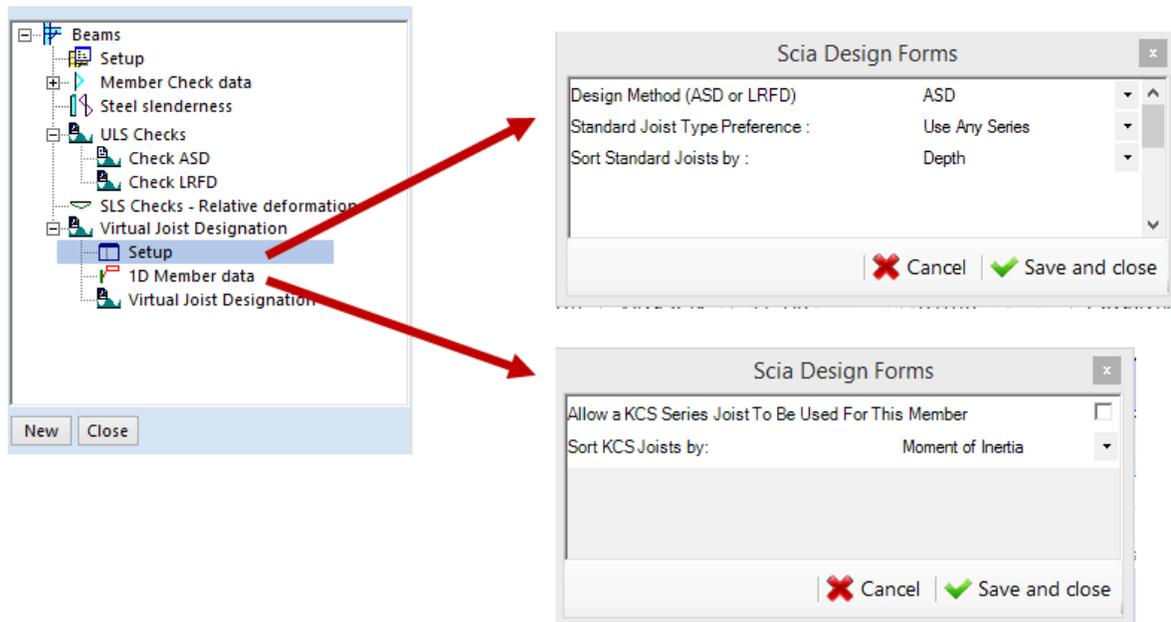
After auto-designing for all cross-sections, **run** the model analysis again. After the model runs, again check the member to see that new cross-sections pass the unity check. If any of the new cross-sections do not pass the check, auto-design once more and run the analysis. Repeat this process until all members pass the code check.



Once all joists pass the code check, open the **Virtual Joist Designation** component tree in the **Steel** service. Select **Setup** to set parameters for the joist designation. These setup parameters are used for all joists in the model. Select the design method (ASD or LRFD), the standard joist preference, and method by which to sort standard joists. **Member Data** can

also be input when a KCS series joist is desired because of the presence of a concentrated load. By default a KCS series joist is not allowed, and **Member Data** must be selected individually for each joist as needed.

See “Inputs for the Virtual Joist Designation” for more information on setup and member data settings.



After making **Setup** and **Member Data** settings, select **Virtual Joist Designation** to view the designation output. Set the type of selection (current, all, etc.), the method of filter for joists in the selection (by material, cross-section, etc.), which load case is use, and on what component the extreme should be considered (this should generally be set to **Member** in order to view the results for all members in the selection). For **Output** select the level of detail to be shown in the report. The **Brief** output only displays the uniform load on each member. **Summary** output displays the joist ID, the VJ or VJG cross-section name and properties (Area and moment of inertia), the joist designation, the methodology for the joist designation, and any loads on the joist if the designation does not use a standard or KCS series joist. In addition to the results shown in the **Summary** output, the **Detailed** output displays model data, system and member settings, the maximum forces on the joist, and the equivalent uniform loading. The **Detailed + Moment & Shear**, shows the **Detailed** output, plus moment and shear diagrams.

Properties 🔍 ✕

Virtual Joist Designation (1) 📄 ⚡ 🖋

Name	Virtual Joist Designation
Selection	
Type of selection	All
Filter	No
Result case	
Type of load	Load cases
Load case	LC1 - Dead
Extreme 1D	Section
Output	Summary
Run using Model Data files (Debug)	<input type="checkbox"/>
Values	w_eq
Drawing setup	
Draw type	Precise
Draw average value	<input type="checkbox"/>
Draw values	<input checked="" type="checkbox"/>
Draw units	<input checked="" type="checkbox"/>
Actions	
Refresh	>>>
Preview	>>>

ft | Plane XY | Ready

Summary output example for standard joist:

Joist Designation

ID	VJ	VJ Target A_x	VJ Target I_x	Uni. Load	Span	Designation	Capacity
B9	VJ18-58	5.49 in ²	309 in ⁴	400 lb/ft	25 ft	16K7	428 lb/ft

Designation Method and Notes:

1. Uniform loading on joist
2. Standard joist used for designation
3. Depth of standard joist is different than depth of virtual joist

Detailed output example for standard joist:

Joist Designation

ID	VJ	VJ Target A_x	VJ Target I_x	Uni. Load	Span	Designation	Capacity
B9	VJ18-58	5.49 in ²	309 in ⁴	400 lb/ft	25 ft	16K7	428 lb/ft

Designation Method and Notes:

1. Uniform loading on joist
2. Standard joist used for designation
3. Depth of standard joist is different than depth of virtual joist

General Design Criteria

System Settings

Joist Series Preference: No Preference - Any Series Allowed

Sort standard joists by: Depth

Member Settings

A KCS series joist may not be chosen for this member

Program Settings

Joist will be considered uniformly loaded and a standard designation will be given if:

- No point load on the joist exceeds 100 lb or
- Moment and shear calculated using the equivalent uniform loading are within 10% of actual values

Maximum Forces on Member

$$M_{y,\max} = 31.2 \text{ kip}\cdot\text{ft} \quad \text{Max Applied Moment on Joist}$$

$$V_{z,\max} = 5 \text{ kip} \quad \text{Max Shear on Joist}$$

(Axial Force is 0)

Equivalent Uniform Loading

$$w_{e\text{q-M}} = \text{abs}\left(\frac{8 \cdot M_{y,\max}}{L^2}\right) = 400 \text{ lb/ft} \quad \text{Equivalent Uniform Loading Based on Max Moment}$$

$$w_{e\text{q-V}} = \text{abs}\left(\frac{2 \cdot V_{z,\max}}{L}\right) = 400 \text{ lb/ft} \quad \text{Equivalent Uniform Loading Based on Max Shear}$$

$$w_{e\text{q}} = \max(400 \text{ lb/ft}; 400 \text{ lb/ft}) = 400 \text{ lb/ft} \quad \text{Equivalent Uniform Loading (max)}$$

$$M_{y-2} = 31.2 \text{ kip}\cdot\text{ft} \quad \text{Calculated Moment Using Equivalent Uniform Loading}$$

$$V_{z-2} = 5 \text{ kip} \quad \text{Calculated Shear Using Equivalent Uniform Loading}$$