

GSE SOFTWARE

General Structural Engineering

APPLICATION

<u>GSE Steel</u>, <u>GSE Concrete</u>, <u>GSE</u> <u>Wood and <u>GSE Aluminum</u></u>

FUNCTIONALITY

Calculates the live load reduction based on tributary area

LIVE LOAD REDUCTION

The live load reduction is available for the GSE steel, concrete, aluminum, and wood modules. The live load reduction will be applied to the columns of the structure.

Live loads can be automatically reduced according to the selected method. The software computes the live load reduction factor (LLRF) that will reduce the effective axial compression force in columns.



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When there is no live load reduction, **Cf** is equal to **Cf (ana)**.

When the live load reduction is enabled, **Cf** is the effective compression force.

For a specific combination used in the compression limit states design, the effective compression force **Cf** (positive value for **compression**) will be computed based on the following equation.

$$C_f = C_f(ana) - \sum_{i=1}^n \{-\alpha_{Li}F_{xi}(1 - LLRF_i)\}$$

The value $C_f(ana)$ is the original unreduced compression force in the column coming from the analysis.

The value F_{xi} is the unfactored axial force (positive value for **tension**) for a reductible basic load.

The value " $-\alpha_{Li}F_{xi}$ " is the factored compression force (positive value for compression) due to the ith reductible live load.

In a combination, the total live load reduction is function of the sum of all **n** reductible basic live loads reduction factor LLRFi.

The live load reduction options are:

CNBC	$0.3 + \sqrt{9.8/A}$ or $0.5 + \sqrt{20/A}$
ASCE 7	$0.25 + 15/\sqrt{KLL \cdot A} \le 1$
Custom (By Tributary Area)	$a + b/\sqrt{A} \le 1$ or $a + b/A \le 1$ or $1 - a(A - b) \le 1$

Custom (By Supported Storeys)

No reduction

STEPS TO APPLY LIVE LOAD REDUCTION

The required steps to apply the live load reduction is defined below. The steps are the same for the steel, concrete, aluminum, and wood modules.

Step 1: Basic loads

Create a basic load with a "Reductible Live Load" type.

For the NBCC, it is also possible to create a "Reductible Live Load (NBCC Assembly)" type. It is possible to define more than one reductible live load.

In this case, the tributary area is computed separately for each basic load.

0 300	Basic Load Name	Load Type	
1	Dead	(D) Dead Load	
2	Live	(L) Reductible Live Load	
3	Snow	<delete load="" this=""></delete>	
4		(B) General Static Load	
5		(D) Dead Load (D) Additional Dead Load	
6		(L) Live Load	
		(W) Wind Load	
7		(I) Ice Load	
8		(S) Snow Load	
9		(E) Static Seismic Load	
10		(Wv) Static Wave Load	
11		(VM) Vessel Motion Load	
12		(H) Earth Pressure Load (C) Crane Load	
		(T) Thermal (Self-Straining) Load	
13		(Lr) Roof Live Load	
14		(L) Reductible Live Load	
15		(L) Reductible Live Load (NBCC Assembly)	
16		(c) Moving Load	
17		(L) Static Moving Load (E) Response Spectrum Seismic Load	
18		(E) Time-History Seismic Load	ОК
19		(Lk) Dynamic Load	Cancel
20			Cancer

Live Load Reduction		? ×
Id =	3	Table
	Options	
Method =	Custom (By Tributary Area)	
	ASCE 7 Parameters	
Equation =	LLRF = a+b/sqrt(A)	
Area Unit =	m.2 💌	
a =	0.3	
b =	3.1305	
	Minimum values	
LLRF min (1 Floor) =	0.6	
LLRF _{min} (>1 Floor) =	0.4	
		ОК
		<u>C</u> ancel
		- <u>H</u> elp
♦ NBCC ASCE	7 Custom NBCC Custom Euro Beam Cu	JE

Step 2: Live load reduction definition

From the **Tables** menu, select the **Live Load Reduction** command to define live load reduction parameters.

Four methods are available:

- NBCC
- ASCE 7
- Custom (By Tributary Area)
- Custom (By Supported Storeys)

Step 3:

Activate the live load reduction method

From the Analysis menu, select the Codes and Standards command. In the appropriate tab (steel, concrete, aluminum, or wood) the Live Load Reduction Method created in the previous step can be selected.

By default, there is no live load reduction active.

Step 4: Defining the storeys

To define the storeys activate the **Edit – Storeys** command.

Step 5 (optional): Override the live load reduction per member

It is possible to customize the method for each member. To do so, edit the **Live Load Reduction** method in the appropriate tab (steel, concrete, aluminum or wood) of the member attributes.

Step 6: Run the analysis

Run the analysis with the appropriate design option.

Seismic Deflections Steel Alum	ninum Reinforced Concrete Wood
Standard: CS	SA S16-14/CSA S136-16
Limit States Calculation:	At each division
Live Load Reduction Method:	3 - Custom NBCC -
Minimum ULS Ratio to Print:	0.1
Limit Slend. (Tension):	300
Limit Slend. (Compression):	200
Slenderness Verification ULS Threshold:	0.1
CompBending Equation for:	Braced Frames

0 8	Label	Height mm	Elevation mm	
	Base		0.0000	
	L1	4000.0000	4000.0000	
	L2	4000.0000	8000.0000	
	L3	4000.0000	12000.0000	
	L4	4000.0000	16000.0000	
	L5	4000.0000	20000.0000	
	L6	4000.0000	24000.0000	
	L7	4000.0000	28000.0000	

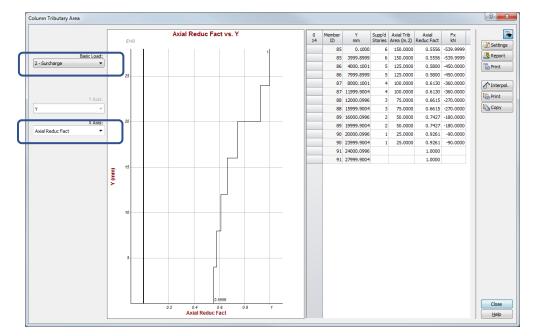
mber Attribute	25	? <mark>×</mark>
General Offse	ts Deflections Steel Composite Aluminum Concrete Wood	
ID:	M86 ¥	
Name:	L _{phys} = 4000 mm → X	
	Bending	
	Unbraced Length	
🔽 Top Flange	Member v2= 0	
🔽 Bot. Flange	Member ▼ w2= 0	
Ignore Ben	ding on the Weak Axis	
Ignore Tors	sion Compression	
I I apore 111 r	nultiplier for 2nd order analysis (subdivided members only)	
	Unsupported Length	
🗸 Axis X	Member Kx= 1 w1,x= 0	
Axis Y	Member • Ky= 1 w1,y= 0	
V Torsion	Min. strong and weal V Kt= 1	
Built-Up See		
Change Lim	it Slenderness in Compression 0	
Change Liv	e Load Reduction Default (3 - Custom NBCC) 🔻 🖽	

Step 7: Validate the tributary area and the LLRF

After the analysis, it is possible to validate the tributary areas and the live load reduction factor (LLRF) for each reductible basic loads in the **Analysis – Numerical results – Analysis – Member Tributary Area** command.

able	<u>C</u> ommands	<u>V</u> iew	Selection	on									
8	e 🛍 🖬 🖷	12-	* •			*.0 .00 E	9 P 🗐	1 II.	3				
0 18	Load ID	Phys Memb	Member ID	Member Type	Supp'd Stories	Axial Trib Area (m.2)	Axial Reduc Fact	Fx kN	Bending Trib Area (m.2)	Fy kN	Fz kN	Notes	
	2 - Surcharge	25	85	Column	6	150.0000	0.5556	-539.9999					
	2 - Surcharge	25	86	Column	5	125.0000	0.5800	-450.0000					
	2 - Surcharge	25	87	Column	4	100.0000	0.6130	-360.0000					
	2 - Surcharge	26	88	Column	3	75.0000	0.6615	-270.0000					
	2 - Surcharge	26	89	Column	2	50.0000	0.7427	-180.0000					
	2 - Surcharge	26	90	Column	1	25.0000	0.9261	-90.0000					
	2 - Surcharge	27	92	Column	6	75.0000	0.6615	-270.0000					
	2 - Surcharge	27	93	Column	5	62.5000	0.6960	-225.0000					
	2 - Surcharge	27	94	Column	4	50.0000	0.7427	-180.0000					
	2 - Surcharge	28	95	Column	3	37.5000	0.8112	-135.0000					
	2 - Surcharge	28	96	Column	2	25.0000	0.9261	-90.0000					
	2 - Surcharge	28	97	Column	1	12.5000		-45.0000					
	2 - Surcharge	1092	1092	Beam					25.0000	45.0000	0.0000		
	2 - Surcharge	1099	1099	Beam					25.0000	45.0000	0.0000		
	2 - Surcharge	1106	1106	Beam					25.0000	45.0000	0.0000		
	2 - Surcharge	1113	1113	Beam					25.0000	45.0000	0.0000		
	2 - Surcharge	1120	1120	Beam					25.0000	45.0000	0.0000		Close
	2 - Surcharge	1127	1127	Beam					25.0000	45.0000	0.0000		

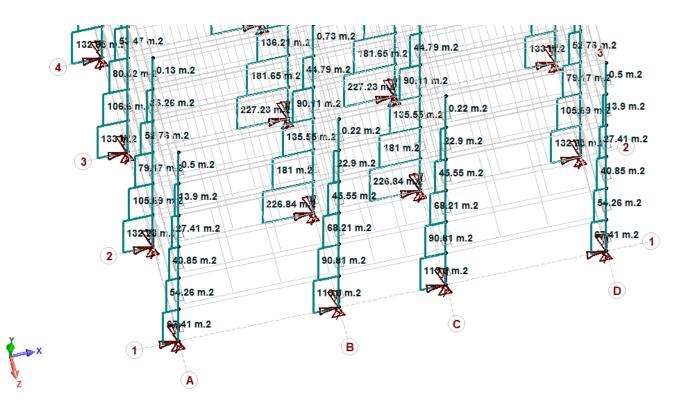
It is also possible to validate tributary area and the LLRF in a graphical way for each column by selecting the **Analysis – Charts – Analysis – Column Tributary Area** command.

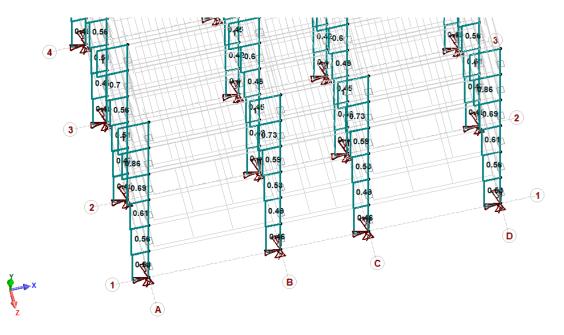


The tributary area and the LLRF can also be displayed directly on the structure. Activate the **Analysis** – **Global Curves**– **Analysis** – **Options**.

Select the option to display as shown below. Select a basic load by clicking on the **Basic Loads** button.

Static Analysis	? <mark>X</mark>
Deformations Global (at joints) Internal	Animate
Forces Forces Forces Envelope Fx (axial) My (bending) Mx (torsion) Fy (shear) Mz (bending) Mxp (pure torsion) Fz (shear) Bw (warping) Mxw (warping) Shear in Diaphragms Do not show	
Stresses Stresses Envelope Sx (due to Fx) Sx (due to My) Txy (due to Fy) Sx (due to Mz) Txy (due to Fy) Sx (due to Mz) Txz (due to Fz) Sx (due to Bw) Txz (due to Mxw)	
Support Reactions Reactions Envelope Rx Rm,x Ry Rm,y Rz Rm,z	
Live load reduction	
Live load reduction value to display: Tributary areas Basic Loads	





Step 8: Look at the compression limit states results

It is possible to compare the original compression with the reduced force for each applicable combination. To look at these values, open the compression or the compression/bending limit states results table in the <u>GSE steel</u>, <u>GSE concrete</u>, <u>GSE aluminum</u>, or <u>GSE wood</u> module.

When the live load reduction factor (LLRF) is less than 1.0, both columns the original force **Cf (ana)** and the reduced force **Cf** will be displayed.

	npressio		t States View Selectic													- 0 X	ון	Cf (ana) kN	Cf kN	ULS Cf/Cr
					a 06 58		P		2									1146.6746	786.7141	0.9488
0 14	Phys Memb	Memb ID	Section	Fey MPa	Lambda x	Lambda y	Cr x kN	Cr y kN	Cr kN	Critical Combination	Critical Position (mm)	Cf (ana) kN	Cf kN	ULS Cf/Cr	Notes			973.9250	690.4254	0.8327
	25		HSS152x152x8.0	25.5196	0.9069	0.9069	829.1311	829.1311		1	0.0000	1146.6746	786.7141					801.1755	592.2225	0.7143
	25	86	HSS152x152x8.0	25.5196				829.1311			0.0000		690.4254							
	25		HSS152x152x8.0					829.1311			0.0000		592.2225					628.4260	491.3250	0.935
	26		HSS152x152x4.8 HSS152x152x4.8					525.0786 525.0786			0.0000		491.3250 386.8538					456.3195	386.8538	0.736
	26		HSS152x152x4.8					525.0786			0.0000		274.2365							
_	26		HSS152x152x4.8					525.0786			0.0000		149.6065					284.2130	274.2365	0.522
	27	92	HSS152x152x8.0	25.5196	0.9069	0.9069	829.1311	829.1311	829.1311	2 - D+L+S	0.0000	586.4104	449.3094	0.5419					149.6065	0.284
	27	93	HSS152x152x8.0	25.5196	0.9069	0.9069	829.1311	829.1311	829.1311	2 - D+L+S	0.0000		395.3777						115.0005	0.201
	27		HSS152x152x8.0					829.1311			0.0000		340.0926					586.4104	449.3094	0.541
	28		HSS152x152x4.8					525.0786			0.0000		282.9019					407.0942	205 2777	0.476
	28		HSS152x152x4.8 HSS152x152x4.8					525.0786 525.0786			0.0000		223.3727 145.5661					497,9045	395.3777	0.4/6
	28		HSS152x152x4.8					525.0786			0.0000		76.5330					409.5583	340.0926	0.410
																		321.1322	282.9019	0.538
																Close		233.3492	223.3727	0.425
4															•	Help			145.5661	0.277
																			76.5330	0.145

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