Structural and Seismic Design of a Steel Staircase using FEM in compliance with Italian Legislation

INDEX

Origin and Characteristics of Calculation Codes

Calculation code:	PRO_SAP PROfessional Structural Analysis Program
Version:	e-TIME (build 2023-07-199)
Producer-Distributor:	2S.I. Software e Servizi per l'Ingegneria s.r.l. Via Garibaldi, 90 44121 Ferrara FE (Italy) Tel. +39 0532 200091 www.2si.it
License Code:	Licenza non individuata

Regarding Section 10.2 of the Technical Standards for Construction (Reliability of the codes used), reference is made to the **Reliability Document** "Validation Testing of PRO_SAP Calculation Software and Additional Modules PRO_SAP Geotechnical Module, PRO_CAD Steel Knots, and PRO_MST" available for download at: https://www.2si.it/it/prodotti/affidabilita/

1. SUMMARY ILLUSTRATIVE REPORT

INTRODUCTION

This introduction provides the main framing elements of the executive design regarding structures, in relation to urban planning instruments, architectural design, the design of technological components in general, and the expected performance of the structure.

NORMATIVE FRAMEWORK ADOPTED

The standards and documents taken as reference for structural design are given below.

Design-verification of the elements	
Reinforced concrete project	D.M. 17-01-2018
Steel project	D.M. 17-01-2018
Timber project	D.M. 17-01-2018
Masonry project	D.M. 17-01-2018
Seismic action	
Standard applied for seismic action	D.M. 17-01-2018

1.1 HISTORICAL-CRITICAL ANALYSIS AND OUTCOME OF THE GEOMETRIC-STRUCTURAL SURVEY

For existing buildings, consistent with paragraph 8.2 of NTC-18, the historical-critical analysis and the geometric-structural survey must highlight the following aspects: (a) the construction reflects the state of knowledge at the time of its realisation; (b) there may be inherent and not evident defects in design and realisation; (c) the construction may have been subject to actions, even exceptional, whose effects are not completely manifest; (d) the structures may present degradation and/or significant modifications with respect to the original situation.

1.2 GENERAL DESCRIPTION OF THE WORK

1.2.1.1.1

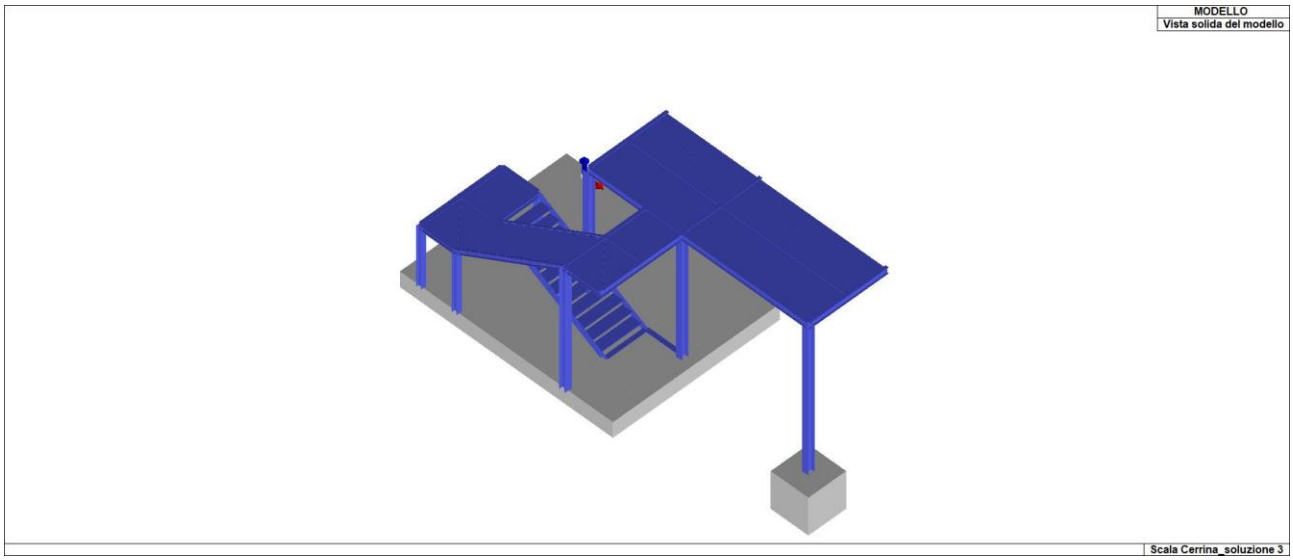
General description of the work	
Work of new realization	SI
Location	Municipality CERRINA MONFERRATO (AL) (Region PIEMONTE)
	Location CERRINA MONFERRATO (AL)
	Longitude 8.215, Latitude 45.120 (Reference WGS84)
Type of foundation	Mista

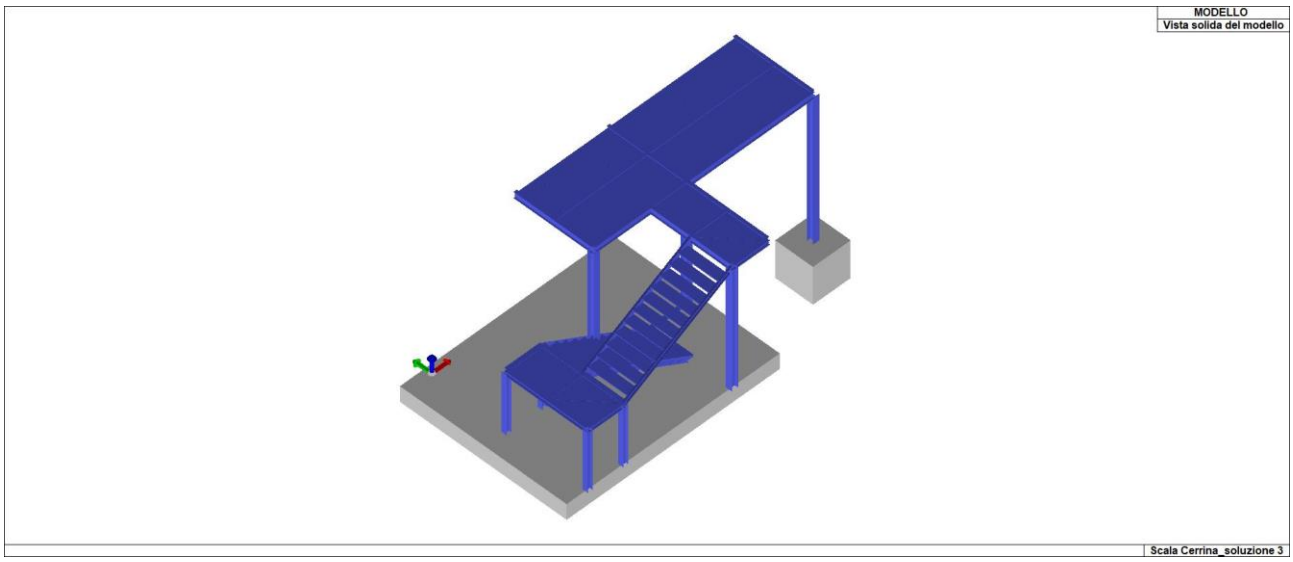
Material used	
Reinforced concrete	SI
Steel	SI
Timber	NO
Masonry	NO

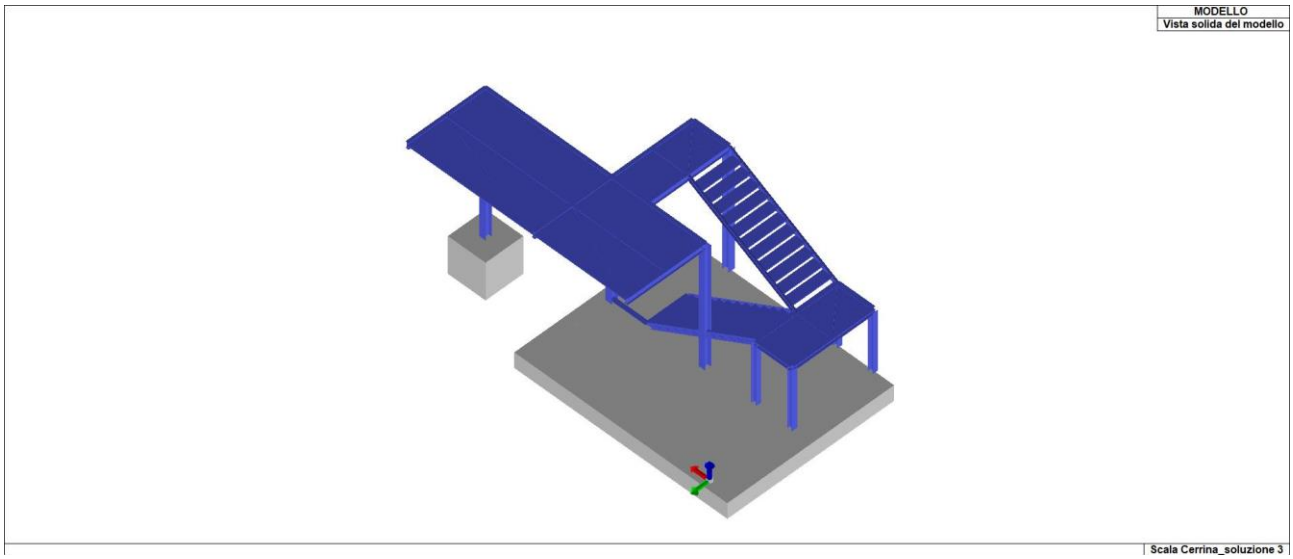
Main features of the structure	
Regular structure in plan	SI
Regular structure in height	SI
Ductility class	B media
Analysis for non-seismic loads	SI
Seismic analysis	Dinamica lineare
SLD strength verification	SI

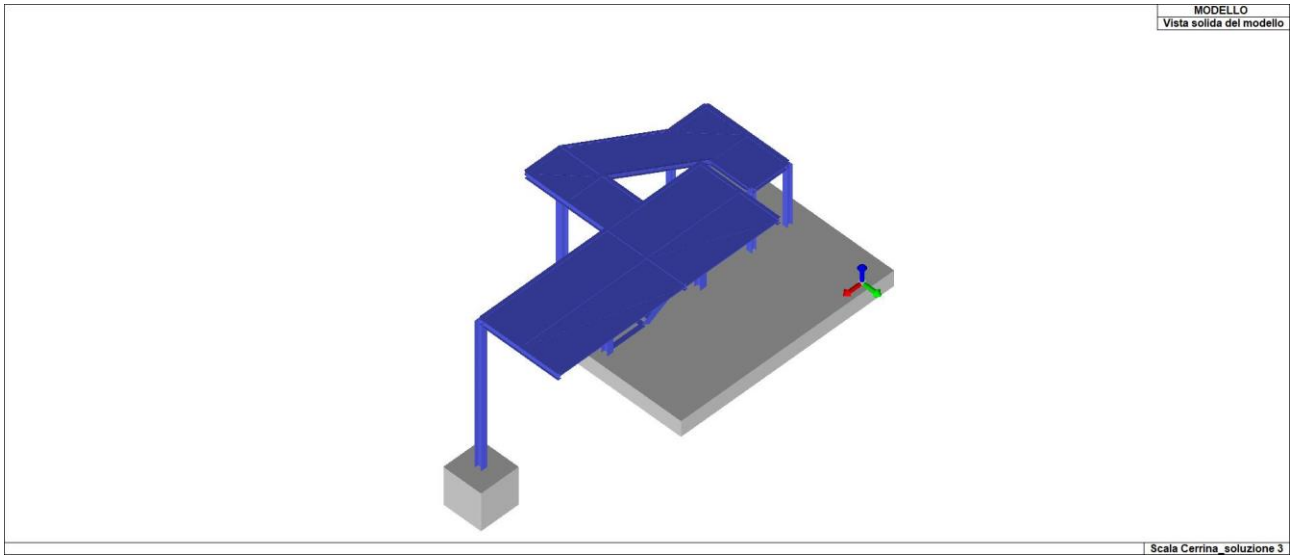
Structure parameters			
Class of use	Life Vn [years]	Use Coeff.	Period Vr [years]
III	50.0	1.5	75.0

Images of the structural model are shown below::









MODELLING

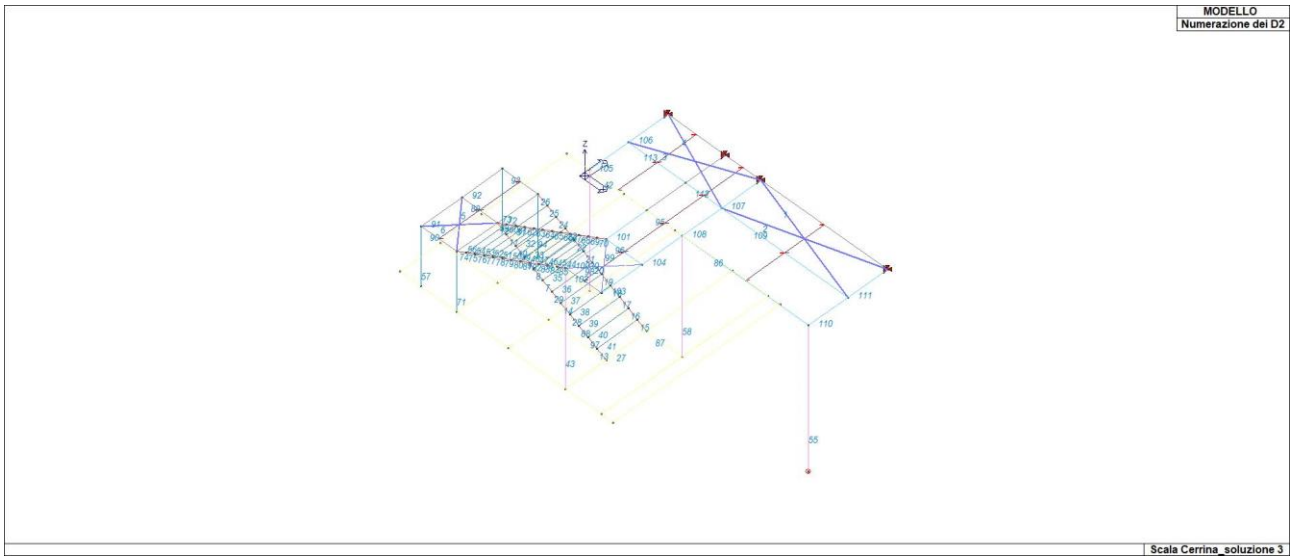
Structural analysis is conducted by the displacement method for evaluation of the stress-strain state induced by static loads. Structural analysis is conducted by the modal analysis and acceleration response spectrum method for the evaluation of the stress-strain state induced by dynamic loads (including seismic loads). Structural analysis is carried out using the finite element method. The above method is based on the schematization of the structure into elements connected only at a set number of points called nodes. The nodes are defined by the three Cartesian coordinates in a global reference system. The unknowns of the problem (within the displacement method) are the displacement components of the nodes referred to the global reference system (translations according to X, Y, Z, rotations around X, Y, Z). The solution of the problem is obtained by a system of linear algebraic equations whose known terms consist of the loads acting on the structure appropriately concentrated at the nodes:

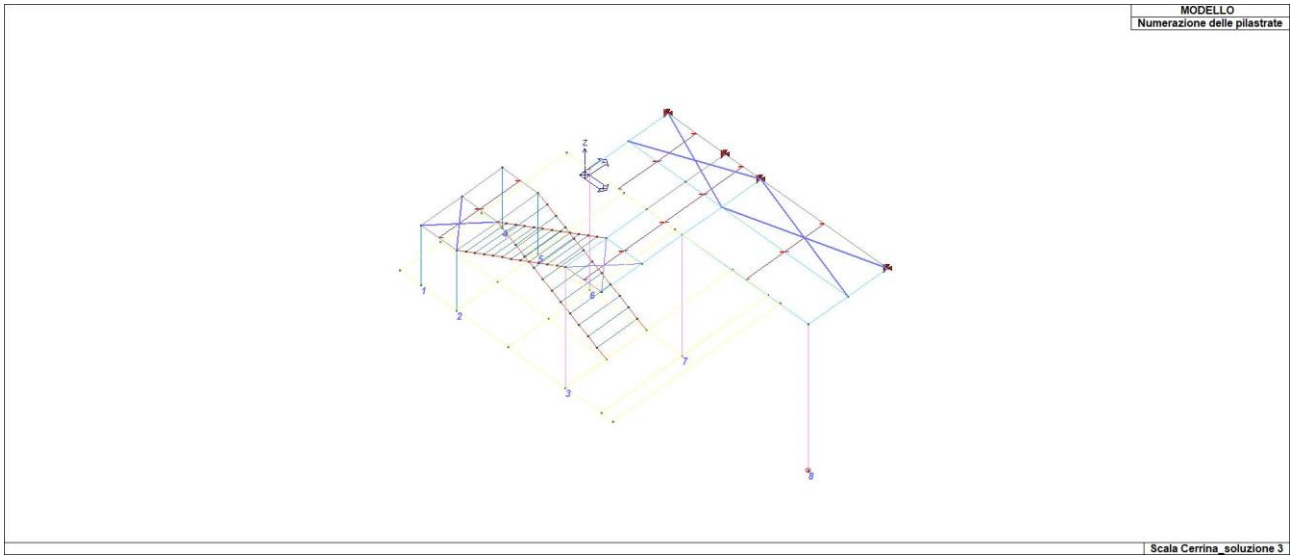
K * u = F where **K** = stiffness matrix
u = nodal displacement vector
F = nodal forces vector

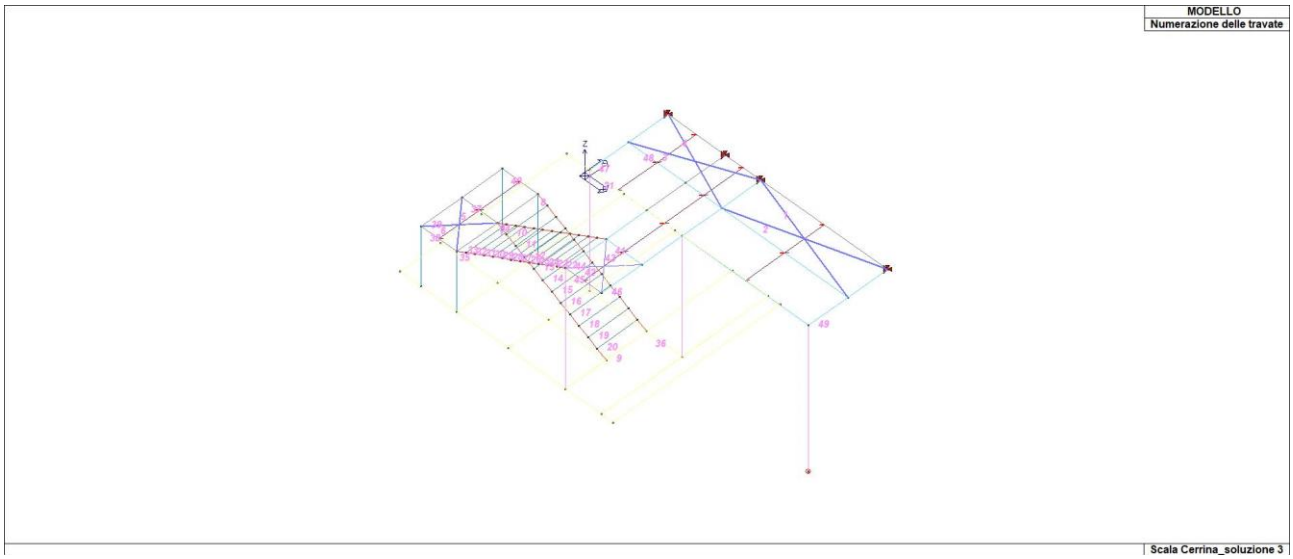
From the displacements obtained by solving the system, the stresses and/or strains of each element are then deduced, generally referred to a triad local to the element.
The reference system used is a right-handed Cartesian tern XYZ. The Z axis is assumed to be vertical and oriented upward.

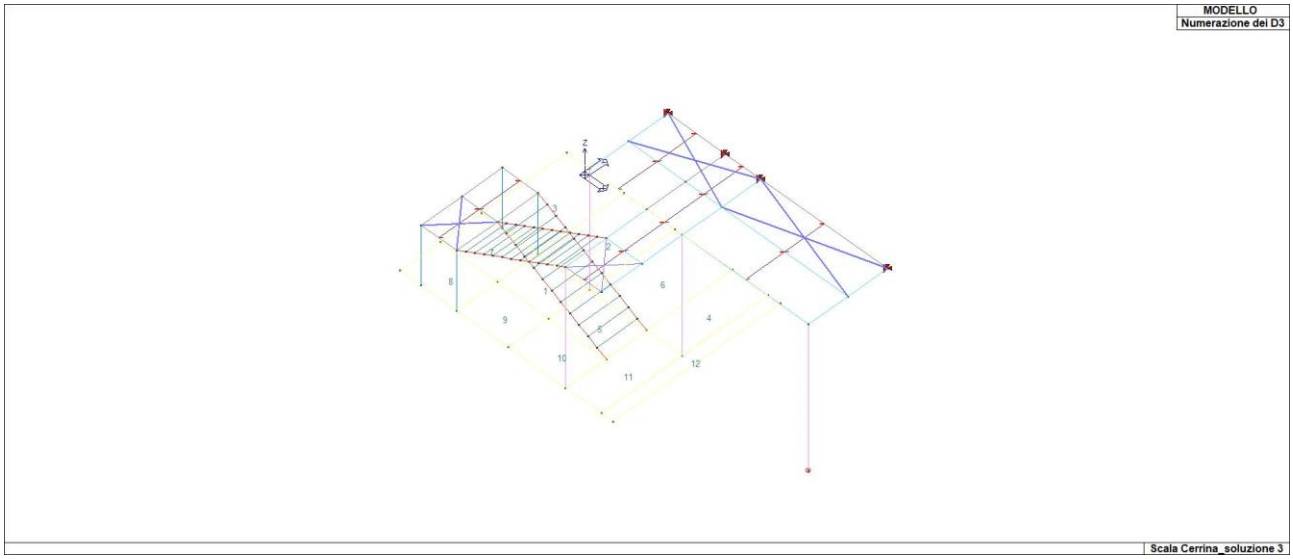
1.3 FINITE ELEMENTS - SECTIONS AND THICKNESSES

We reproduce images related to the numbers of interest:









Si riportano di seguito le caratteristiche di sezioni e spessori degli elementi strutturali, in formato tabellare e immagini:

TABELLA_SEZIONI

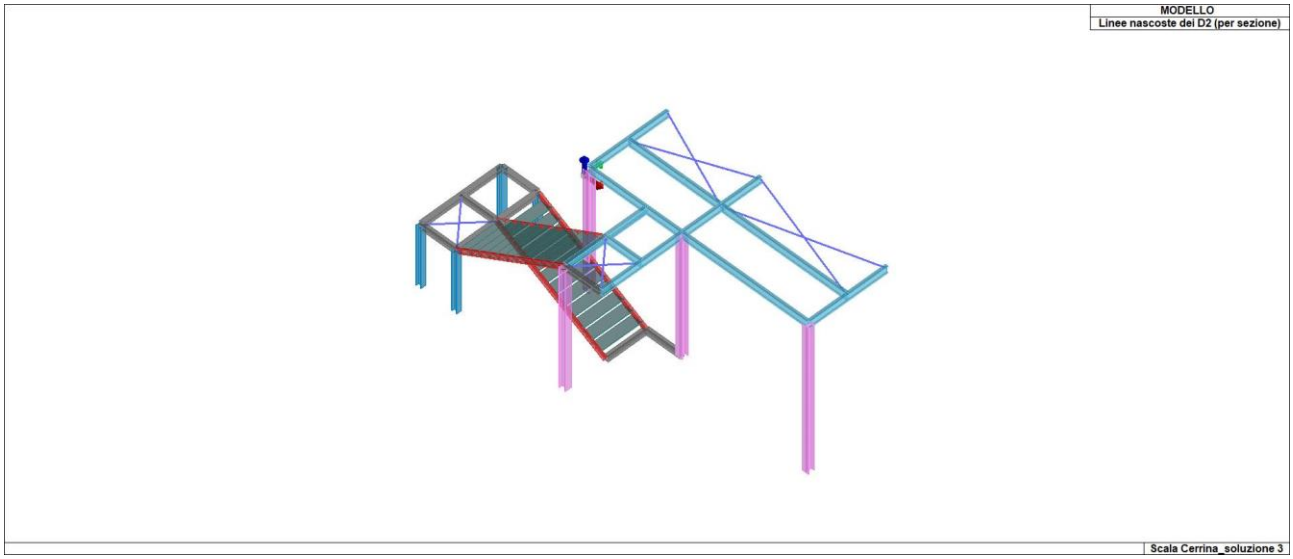
Id		Tipo SEZ	Area	A V2	A V3	Jt	J 2-2	J 3-3	W 2-2	W 3-3	Wp 2-2	Wp 3-3
-	-	-	cm2	cm2	cm2	cm4	cm4	cm4	cm3	cm3	cm3	cm3
1		HEB 140	43.00	0.0	0.0	20.10	550.00	1509.00	78.50	215.60	119.80	245.40
2		HEB 160	54.30	0.0	0.0	31.20	889.00	2492.00	111.20	311.50	170.00	354.00
3		Rettangolare: b=32.9 h=2.5	82.25	68.54	68.54	163.15	7419.02	42.84	451.00	34.27	676.51	51.41
5		IPE 200	28.50	0.0	0.0	7.00	142.00	1943.00	28.50	194.30	44.60	220.60
6		Circolare: r=1.5	7.07	5.96	5.96	7.95	3.98	3.98	2.65	2.65	4.50	4.50
7		HEB 200	78.10	0.0	0.0	59.30	2003.00	5696.00	200.30	569.60	305.80	642.50
9		UNP 140	20.40	0.0	0.0	5.68	62.50	605.00	14.70	86.40	28.30	103.00

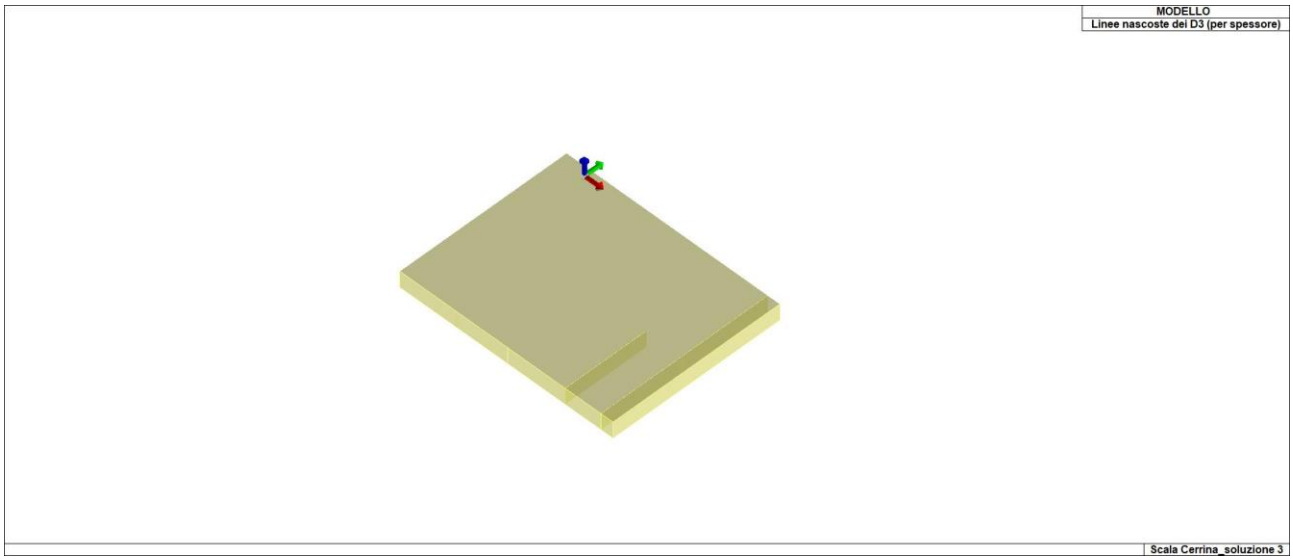
Legenda

Area	Section area
A V2	Section area/Shear factor (direction 2)
A V3	Section area/Shear factor (direction 3)
Jt	Torsional moment of inertia of the section
J 2-2	Moment of inertia of the section referred to Axis 2
J 3-3	Moment of inertia of the section referred to Axis 3
W 2-2	Section modulus referred to Axis 2
W 3-3	Section modulus referred to Axis 3
Wp 2-2	Plastic section modulus referred to Axis 2
Wp 3-3	Plastic section modulus referred to Axis 3

TABELLA_SPESSORI

Id		Spessore Gusci	Spessore Setti	Sp. solai piano rigido
-	-	cm	cm	cm
1		50.00	-	-





2. CHARACTERISTICS OF MATERIALS USED

In the execution of the works covered by this report, the following materials were used with their characteristics:

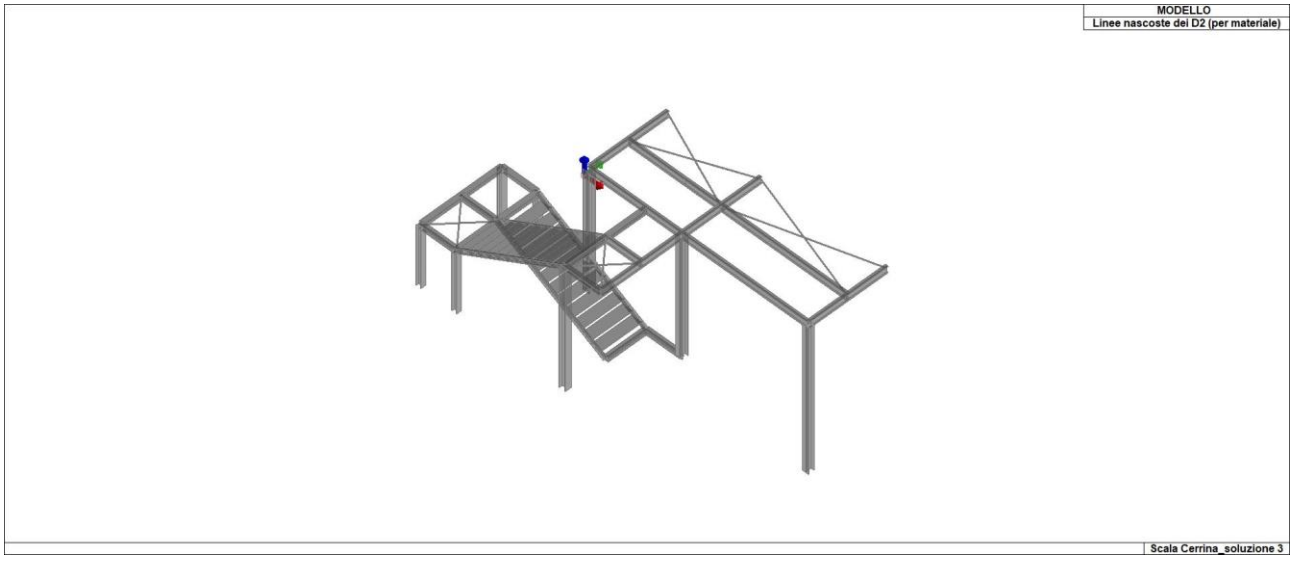
2.1 LIST OF MATERIALS USED

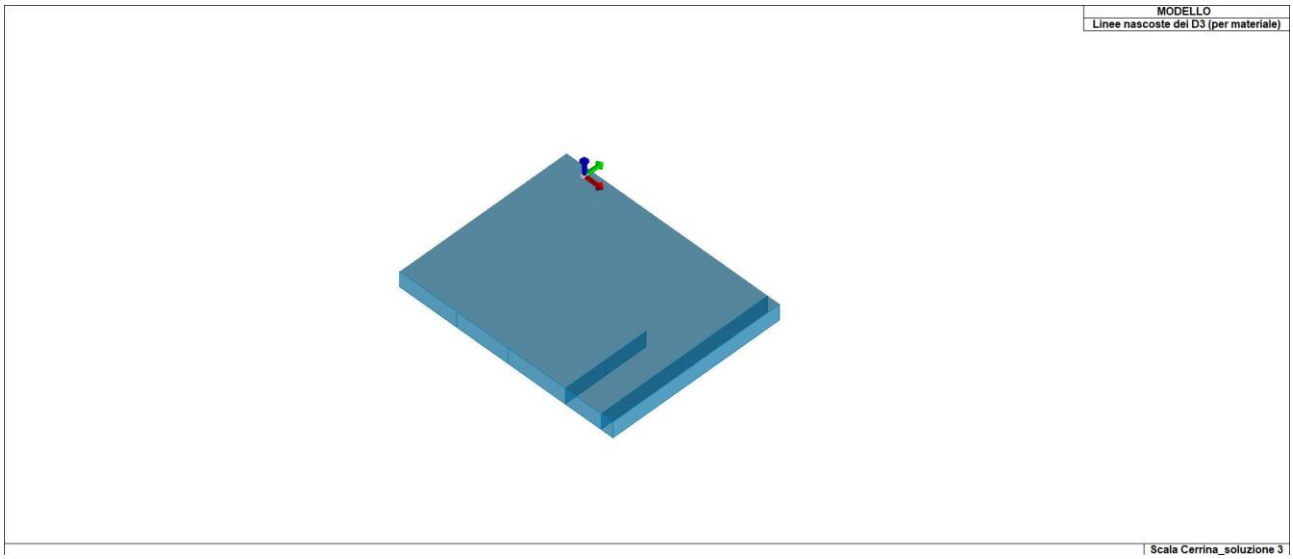
[2]- MATERIALE PER FONDAZIONE -

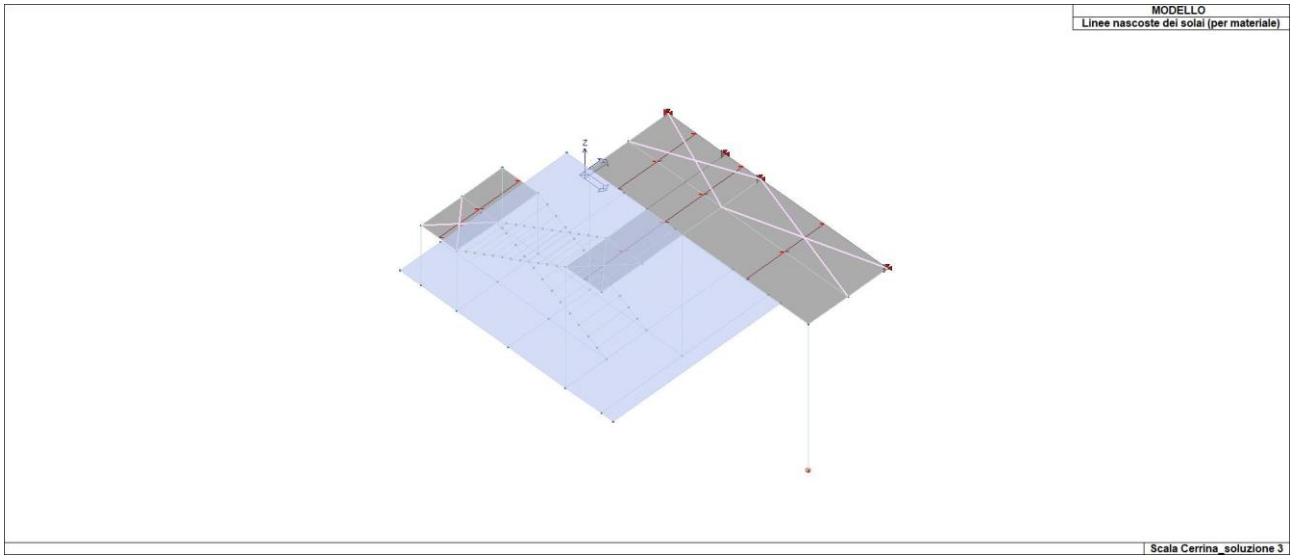
		Calcestruzzo Classe C28/35		
Id	-	-	-	u.m.
2		< MATERIALE NUOVO >		
		Resistenza caratteristica cubica Rck	3.500e+04	kN/ m2
		Resistenza caratteristica cilindrica fck	2.905e+04	kN/ m2
		Resistenza fctm	4000.0	kN/ m2
		Tensione caratteristica di snervamento acciaio	4.500e+05	kN/ m2
		Tipo acciaio	tipo C	
		Coefficiente gamma c	1.5	
		Coefficiente gamma s	1.1	
		Rapporto Rfessurata (assiale)	1.00	
		Rapporto Rfessurata (flessione)	1.00	
		Rapporto Rfessurata (taglio)	1.00	

[1]- MATERIALE PER ELEVAZIONE -

		acciaio Fe360-S235		
Id	-	-	-	u.m.
1		< MATERIALE NUOVO >		
		Tensione ft	3.600e+05	kN/ m2
		Tensione fy	2.350e+05	kN/ m2
		Coefficiente gammaM0 (resistenza)	1.1	
		Coefficiente gammaM1 (stabilità)	1.1	
		Coefficiente gammaM2 (frattura)	1.2	







ANALYSIS OF SLAB LOADS

The analysis of loads related to the floors in the subject structure is given:

TABELLA_CARICHI_SOLAI

ID Arch.		Tipo SOL	G1	G2	Q	Fatt. A	s sis.	Psi 0	Psi 1	Psi 2	Psi S 2	Fatt. Fi
-	-	-	kN/ m2	kN/ m2	kN/ m2	-	-	-	-	-	-	-
1		Variab.	4.50	1.00	2.00		1.00	0.70	0.50	0.30	0.30	1.00

Legenda

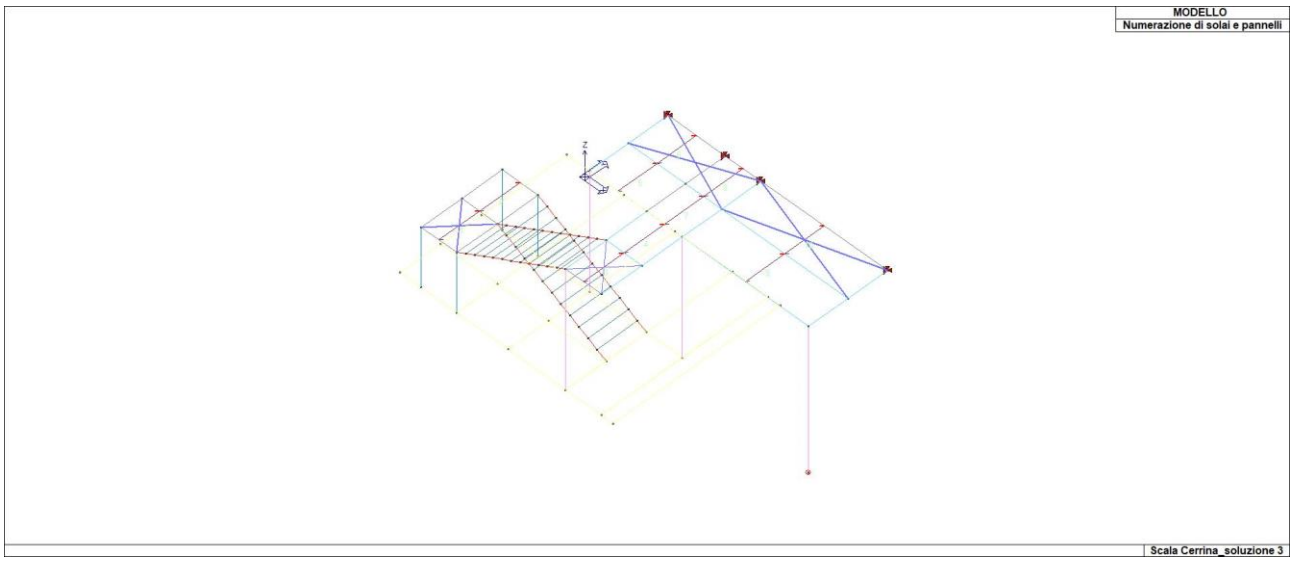
G1 Permanent loads
G2 Permanent non-structural loads
Q Variable loads and snow
Psi 0 Combination coefficient -(tab. 2.5.I NTC2018)-
Psi 1 Combination coefficient -(tab. 2.5.I NTC2018)-
Psi 2 Combination coefficient -(tab. 2.5.I NTC2018)-
Psi S 2 Combination coefficient which gives the Quasi Permanent value of the variable action Qi -(OPCM3274)-

1 - Carichi solaio

Per il solaio si adottano i seguenti carichi in daN/mq:

Permanente G1	Permanente G2	Variabile Q
450.0	100.0	200.0

Coefficienti di combinazione carichi variabili: $\psi 0 = 0.70$, $\psi 1 = 0.50$, $\psi 2 = 0.30$



3. SEISMIC ACTION.

Seismic action on buildings is evaluated from the "basic seismic hazard," under ideal conditions of a rigid reference site with a horizontal topographic surface.
The elastic acceleration response spectrum of the horizontal component of seismic motion, Se, is defined by the following expressions:

Where for subsoil category **A** the SS and CC coefficients are worth 1; while for subsoil categories **B**, **C**, **D**, **E** the SS and CC coefficients are calculated using the expressions given in the following Table:

Categoria sottosuolo	S_S	C_C
A	1,00	1,00
B	$1,00 \le 1,40 - 0,40 \cdot F_o \cdot \frac{a_g}{g} \le 1,20$	$1,10 \cdot (T_C^*)^{-0,20}$
C	$1,00 \le 1,70 - 0,60 \cdot F_o \cdot \frac{a_g}{g} \le 1,50$	$1,05 \cdot (T_C^*)^{-0,33}$
D	$0,90 \le 2,40 - 1,50 \cdot F_o \cdot \frac{a_g}{g} \le 1,80$	$1,25 \cdot (T_C^*)^{-0,50}$
E	$1,00 \le 2,00 - 1,10 \cdot F_o \cdot \frac{a_g}{g} \le 1,60$	$1,15 \cdot (T_C^*)^{-0,40}$

In order to take into account the topographical conditions and in the absence of specific local seismic response analyses, the values of the topographical coefficient S_T given in the following Table are used:

Categoria topografica	Ubicazione dell'opera o dell'intervento	S_T
T1	-	1,0
T2	In corrispondenza della sommità del pendio	1,2
T3	In corrispondenza della cresta di un rilievo con pendenza media minore o uguale a 30°	1,2
T4	In corrispondenza della cresta di un rilievo con pendenza media maggiore di 30°	1,4

The elastic acceleration response spectrum of the vertical component of seismic motion, Sve, is defined by the expressions:

$$0 \le T < T_B \qquad S_{ve}(T) = a_g \cdot S \cdot \eta \cdot F_v \cdot \left[\frac{T}{T_B} + \frac{1}{\eta \cdot F_o} \left(1 - \frac{T}{T_B} \right) \right]$$

$$T_B \le T < T_C \qquad S_{ve}(T) = a_g \cdot S \cdot \eta \cdot F_v$$

$$T_C \le T < T_D \qquad S_{ve}(T) = a_g \cdot S \cdot \eta \cdot F_v \cdot \left(\frac{T_C}{T} \right)$$

$$T_D \le T \qquad S_{ve}(T) = a_g \cdot S \cdot \eta \cdot F_v \cdot \left(\frac{T_C \cdot T_D}{T^2} \right)$$

The values of S_S, T_B, T_C and T_D, are given in the following Table:

Categoria di sottosuolo	S_S	T_B	T_C	T_D
A, B, C, D, E	1,0	0,05 s	0,15 s	1,0 s

The structure is located in:

Geolocation
Location CERRINA MONFERRATO (AL)
Municipality of CERRINA MONFERRATO (AL)
Region PIEMONTE
Longitude 8.215, Latitude 45.120 (Reference WGS84)

The seismic action is defined in relation to a reference period Vr which is obtained, for each type of construction, by multiplying its nominal life by the coefficient of use (see table Structure Parameters). Having fixed the reference period Vr and the probability of exceedance Pver associated with each of the limit states considered, the return period Tr and the relative seismic hazard parameters are obtained (see table below):
ag: maximum horizontal ground acceleration;
Fo: maximum value of the amplification factor of the spectrum in horizontal acceleration;
T*c: start period of the constant velocity section of the spectrum in horizontal acceleration;

Structure parameters						
Class of use	Life Vn	Use Coeff.	Period Vr	Soil type	Topographic category	Relative altitude
	[years]		[years]			[%]
III	50.0	1.5	75.0	C	T1	-

La risposta sismica locale (RSL) è definita come da NTC 2018 Tab. 3.2.II e Tab. 3.2.III

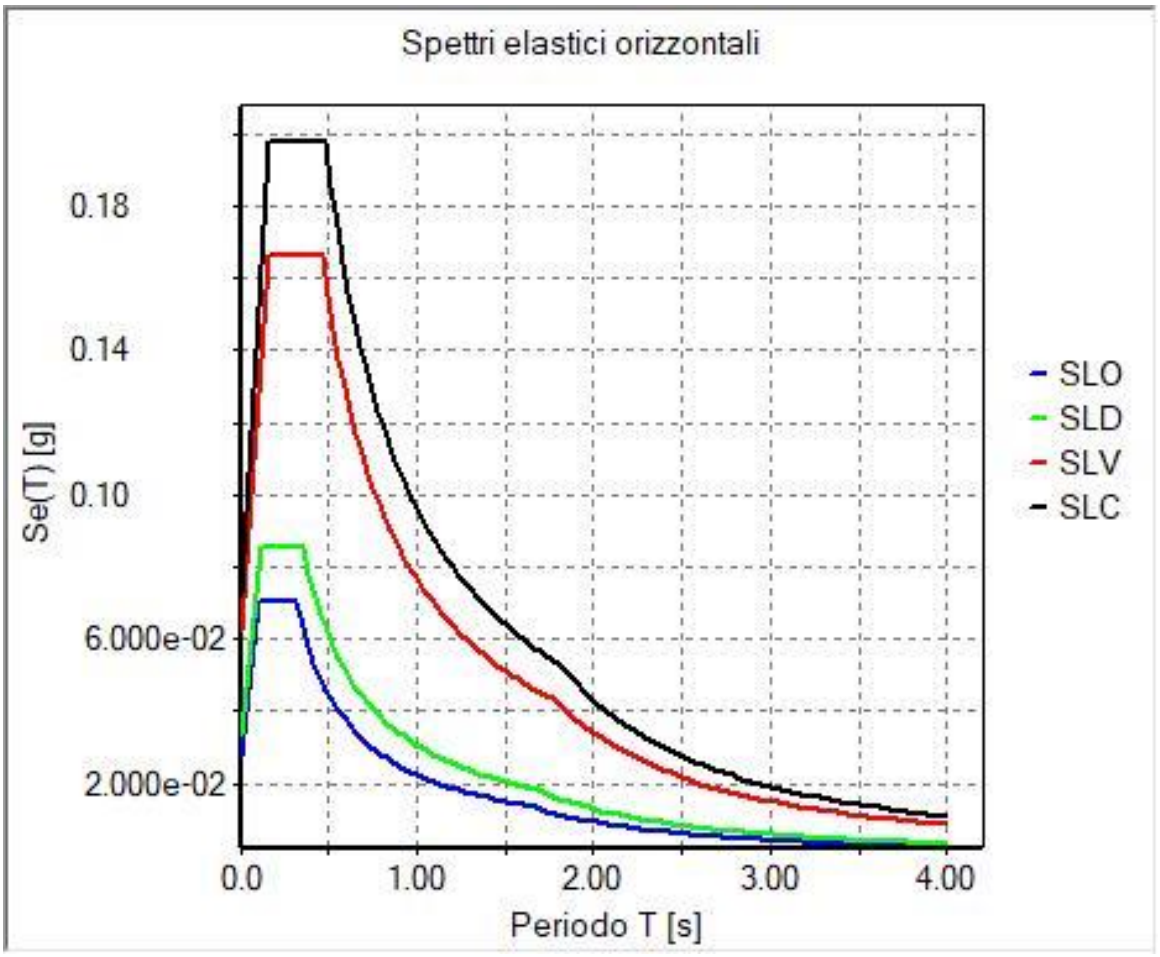
3.1 BEHAVIOUR FACTOR CALCULATION

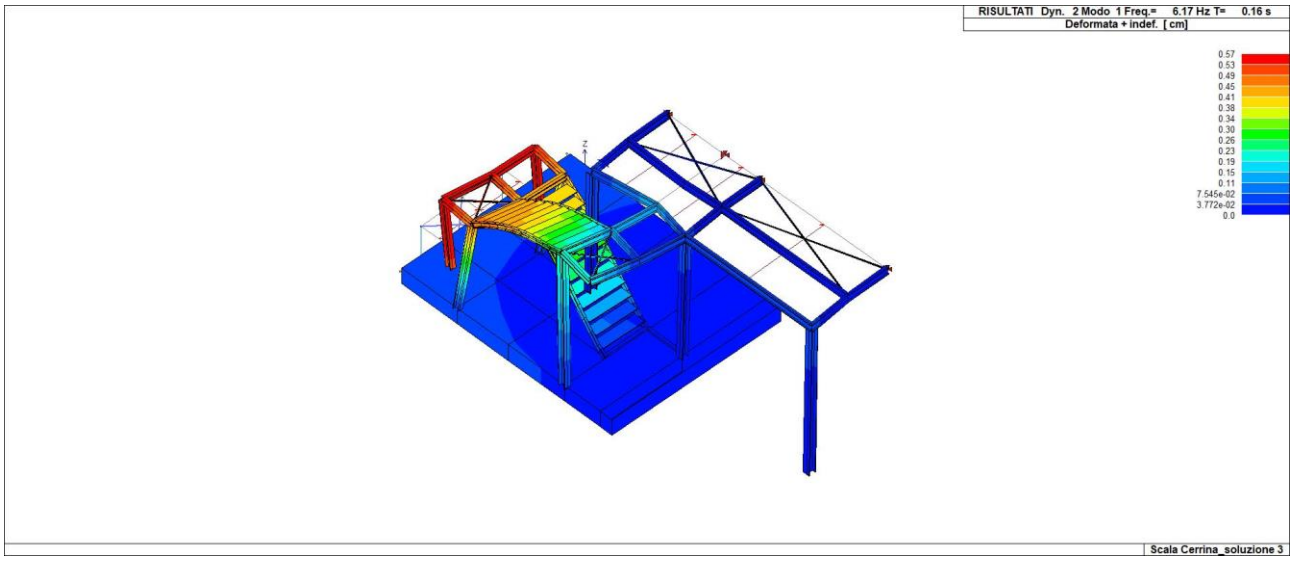
Main characteristics of the structures	
	SI
Work of new realization	SI
Regular structure in plan	SI
Ductility class	B media
Analysis for non-seismic loads	SI
Seismic analysis	Dinamica lineare
SLD strength verification	SI

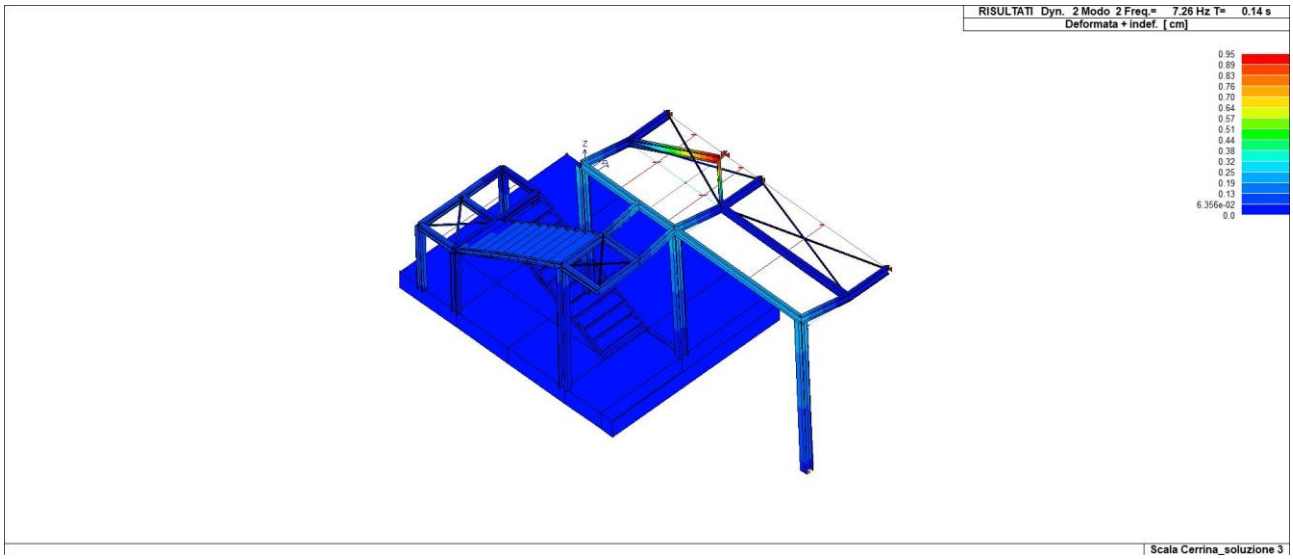
Behaviour factors use for SLU			
	Dissipativi	Verifiche fragili	Non Dissipativi
q SLU x	1.00	1.00	1.00
q SLU y	1.00	1.00	1.00
q SLU z	1.50	-	-

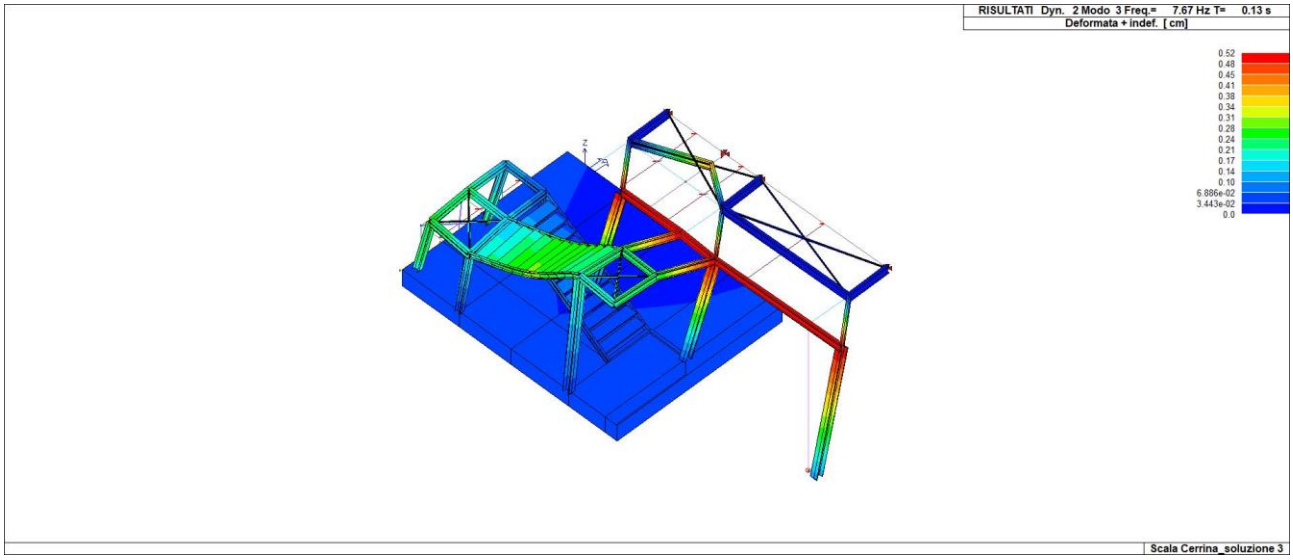
Behaviour factors use for SLD	
q SLD x	1.00
q SLD y	1.00
q SLD z	1.00
Eta SLO	1.00

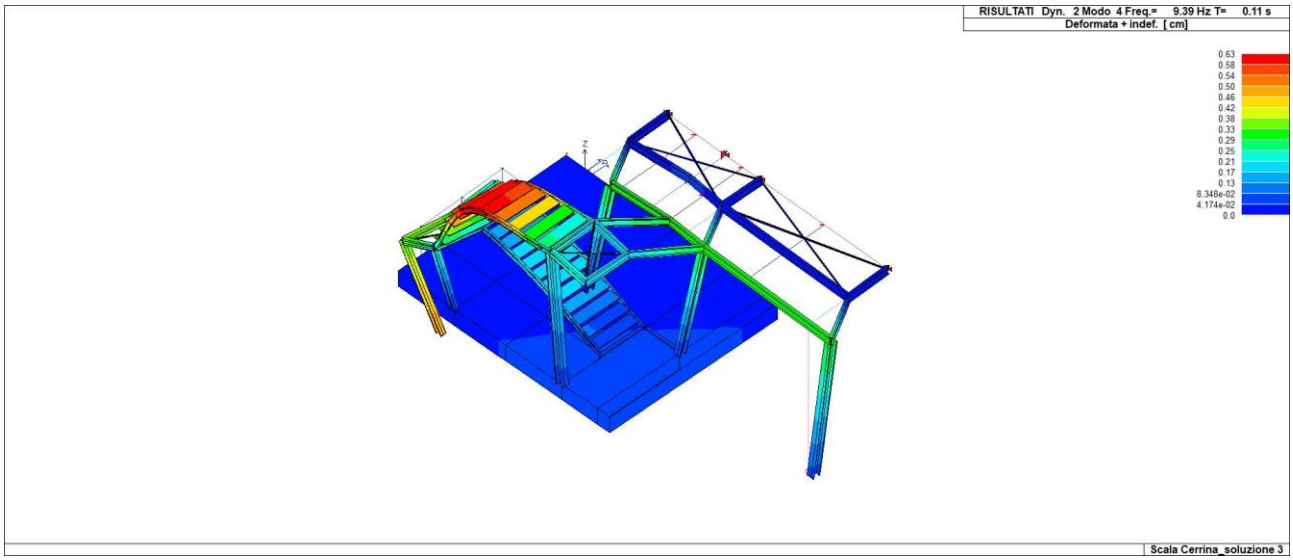
Si riportano di seguito, per completezza, le videate delle opzioni così come impostate nel programma:
Si riportano di seguito gli SPETTRI di input sismico e le caratteristiche dinamiche proprie della struttura, pertanto in assenza di eccentricità aggiuntive:

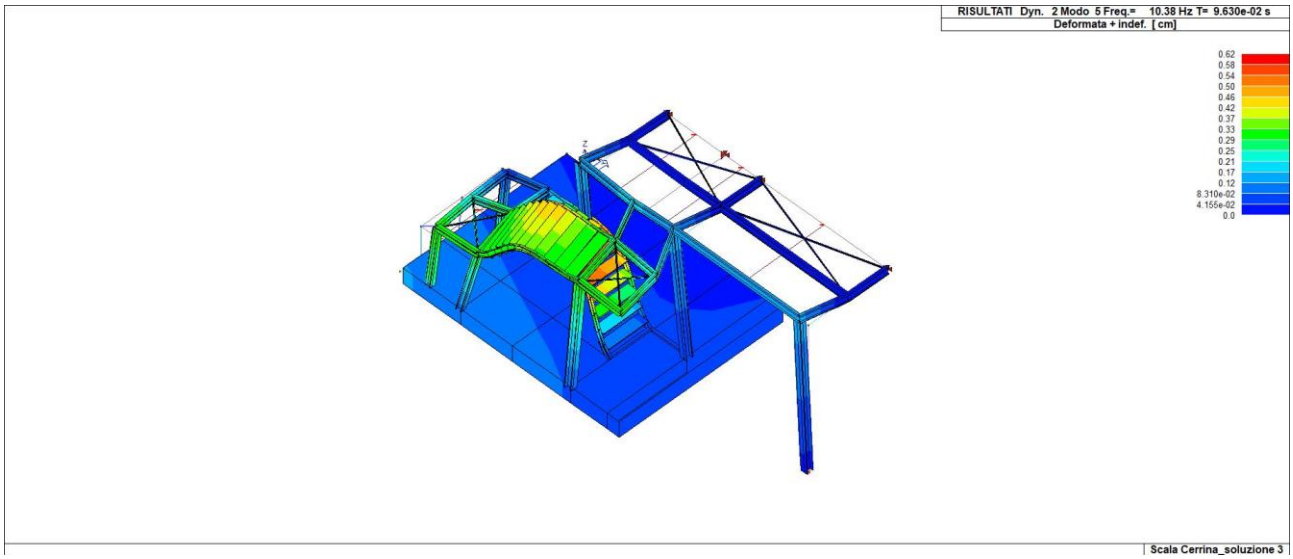

Spettri elastici orizzontali
0.18
0.14
0.10
6.000e-02
2.000e-02
Se(T) [g]
0.0
1.00
2.00
3.00
4.00
Periodo T [s]
SLO
SLD
SLV
SLC

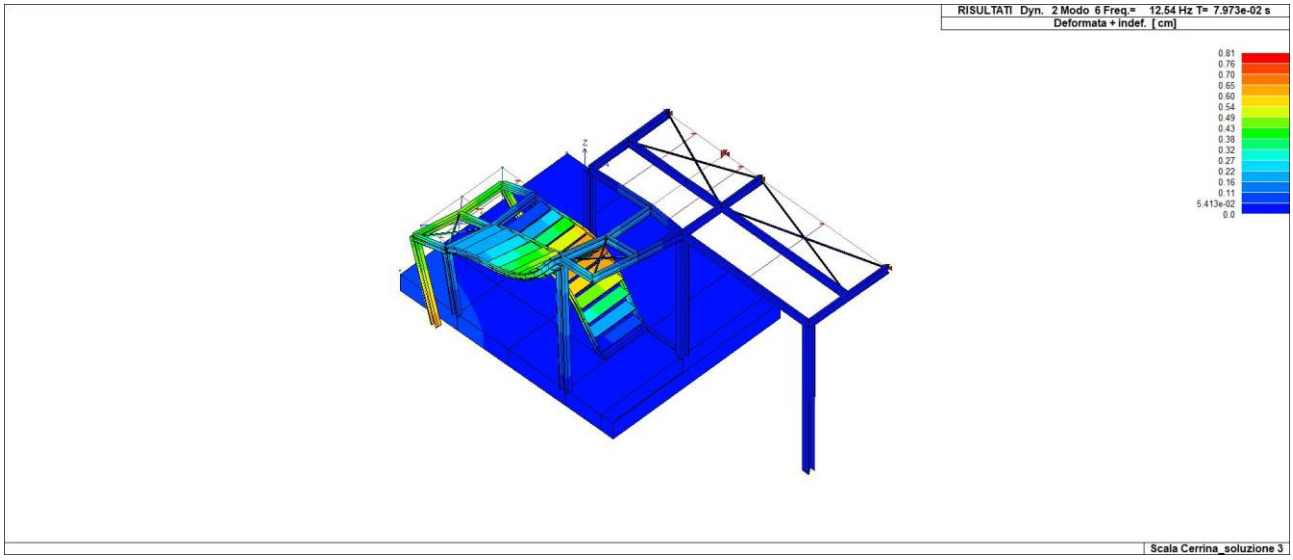

RISULTATI Dyn. 2 Modo 1 Freq.= 6.17 Hz T= 0.16 s
Deformata + indef. [cm]
0.57
0.53
0.49
0.45
0.41
0.38
0.34
0.30
0.26
0.23
0.19
0.15
0.11
7.545e-02
3.772e-02
0.0
Scala Cerrina_soluzione 3


RISULTATI Dyn. 2 Modo 2 Freq.= 7.26 Hz T= 0.14 s
Deformata + indef. [cm]
0.95
0.89
0.83
0.76
0.70
0.64
0.57
0.51
0.44
0.38
0.32
0.25
0.19
0.13
6.356e-02
0.0
Scala Cerrina_soluzione 3


RISULTATI Dyn. 2 Modo 3 Freq.= 7.67 Hz T= 0.13 s
Deformata + indef. [cm]
0.52
0.48
0.45
0.41
0.38
0.34
0.31
0.28
0.24
0.21
0.17
0.14
0.10
6.886e-02
3.443e-02
0.0
Scala Cerrina_soluzione 3


RISULTATI Dyn. 2 Modo 4 Freq.= 9.39 Hz T= 0.11 s
Deformata + indef. [cm]
0.63
0.58
0.54
0.50
0.46
0.42
0.38
0.33
0.29
0.25
0.21
0.17
0.13
8.348e-02
4.174e-02
0.0
Scala Cerrina_soluzione 3





ANALISI_MODALE_NO_ECCENTRICITA

Modo	Frequenza	Periodo	X M efficace x g	%	Y M efficace x g	%	Z M efficace x g	%	RZ M efficace x g	%
-	Hz	sec	kN	-	kN	-	kN	-	kN m2	-
1	6.17	0.16	1.7	1	56.8	44	0.2	0	5.57e-02	49
2	7.26	0.14	8.0	6	8.2	6	1.40e-02	0	5.67e-04	0
3	7.67	0.13	50.8	39	4.0	3	0.1	0	2.24e-03	2
4	9.39	0.11	1.7	1	3.6	2	9.4	7	4.86e-04	0
5	10.38	0.10	11.4	8	0.5	0	37.0	28	2.10e-03	1
6	12.54	0.08	0.7	0	3.63e-02	0	1.8	1	2.80e-05	0

SCHEMATIZATION OF LOAD CASES

It is possible to define load cases by choosing from the twelve types listed in the table below:

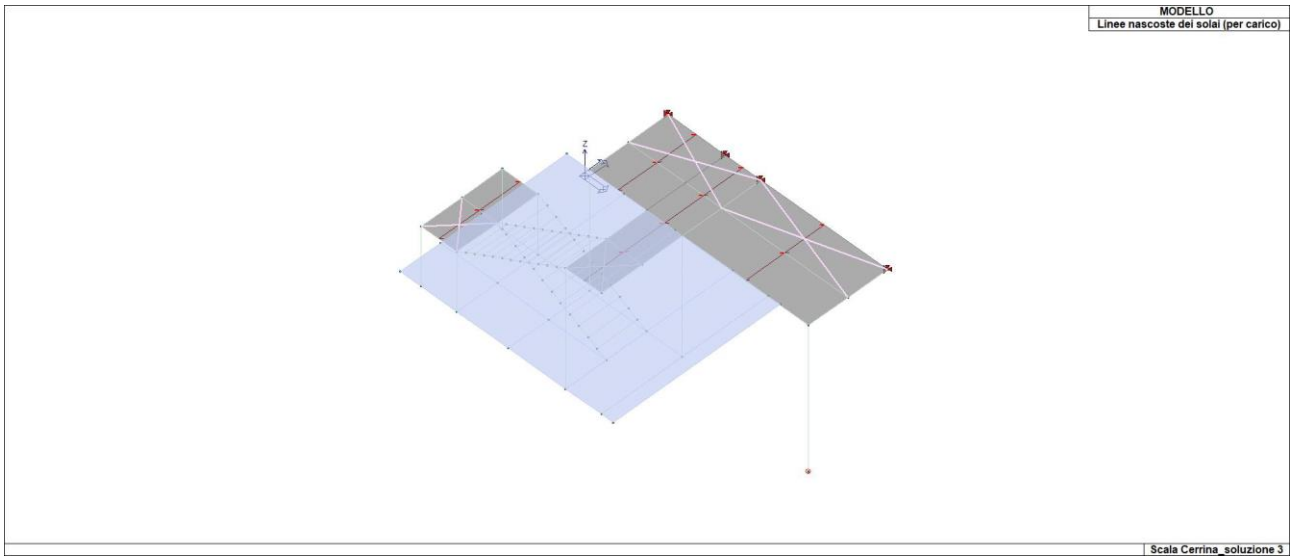
	CDC type	Description
1	Ggk	case of load including structure's own weight
2	Gk	load case with permanent actions
3	Qk	load case with variable actions
4	Gsk	load case including permanent loads on floors and roofs
5	Qsk	load case including variable loads on floors and roofs
6	Qnk	load case including snow loads on roofs
7	Qtk	load case including a thermal variation acting on the structure
8	Qvk	load case including wind loads on the structure
9	Esk	seismic loads case with equivalent static analysis

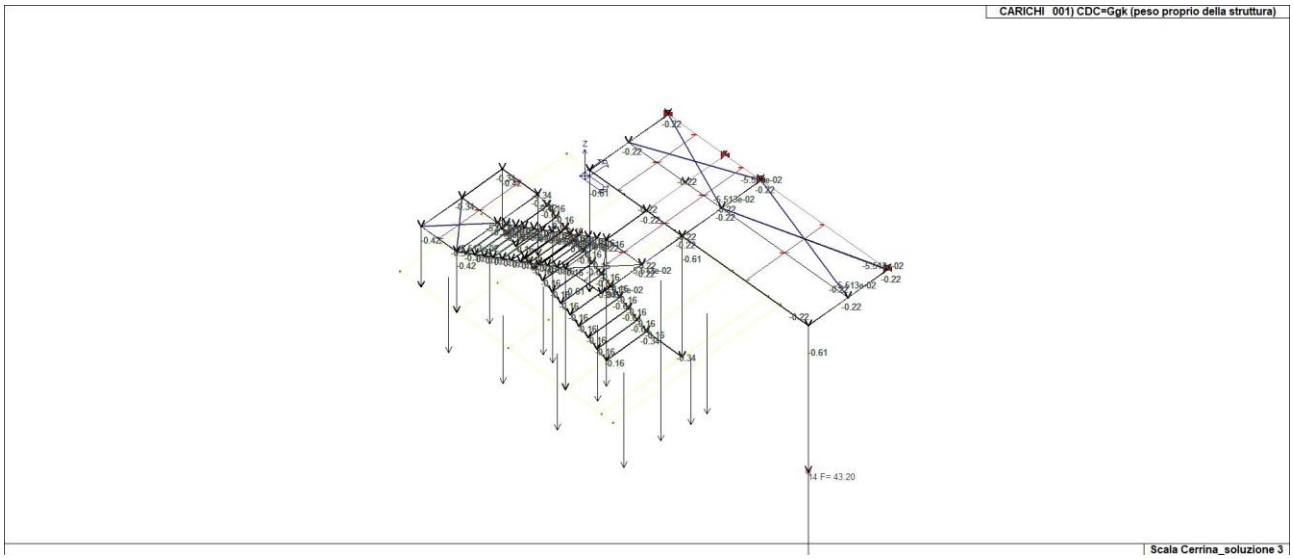
10	Edk	seismic loads case with dynamic analysis
11	Etk	load case including actions deriving from an increase in the earth's thrust in a seismic condition
12	Pk	load case including actions deriving from compression, subsidence and prestress

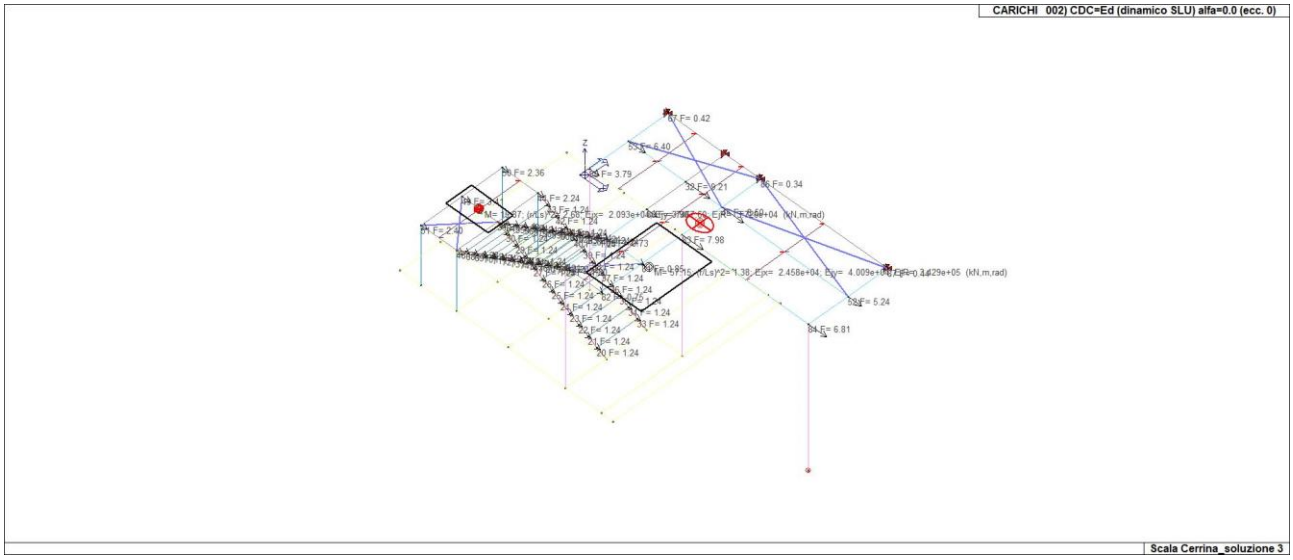
The load cases used in the modeling covered in this report are as follows:

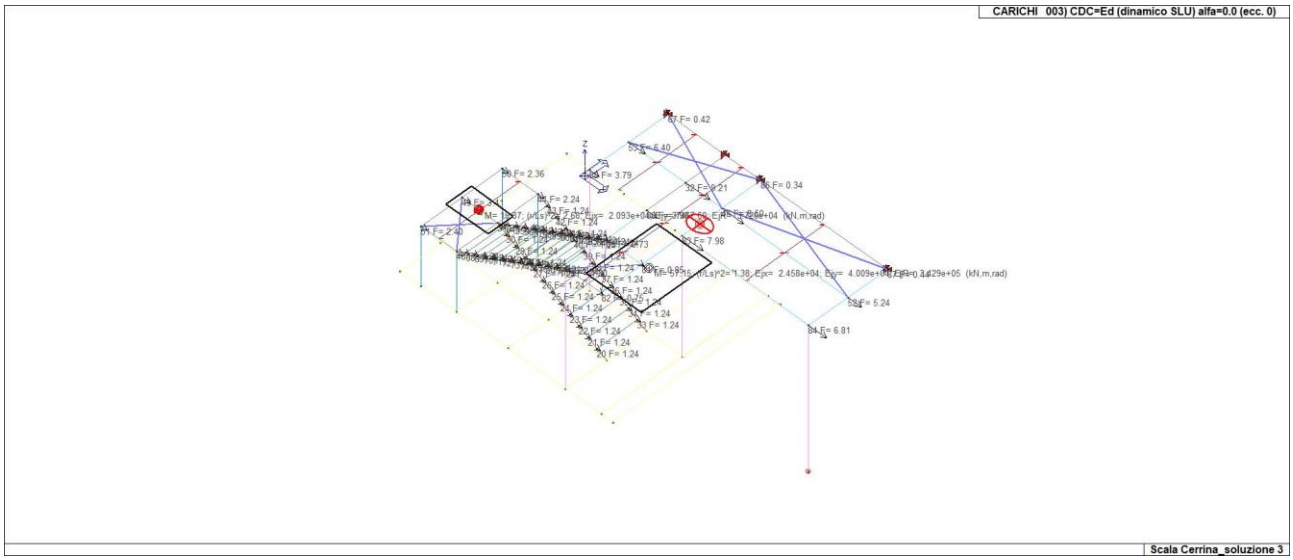
TABELLA_CASI_DI_CARICO

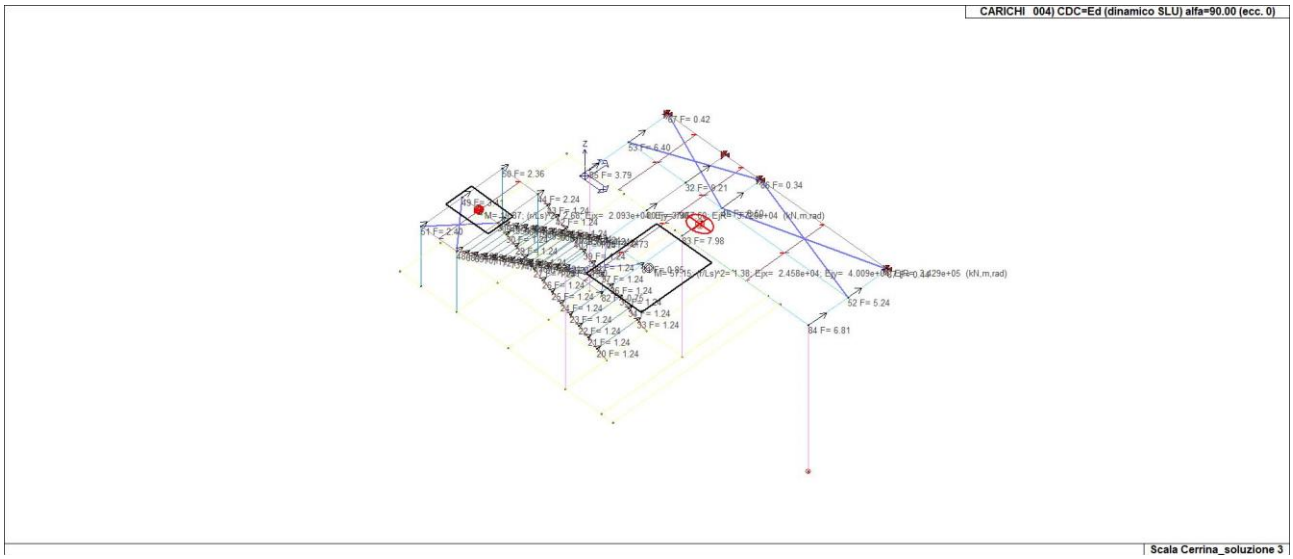
CDC	Tipo CDC	Sigla Id	Note
1	Ggk	CDC=Ggk (peso proprio della struttura)	
2	Edk	CDC=Ed (dinamico SLU) alfa=0.0 (ecc. 0)	
3	Edk	CDC=Ed (dinamico SLU) alfa=0.0 (ecc. 0)	
4	Edk	CDC=Ed (dinamico SLU) alfa=90.00 (ecc. 0)	
5	Edk	CDC=Ed (dinamico SLU) alfa=90.00 (ecc. 0)	
6	Edk	CDC=Ed (dinamico SLD) alfa=0.0 (ecc. 0)	
7	Edk	CDC=Ed (dinamico SLD) alfa=0.0 (ecc. 0)	
8	Edk	CDC=Ed (dinamico SLD) alfa=90.00 (ecc. 0)	
9	Edk	CDC=Ed (dinamico SLD) alfa=90.00 (ecc. 0)	
10	Qnk	CDC=Qnk (carico da neve)	
11	Qvk	CDC=Qvk (carico da vento) .....SINISTRA DESTRA	
12	Qk	CDC=Qk (variabile generico) .....CARICO VARIABILE SCALE	
13	Esk	CDC=Es (statico SLU) alfa=0.0 (ecc. C)	
14	Qvk	CDC=Qvk (carico da vento) .....DESTRA SINISTRA	
15	Qvk	CDC=Qvk (carico da vento) .....ALTO BASSO	
16	Qvk	CDC=Qvk (carico da vento) .....BASSO ALTO	
17	Gk	CDC=G1k (permanente generico) .....CORRIMANO E RINGHIERA	
18	Qk	CDC=Qk (variabile generico) .....SPINTA CORRIMANO LUNGO X	
19	Qk	CDC=Qk (variabile generico) .....SPINTA CORRIMANO LUNGO Y	

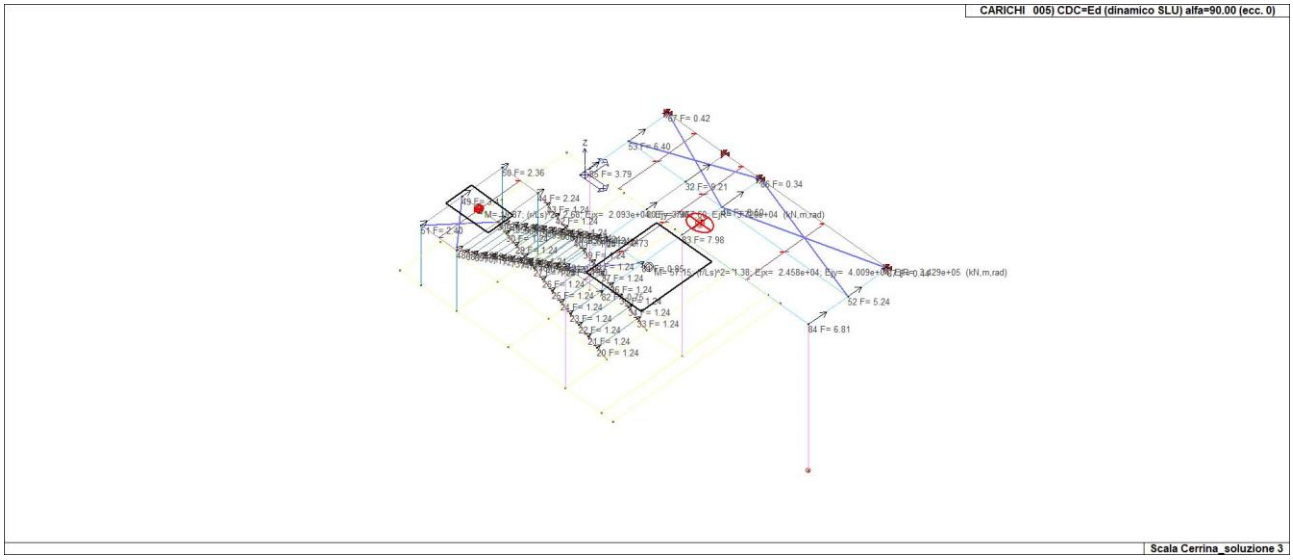


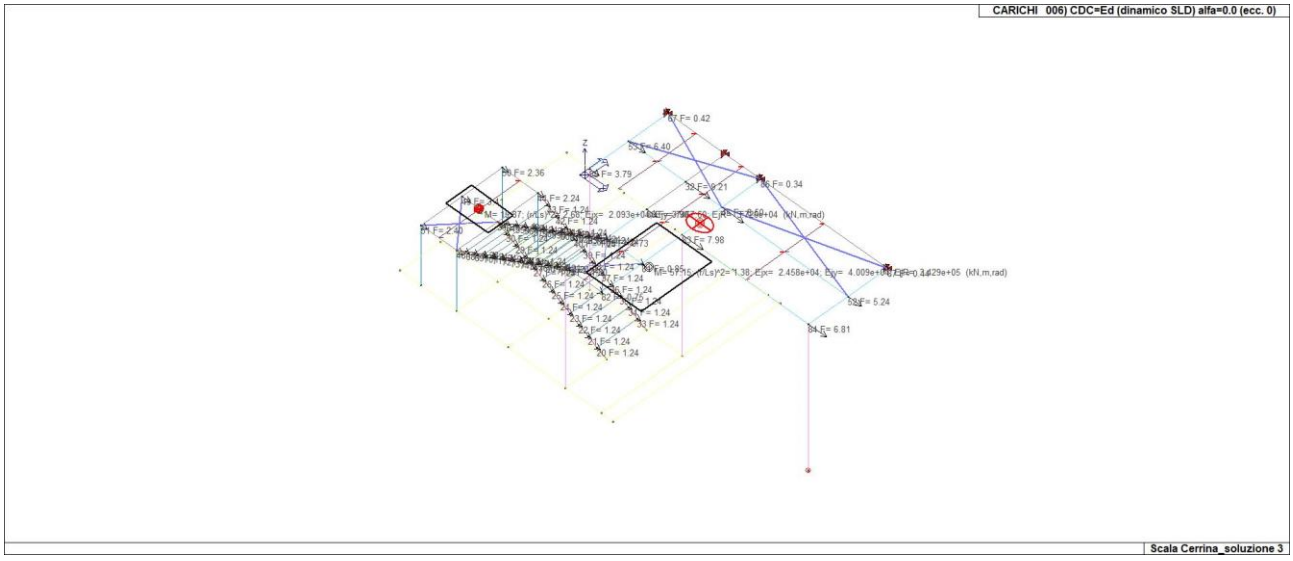

CARICHI 001) CDC=Ggk (peso proprio della struttura)
-0.22
-0.61
-0.42
-0.34
-0.16
14 F= 43.20
Scala Cerrina_soluzione 3

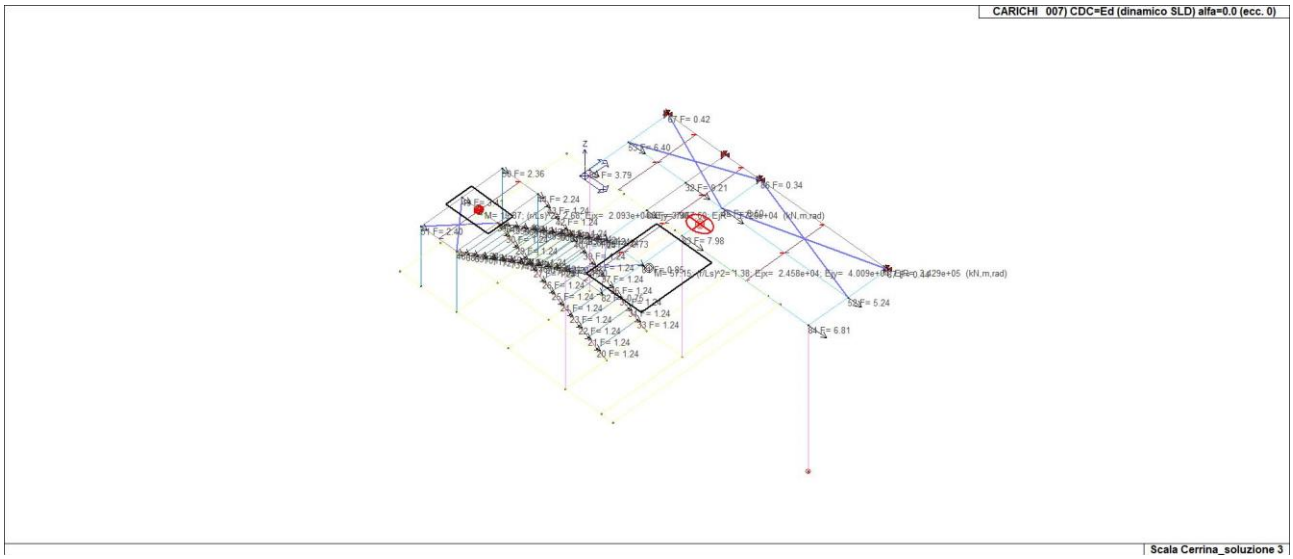

CARICHI 002) CDC=Ed (dinamico SLU) alfa=0.0 (ecc. 0)
37 F= 0.42
36 F= 2.36
35 F= 3.79
33 F= 2.21
26 F= 0.34
34 F= 2.24
32 F= 7.98
31 F= 2.40
30 F= 1.24
29 F= 1.24
28 F= 1.24
27 F= 1.24
25 F= 1.24
24 F= 1.24
23 F= 1.24
22 F= 1.24
21 F= 1.24
20 F= 1.24
33 F= 5.24
34 F= 6.81
Scala Cerrina_soluzione 3

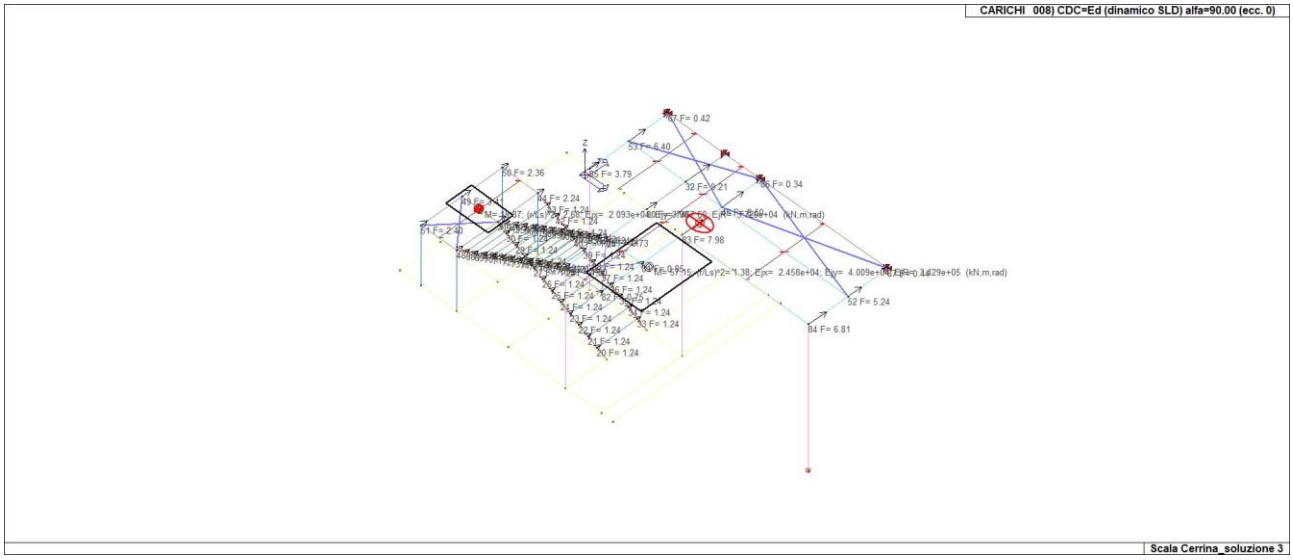

CARICHI 003) CDC=Ed (dinamico SLU) alfa=0.0 (ecc. 0)
37 F= 0.42
36 F= 2.36
35 F= 3.79
33 F= 2.21
26 F= 0.34
34 F= 2.24
32 F= 7.98
31 F= 2.40
33 F= 5.24
34 F= 6.81
Scala Cerrina_soluzione 3

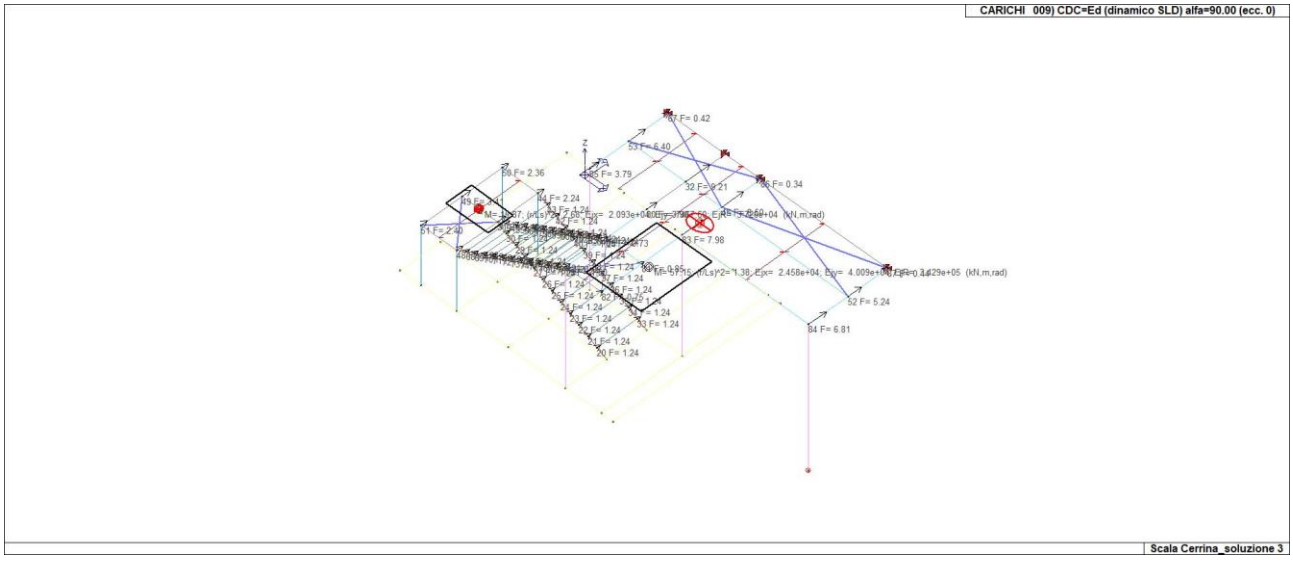

CARICHI 004) CDC=Ed (dinamico SLU) alfa=90.00 (ecc. 0)
Scala Cerrina_soluzione 3


CARICHI 005) CDC=Ed (dinamico SLU) alfa=90.00 (ecc. 0)
Scala Cerrina_soluzione 3

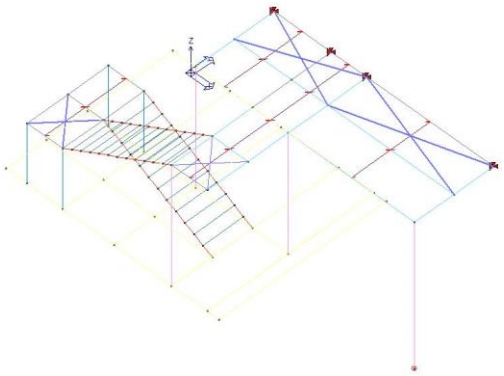

CARICHI 006) CDC=Ed (dinamico SLD) alfa=0.0 (ecc. 0)
Scala Cerrina_soluzione 3


CARICHI 007) CDC=Ed (dinamico SLD) alfa=0.0 (ecc. 0)
Scala Cerrina_soluzione 3


CARICHI 008) CDC=Ed (dinamico SLD) alfa=90.00 (ecc. 0)
Scala Cerrina_soluzione 3

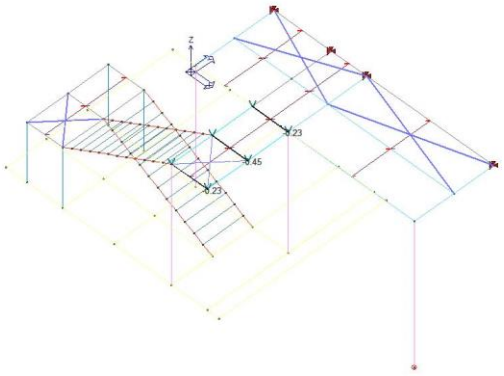

CARICHI 009) CDC=Ed (dinamico SLD) alfa=90.00 (ecc. 0)
Scala Cerrina_soluzione 3

CARICHI 010) CDC=Qnk (carico da neve)



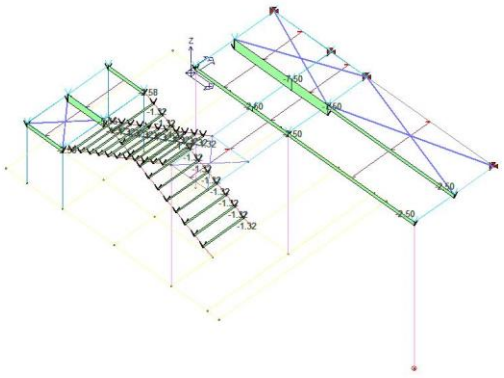
Scala Cerrina_soluzione 3

CARICHI 011) CDC=Qvk (carico da vento) .....SINISTRA DESTRA



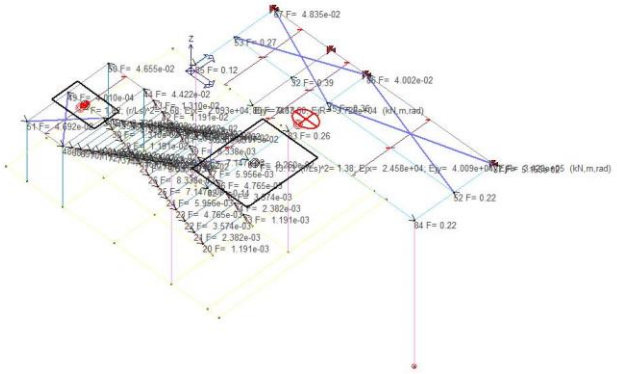
Scala Cerrina_soluzione 3

CARICHI 012) CDC=Qk (variabile generico) .....CARICO VARIABILE SCALE



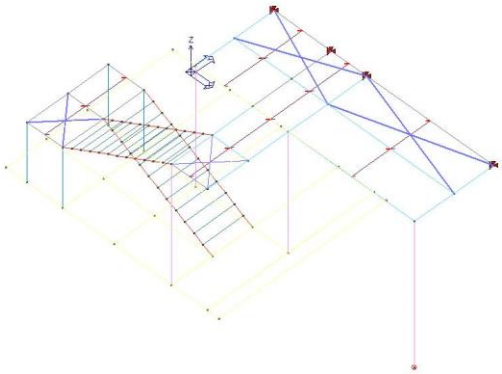
Scala Cerrina_soluzione 3

CARICHI 013) CDC=Es (statico SLU) alfa=0.0 (ecc. C)



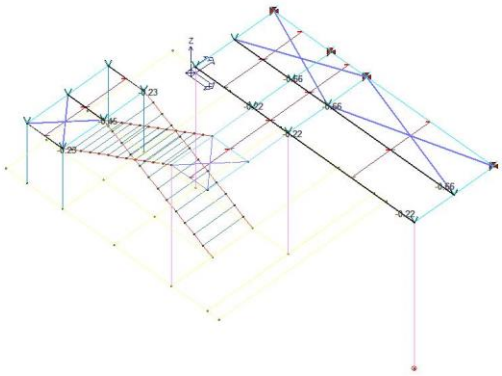
Scala Cerrina_soluzione 3

CARICHI 014) CDC=Qvk (carico da vento) .....DESTRA SINISTRA



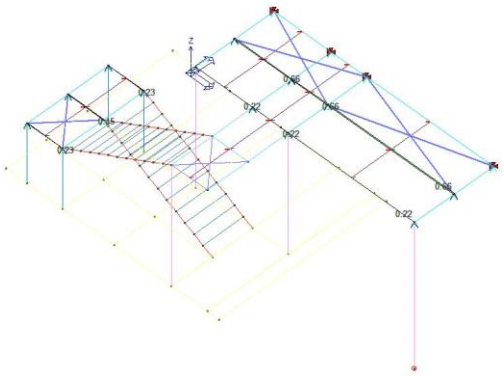
Scala Cerrina_soluzione 3

CARICHI 015) CDC=Qvk (carico da vento) .....ALTO BASSO



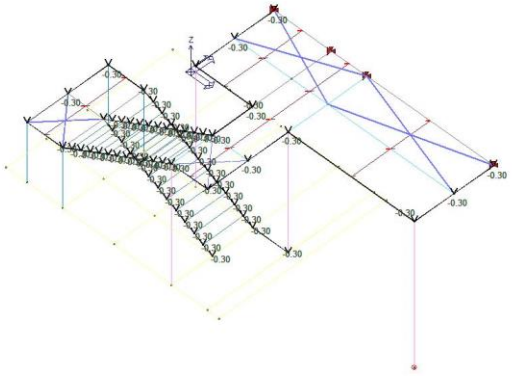
Scala Cerrina_soluzione 3

CARICHI 016) CDC=Qvk (carico da vento) .....BASSO ALTO



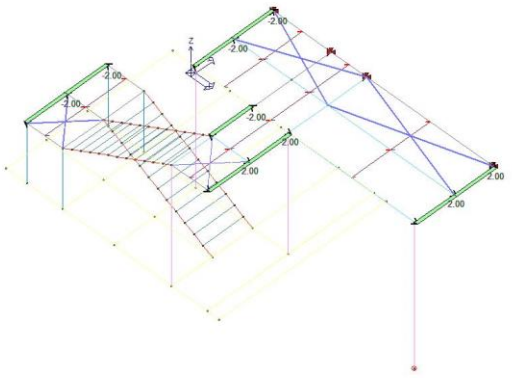
Scala Cerrina_soluzione 3

CARICHI 017) CDC=G1k (permanente generico) .....CORRIMANO E RINGHIERA

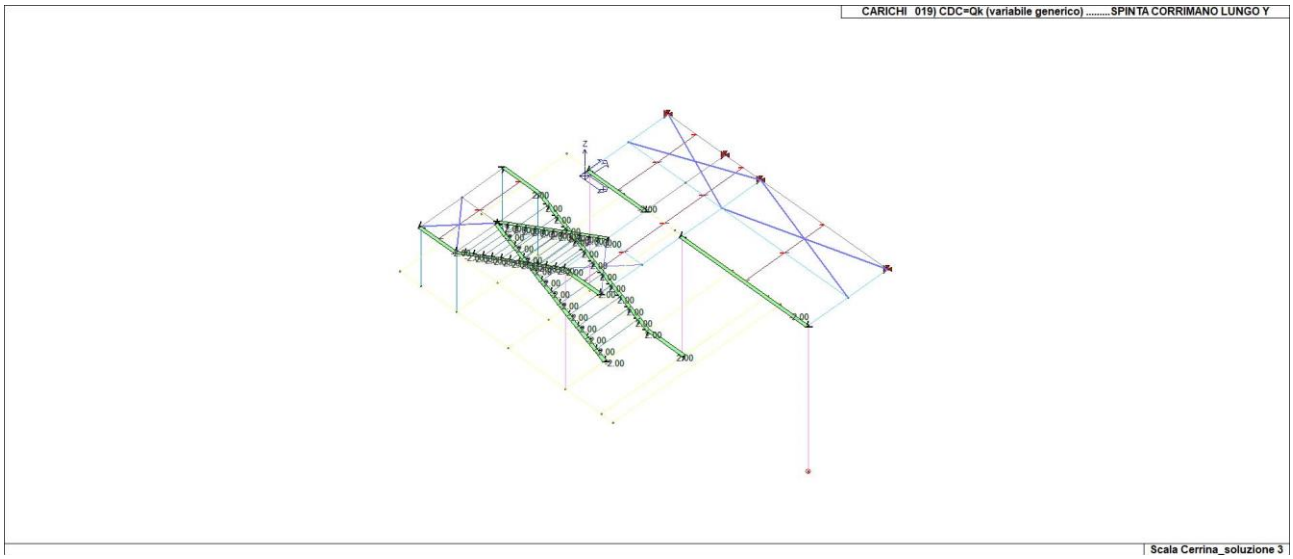


Scala Cerrina_soluzione 3

CARICHI 018) CDC=Qk (variabile generico) .....SPINTA CORRIMANO LUNGO X



Scala Cerrina_soluzione 3


CARICHI 019) CDC=Qk (variabile generico) .....SPINTA CORRIMANO LUNGO Y
Scala Cerrina_soluzione 3

4. DEFINITION OF COMBINATIONS

The combinations provided for the different load cases (CDCs) follow the rules laid down in the current Standard and are intended for safety control of the structure and verification of displacements and stresses.

For the purpose of limit state verifications, the following combinations of actions are defined:

SLU fundamental combination

$\gamma G1 \cdot G_1 + \gamma G2 \cdot G2 + \gamma P \cdot P + \gamma Q1 \cdot Qk1 + \gamma Q2 \cdot \psi 0_2 \cdot Qk2 + \gamma Q3 \cdot \psi 03 \cdot Qk3 + \ldots$

Characteristic combination (rare) SLE

$G_1 + G2 + P + Qk1 + \psi 02 \cdot Qk2 + \psi 03 \cdot Qk3 + \ldots$

Frequent combination SLE

$G_1 + G2 + P + \psi 11 \cdot Qk1 + \psi 22 \cdot Qk2 + \psi 23 \cdot Qk3 + \ldots$

Almost permanent combination SLE

$G_1 + G2 + P + \psi 21 \cdot Qk1 + \psi 22 \cdot Qk2 + \psi 23 \cdot Qk3 + \ldots$

Seismic combination, used for ultimate and serviceability limit states related to seismic action E

$E + G_1 + G2 + P + \psi 21 \cdot Qk1 + \psi 22 \cdot Qk2 + \psi 23 \cdot Qk3 + \ldots$

Exceptional combination, used for limit states related to exceptional actions

$A_d + G_1 + G2 + P + \psi 21 \cdot Qk1 + \psi 22 \cdot Qk2 + \psi 23 \cdot Qk3 + \ldots$

Where:

NTC 2018 Table 2.5.I

Intended use	ψ_0	ψ_1	ψ_2
Category A residential	0,70	0,50	0,30
Category B office	0,70	0,50	0,30
Category C crowded rooms	0,70	0,70	0,60
Category D rooms for commercial use	0,70	0,70	0,60
Category E libraries, archives, storerooms...	1,00	0,90	0,80
Category F Rgarages anc car parks (vehicles <= 30kN)	0,70	0,70	0,60
Category G garaging and parking (vehicles > 30kN)	0,70	0,50	0,30
Category H Roofs	0,00	0,00	0,00
Wind	0,60	0,20	0,00
Snow height <= 1000 m	0,50	0,20	0,00
Snow height > 1000 m	0,70	0,50	0,20
Thermal variations	0,60	0,50	0,00

Two different design approaches may alternatively be adopted in the verifications:
- for approach 1, two different combinations of groups of partial safety coefficients for actions, for materials and for overall resistance are considered (combination 1 with A1 coefficients and combination 2 with A2 coefficients),
- for approach 2, a single combination is defined for actions, for material strength and for global strength (with A1 coefficients).

NTC 2018 Table 2.6.I

		Coefficient γ_F	EQU	A1	A2
Permanent loads	Favourable Unfavourable	γG1	0,9 1,1	1,0 1,3	1,0 1,0
Non-structural permanent loads (Not fully defined)	Favourable Unfavourable	γG2	0,8 1,5	0,8 1,5	0,8 1,3
Variable loads	Favourable Unfavourable	γQi	0,0 1,5	0,0 1,5	0,0 1,3

4.1 TYPE OF ANALYSIS PERFORMED

Type of structural analysis	
Analysis for non-seismic loads	SI
Linear static seismic	SI
Linear dynamic seismic	SI
Non-linear static seismic (triangular; G1 – a §7.3.3.2)	NO
Non-linear static seismic (prop. mode; G1 – b §7.3.4.2)	NO
Non-linear static seismic (prop. plan cuts; G1 – c §7.3.4.2)	NO
Non-linear static seismic (prop. masses; G2 – a §7.3.4.2)	NO
Non-linear static seismic (multimod; G2 – c §7.3.4.2)	NO
Geometric nonlinearities (P delta factor)	NO

4.2 COMBINATIONS AND/OR LOAD PATHS

Load case combinations	
DESIGN APPROACH	Approccio 2
SLU	SI
SLV (SLU with earthquake)	SI
SLC	NO
SLD	SI
SLO	NO
SLU GEO A2 (for approach 1)	NO
SLU EQU	NO
Characteristic combination (rare)	SI
Frequent combination	SI
Almost permanent combination (SLE)	SI
SLA (accidental as fire)	SI

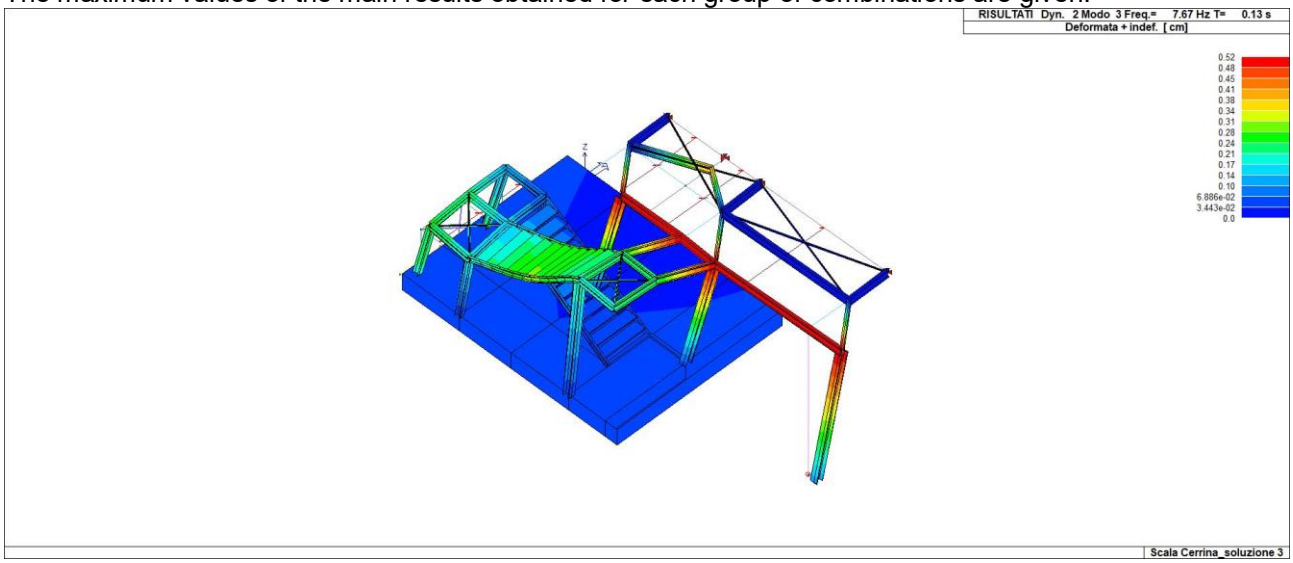
TABELLA_COMBINAZIONI

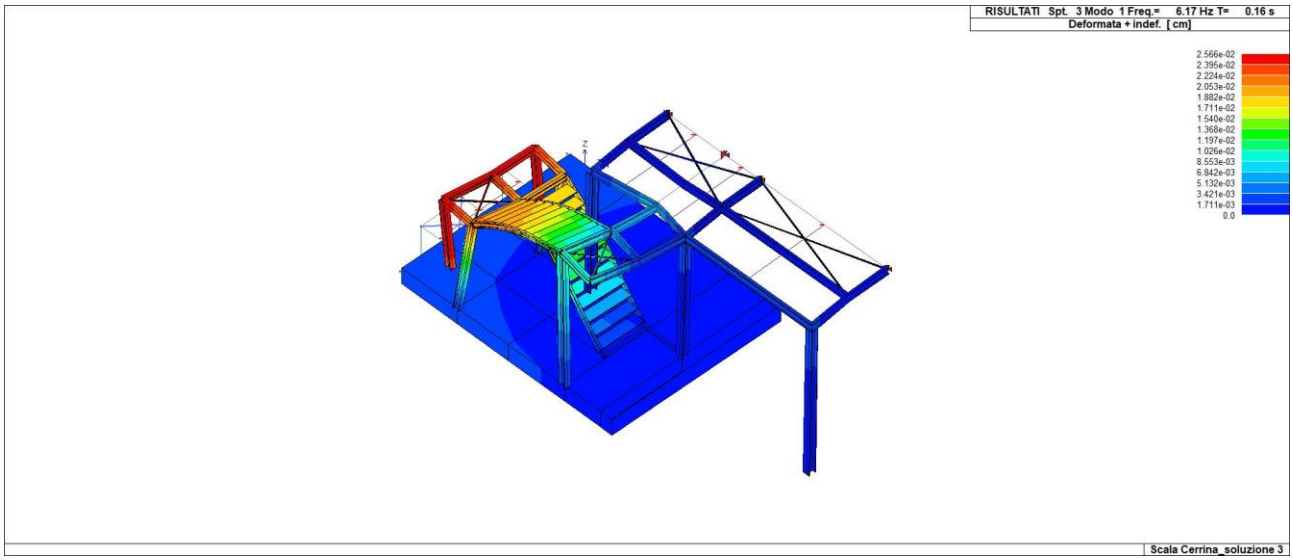
Tipo CMB	**Da**	**Da**	**A**	**A**
-	**Id**	**Nome**	**Id**	**Nome**
SLU	1	Comb. SLU A1 1	32	Comb. SLU A1 32
SLV	33	Comb. SLU A1 (SLV sism.) 33	64	Comb. SLU A1 (SLV sism.) 64
SLD	65	Comb. SLE (SLD Danno sism.) 65	96	Comb. SLE (SLD Danno sism.) 96
SL eccezionale	97	Comb. SLU (Accid.) 97	98	Comb. SLU (Accid.) 98
SLE rara	99	Comb. SLE(rara) 99	114	Comb. SLE(rara) 114
SLE frequente	115	Comb. SLE(freq.) 115	119	Comb. SLE(freq.) 119
SLE quasi permanente	120	Comb. SLE(perm.) 120	121	Comb. SLE(perm.) 121

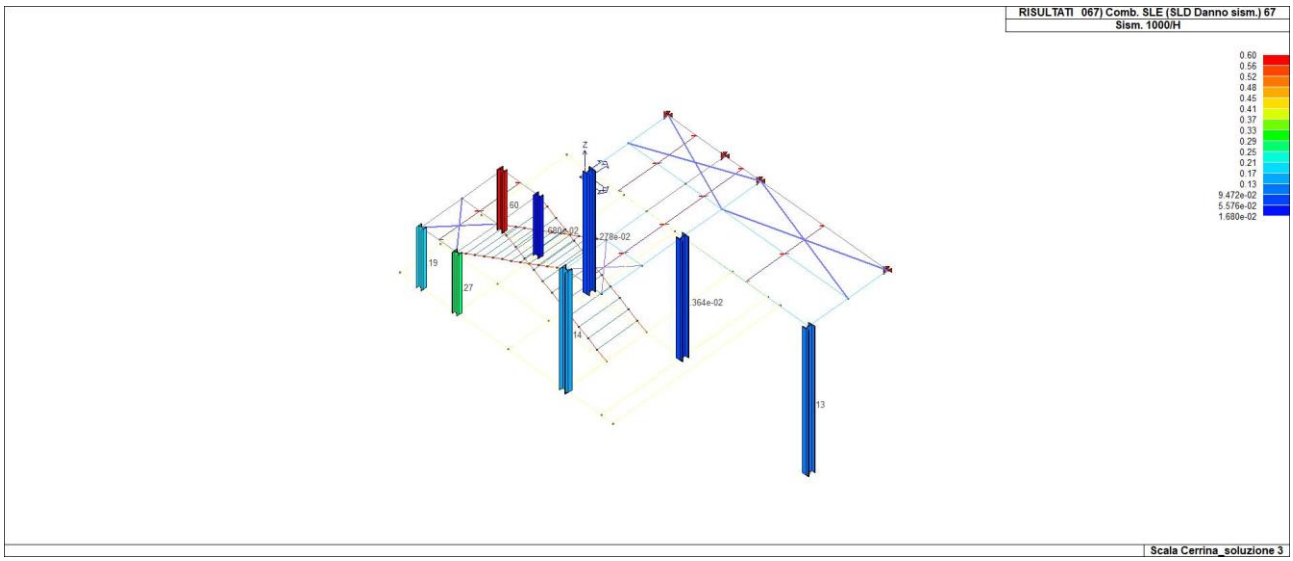
Si riportano di seguito, per completezza, le videate delle opzioni così come impostate nel programma:

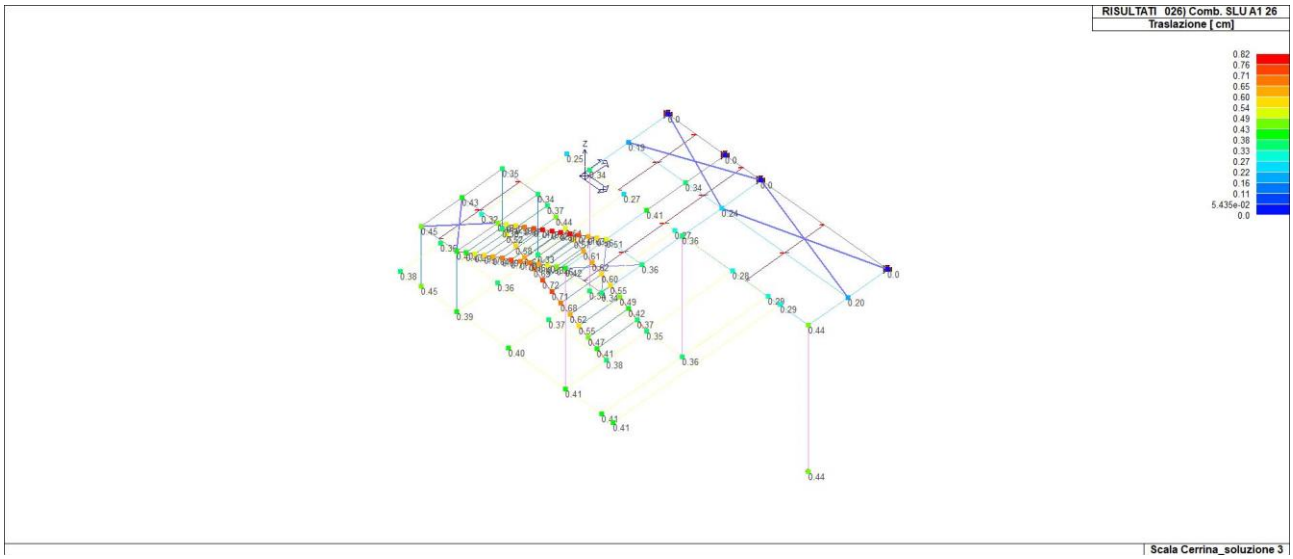
5. MAIN RESULTS

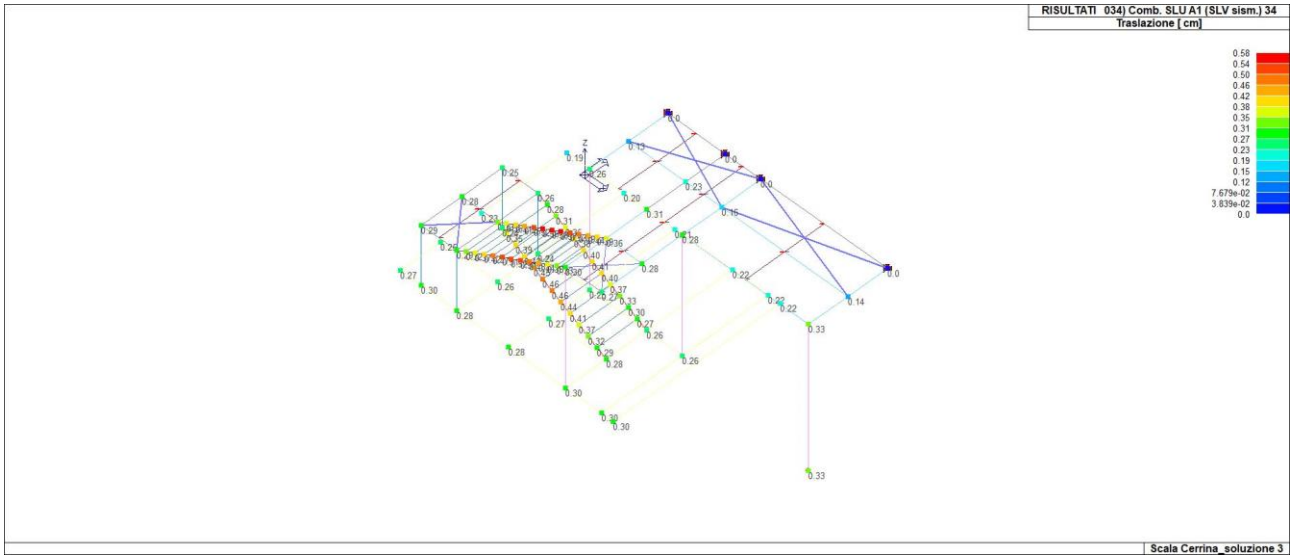
The maximum values of the main results obtained for each group of combinations are given:

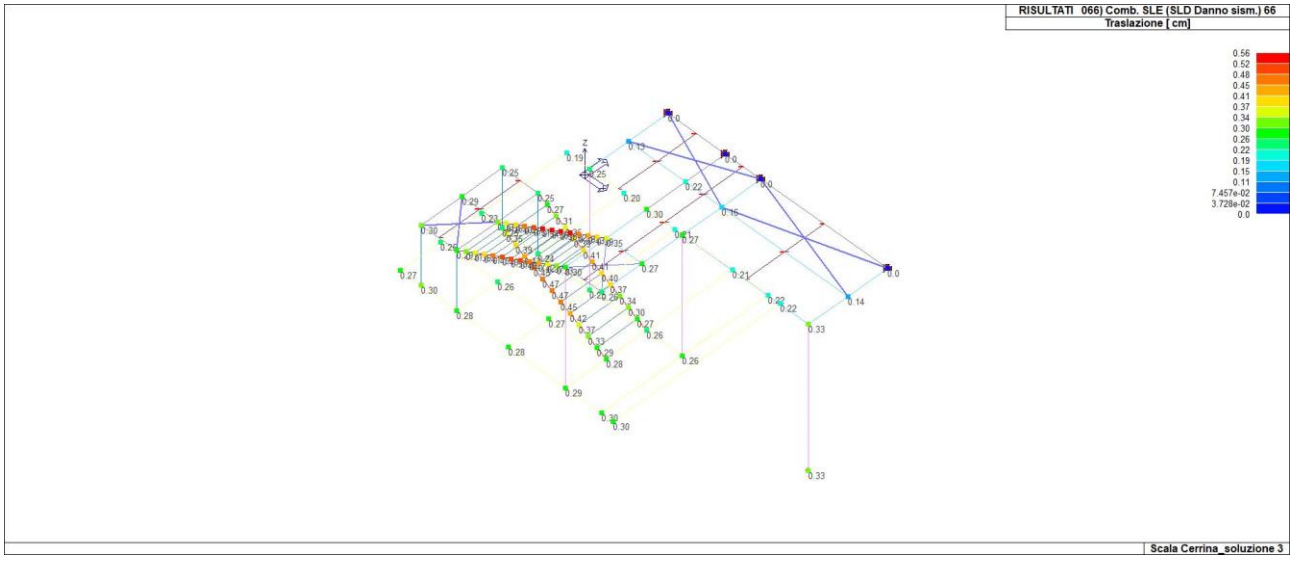


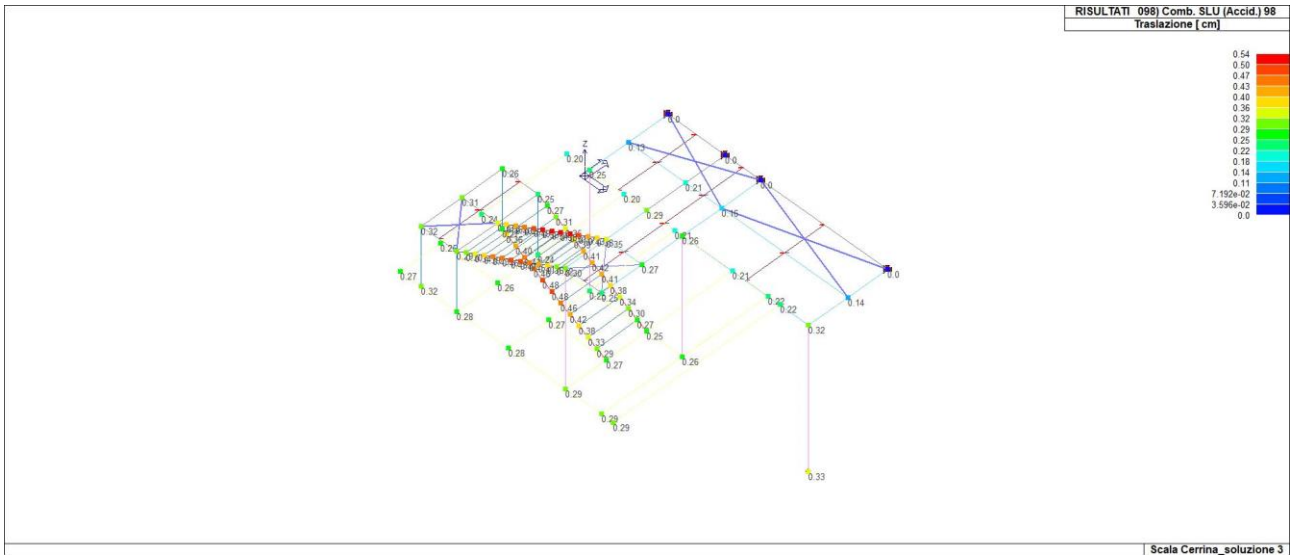


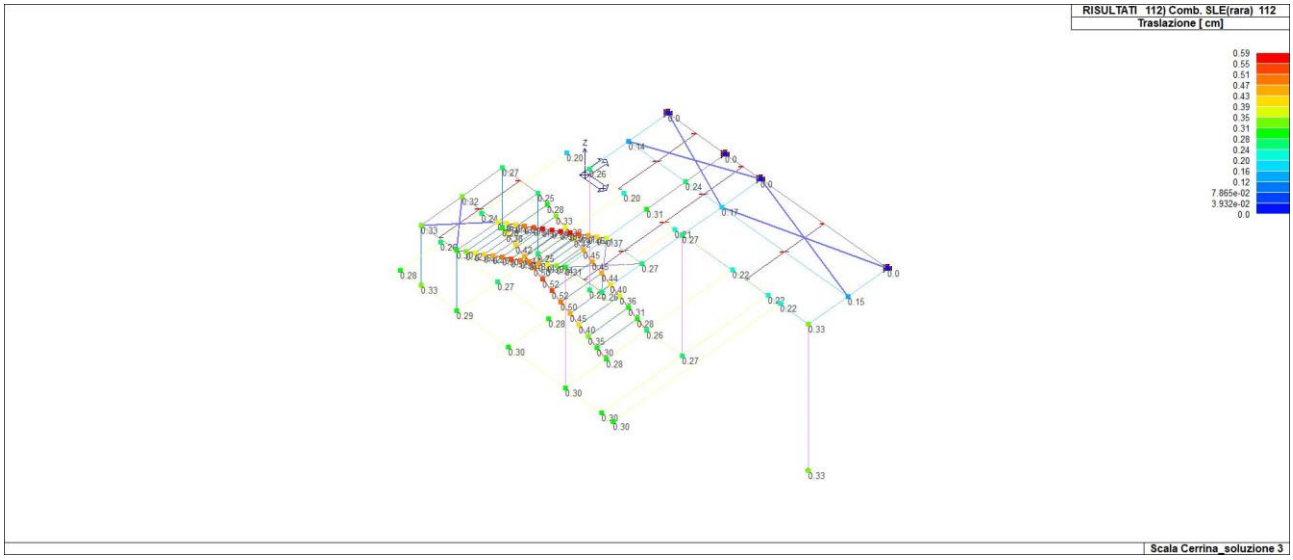


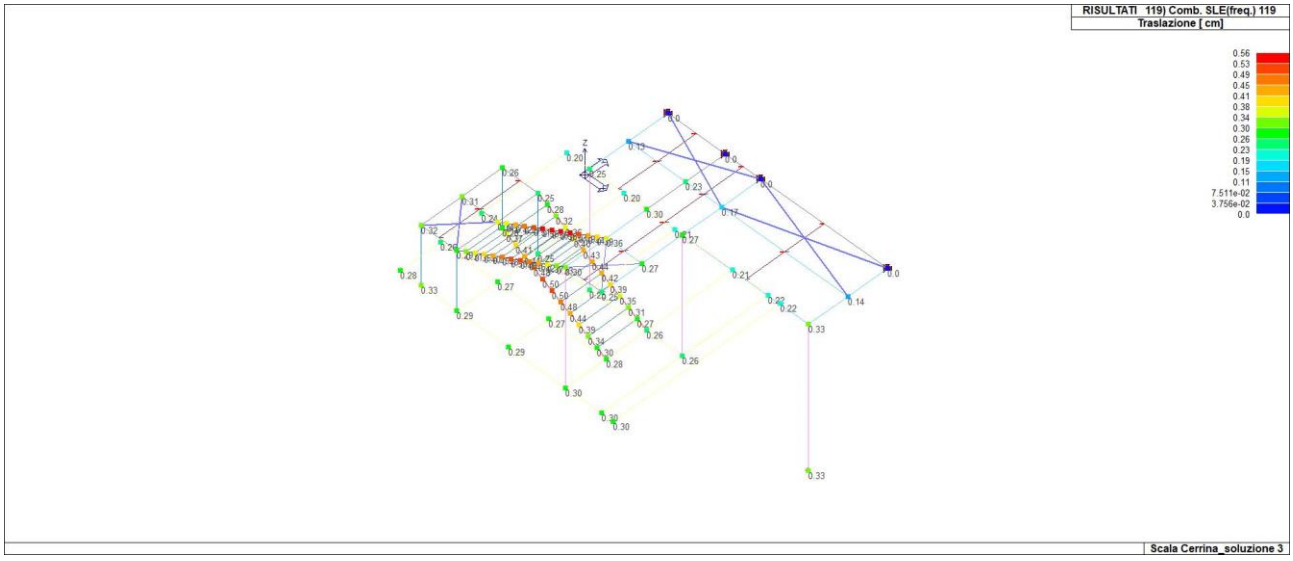

RISULTATI 026) Comb. SLU A1 26
Traslazione [cm]
0.82
0.76
0.71
0.65
0.60
0.54
0.49
0.43
0.38
0.33
0.27
0.22
0.16
0.11
5.435e-02
0.0
Scala Cerrina_soluzione 3

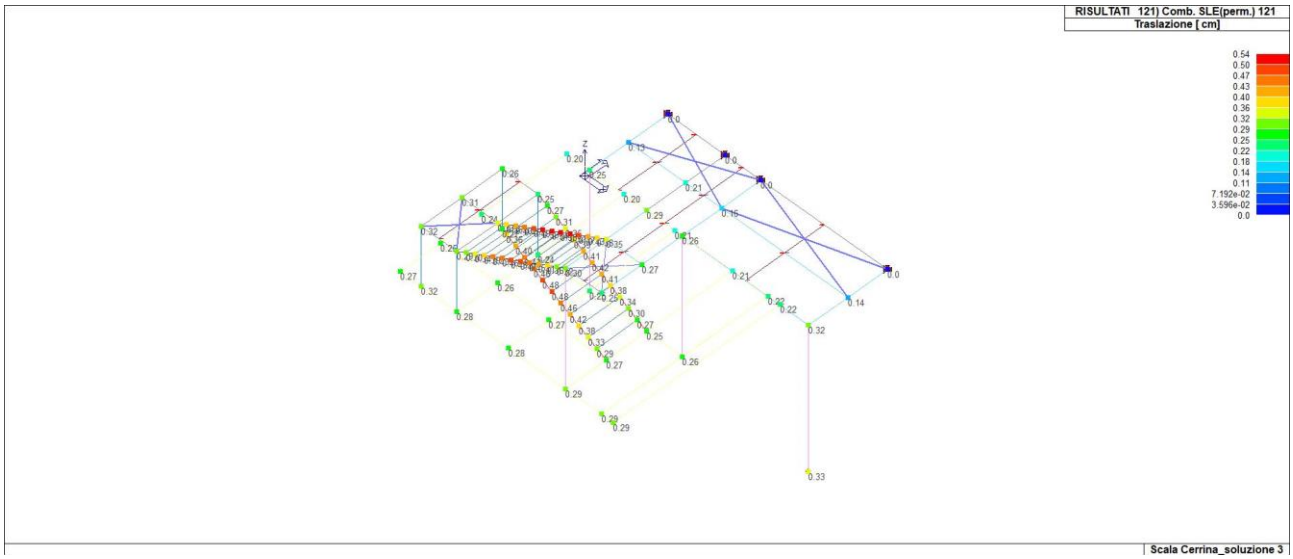

RISULTATI 034) Comb. SLU A1 (SLV sism.) 34
Traslazione [cm]
0.58
0.54
0.50
0.46
0.42
0.38
0.35
0.31
0.27
0.23
0.19
0.15
0.12
7.679e-02
3.839e-02
0.0
Scala Cerrina_soluzione 3

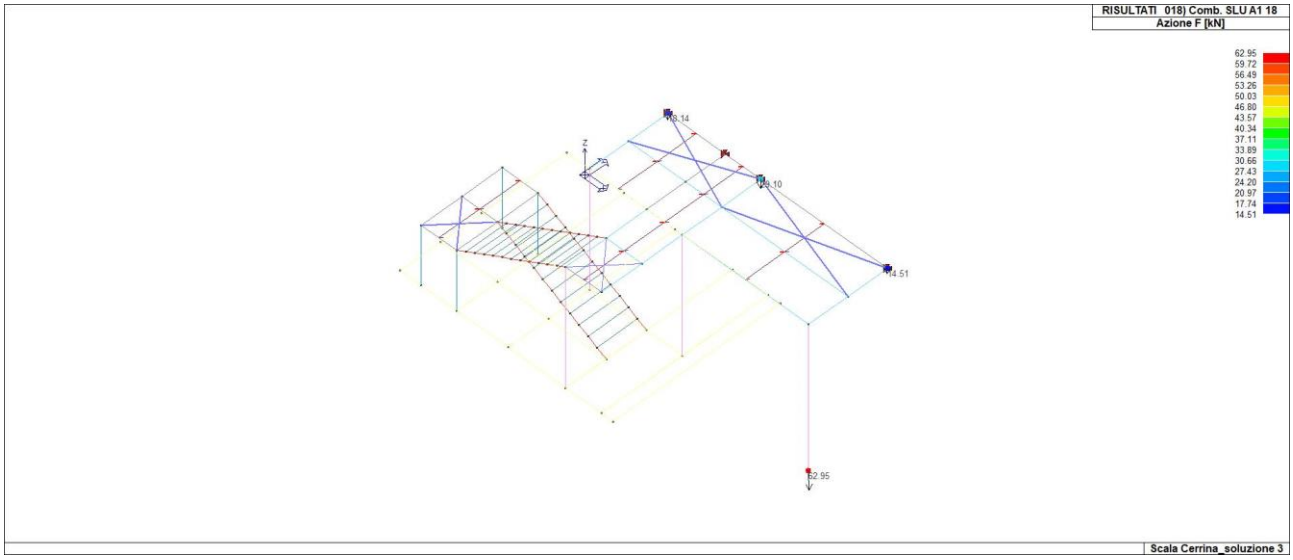

RISULTATI 066) Comb. SLE (SLD Danno sism.) 66
Traslazione [cm]
0.56
0.52
0.48
0.45
0.41
0.37
0.34
0.30
0.26
0.22
0.19
0.15
0.11
7.457e-02
3.728e-02
0.0
Scala Cerrina_soluzione 3

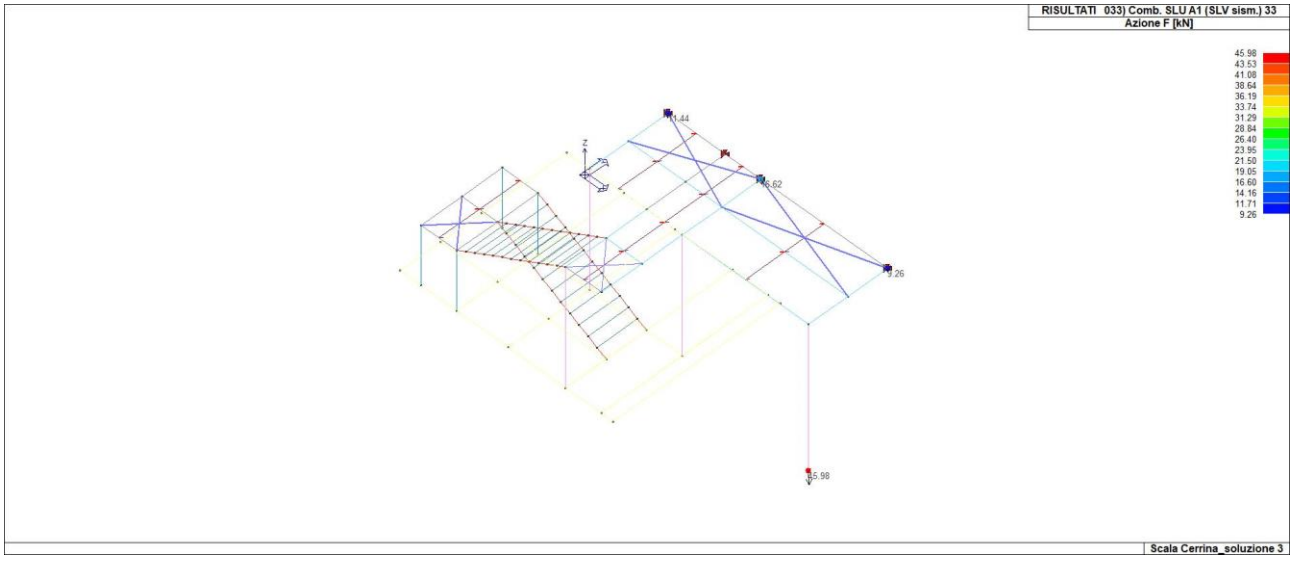

RISULTATI 098) Comb. SLU (Accid.) 98
Traslazione [cm]
0.54
0.50
0.47
0.43
0.40
0.36
0.32
0.29
0.25
0.22
0.18
0.14
0.11
7.192e-02
3.596e-02
0.0
Scala Cerrina_soluzione 3

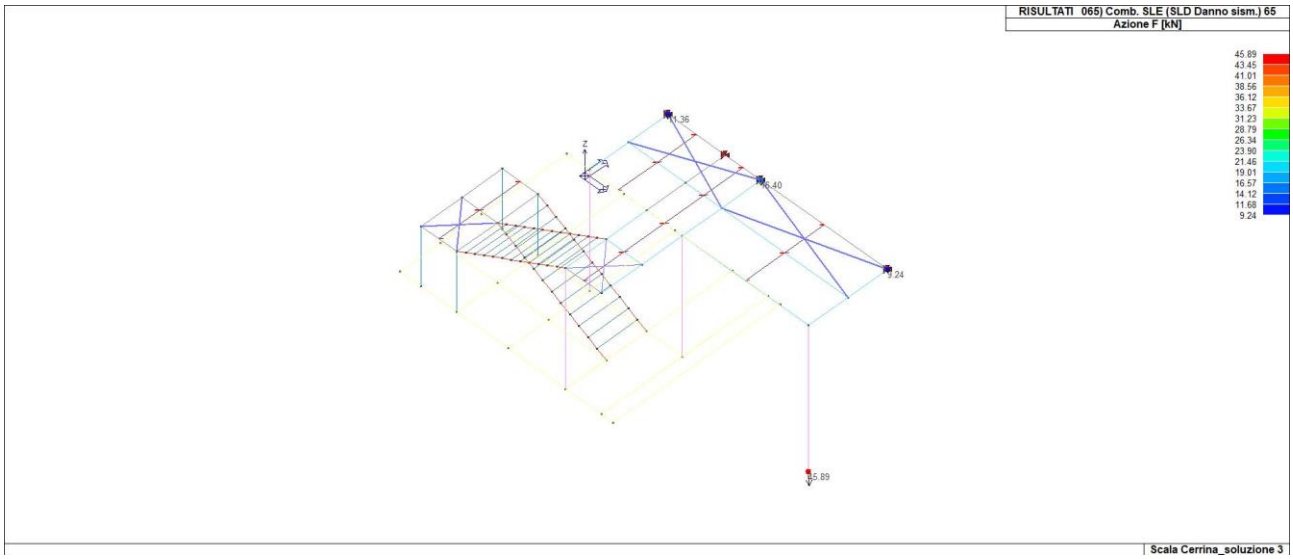

RISULTATI 112) Comb. SLE(rara) 112
Traslazione [cm]
0.59
0.55
0.51
0.47
0.43
0.39
0.35
0.31
0.28
0.24
0.20
0.16
0.12
7.865e-02
3.932e-02
0.0
Scala Cerrina_soluzione 3

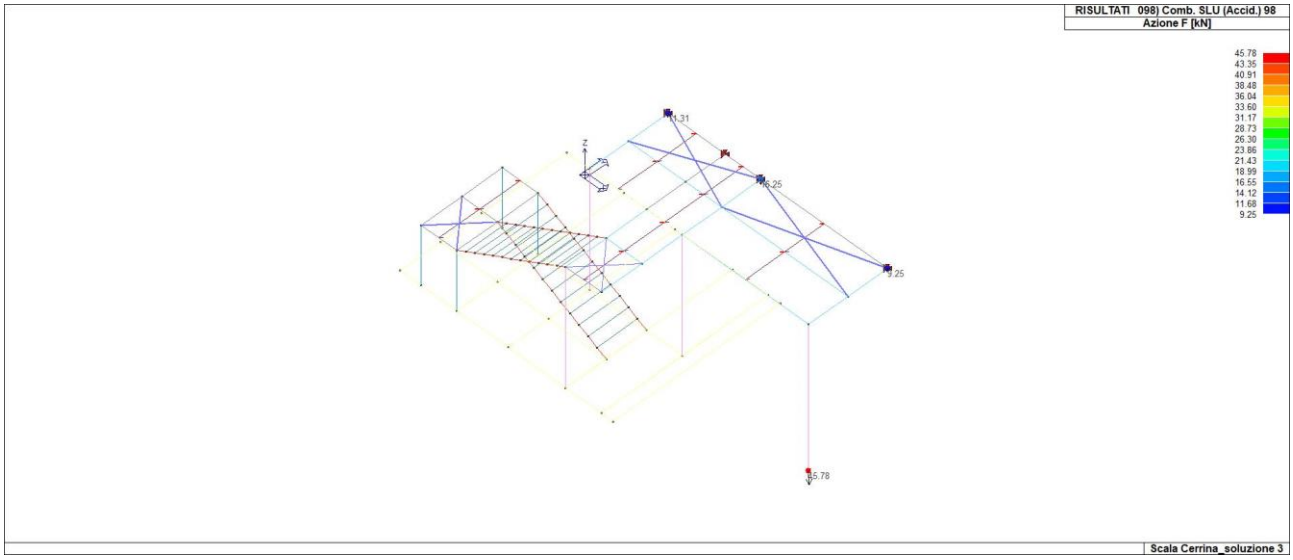

RISULTATI 119) Comb. SLE(freq.) 119
Traslazione [cm]
0.56
0.53
0.49
0.45
0.41
0.38
0.34
0.30
0.26
0.23
0.19
0.15
0.11
7.511e-02
3.756e-02
0.0
Scala Cerrina_soluzione 3

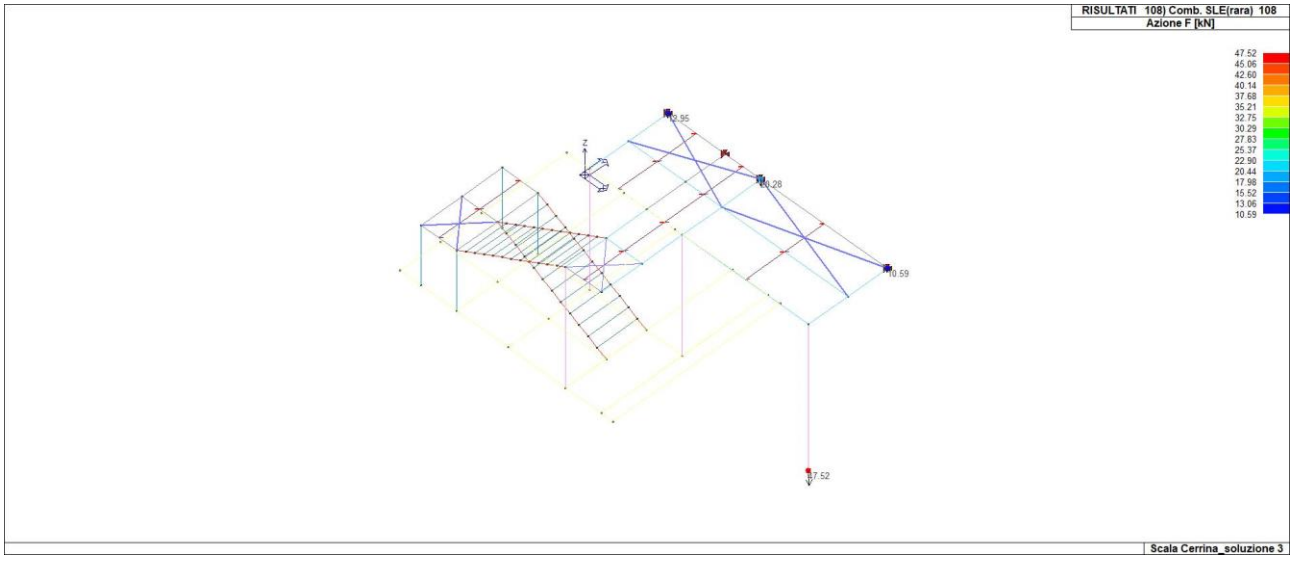

RISULTATI 121) Comb. SLE(perm.) 121
Traslazione [cm]
0.54
0.50
0.47
0.43
0.40
0.36
0.32
0.29
0.25
0.22
0.18
0.14
0.11
7.192e-02
3.596e-02
0.0
Scala Cerrina_soluzione 3

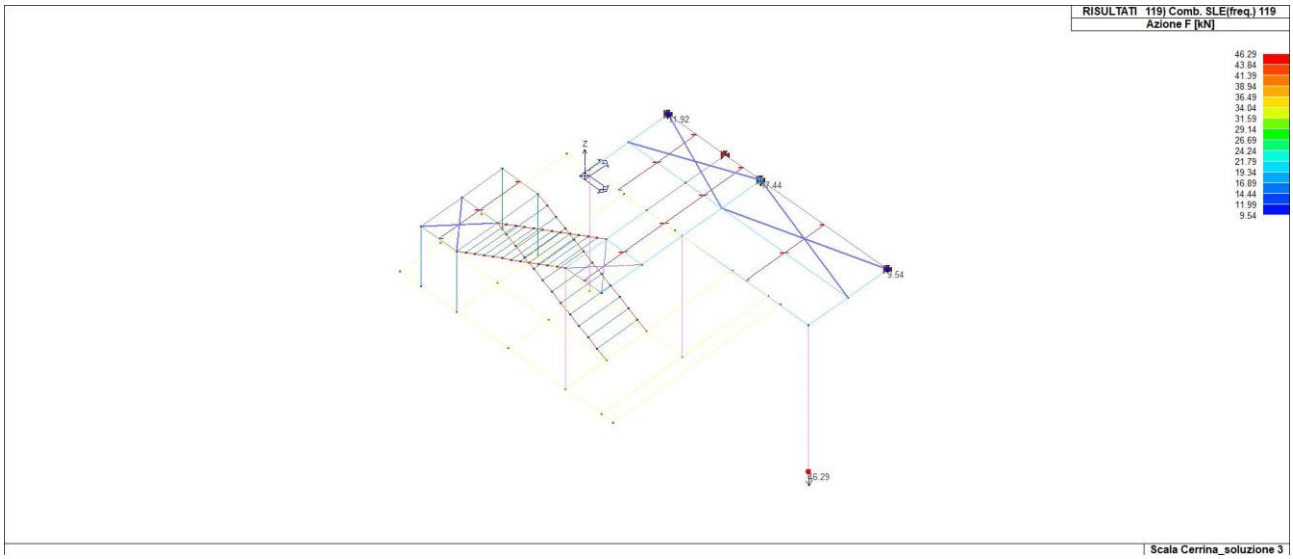

RISULTATI 018) Comb. SLU A1 18
Azione F [kN]
62.95
59.72
56.49
53.26
50.03
46.80
43.57
40.34
37.11
33.89
30.66
27.43
24.20
20.97
17.74
14.51
Scala Cerrina_soluzione 3

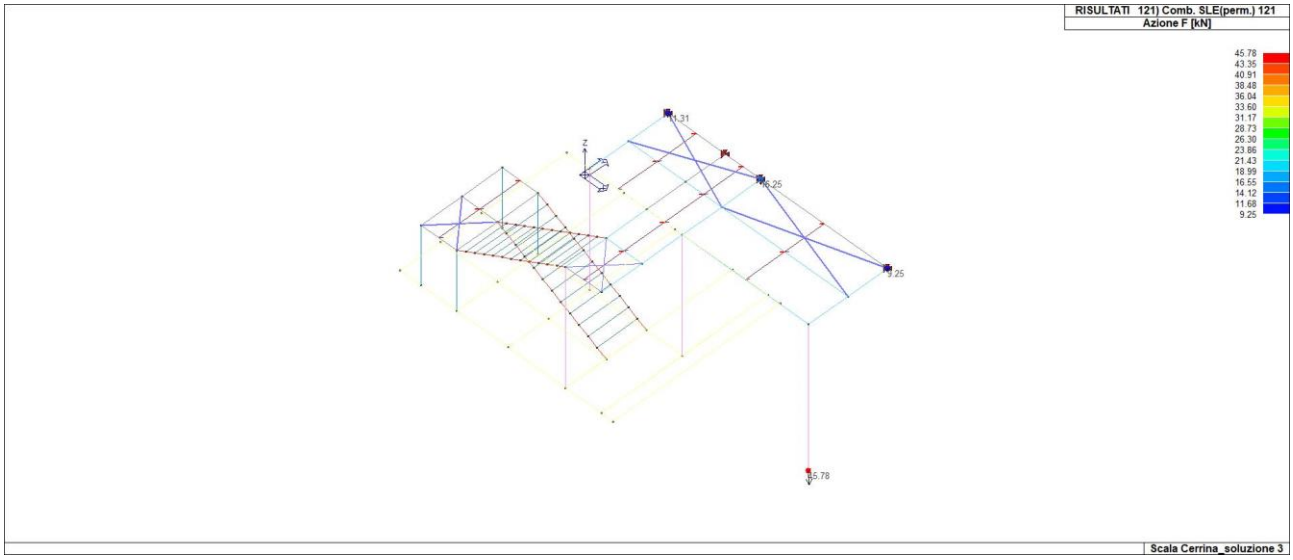

RISULTATI 033) Comb. SLU A1 (SLV sism.) 33
Azione F [kN]
45.98
43.53
41.08
38.64
36.19
33.74
31.29
28.84
26.40
23.95
21.50
19.05
16.60
14.16
11.71
9.26
Scala Cerrina_soluzione 3

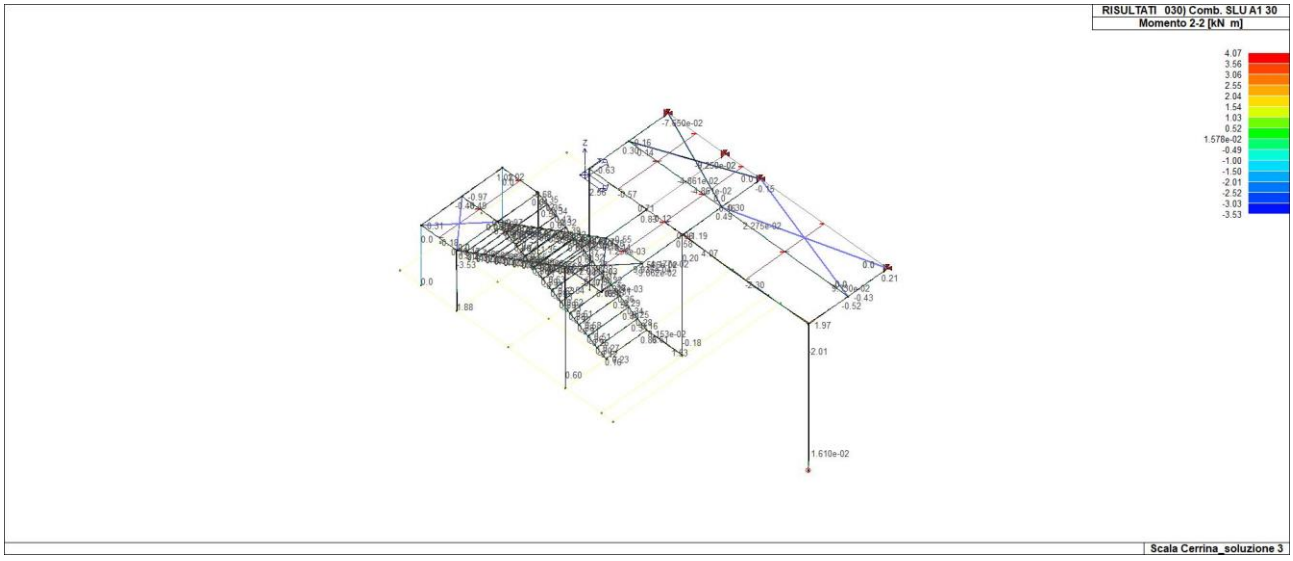

RISULTATI 065) Comb. SLE (SLD Danno sism.) 65
Azione F [kN]
45.89
43.45
41.01
38.56
36.12
33.67
31.23
28.79
26.34
23.90
21.46
19.01
16.57
14.12
11.68
9.24
11.36
16.40
9.24
5.89
Scala Cerrina_soluzione 3

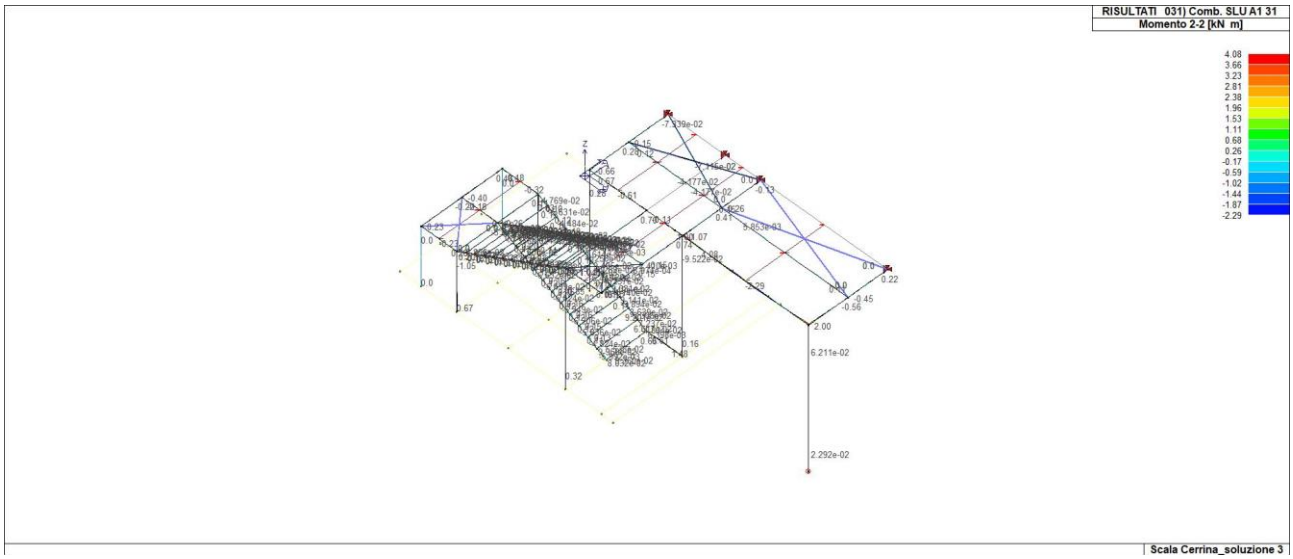

RISULTATI 098) Comb. SLU (Accid.) 98
Azione F [kN]
45.78
43.35
40.91
38.48
36.04
33.60
31.17
28.73
26.30
23.86
21.43
18.99
16.55
14.12
11.68
9.25
11.31
16.25
9.25
5.78
Scala Cerrina_soluzione 3

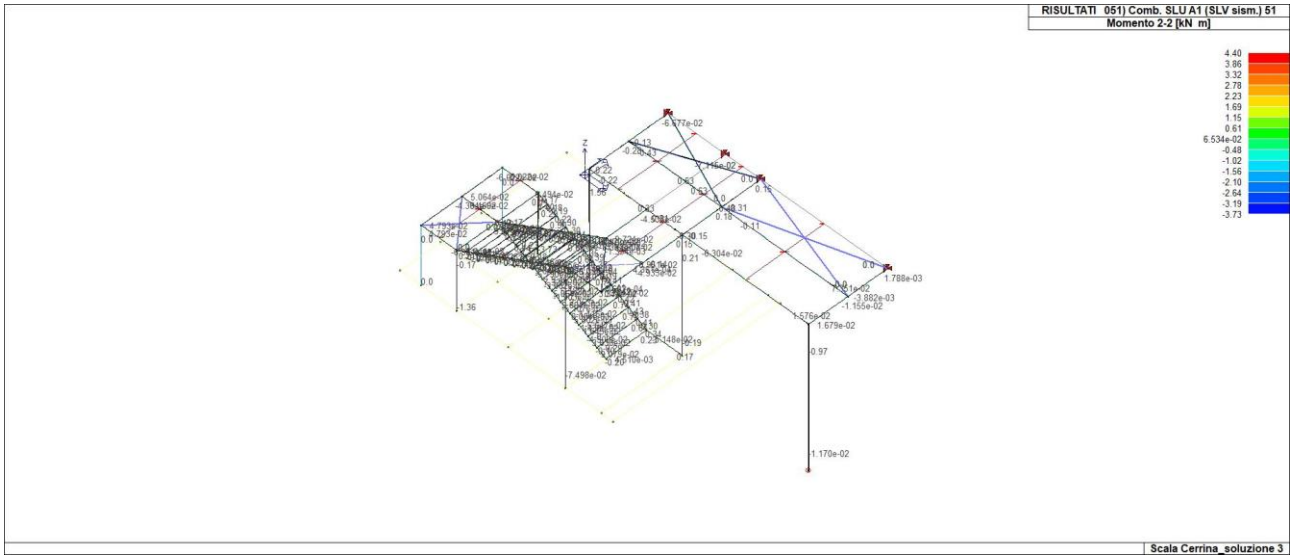

RISULTATI 108) Comb. SLE(rara) 108
Azione F [kN]
47.52
45.06
42.60
40.14
37.68
35.21
32.75
30.29
27.83
25.37
22.90
20.44
17.98
15.52
13.06
10.59
12.95
20.28
10.59
7.52
Scala Cerrina_soluzione 3

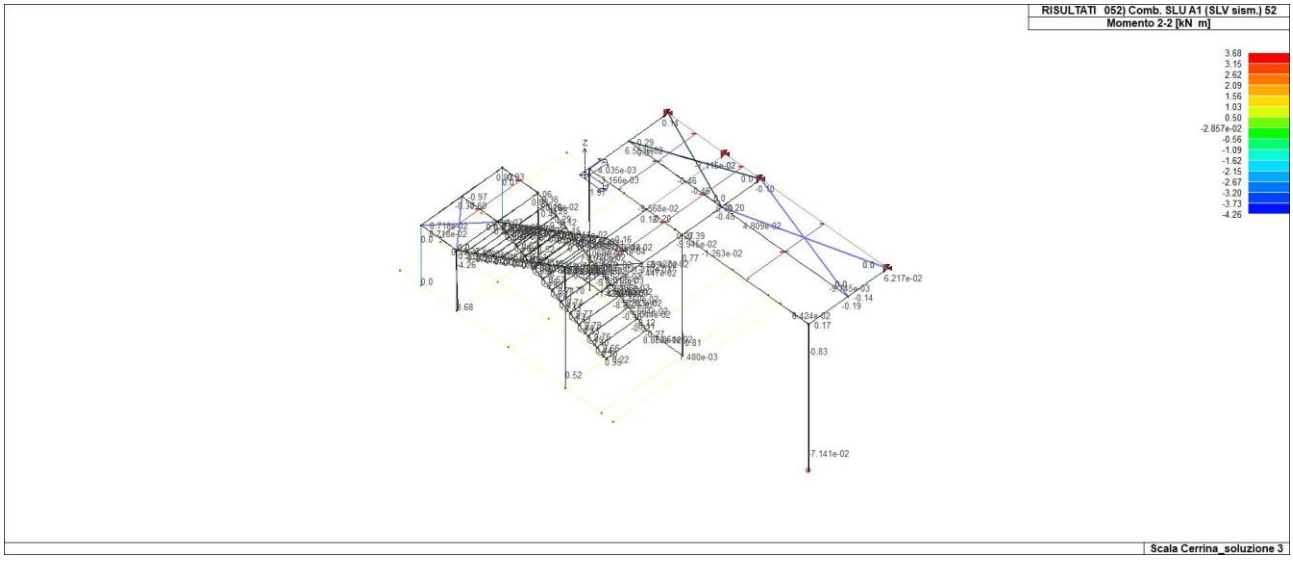

RISULTATI 119) Comb. SLE(freq.) 119
Azione F [kN]
46.29
43.84
41.39
38.94
36.49
34.04
31.59
29.14
26.69
24.24
21.79
19.34
16.89
14.44
11.99
9.54
11.92
7.44
9.54
6.29
Scala Cerrina_soluzione 3

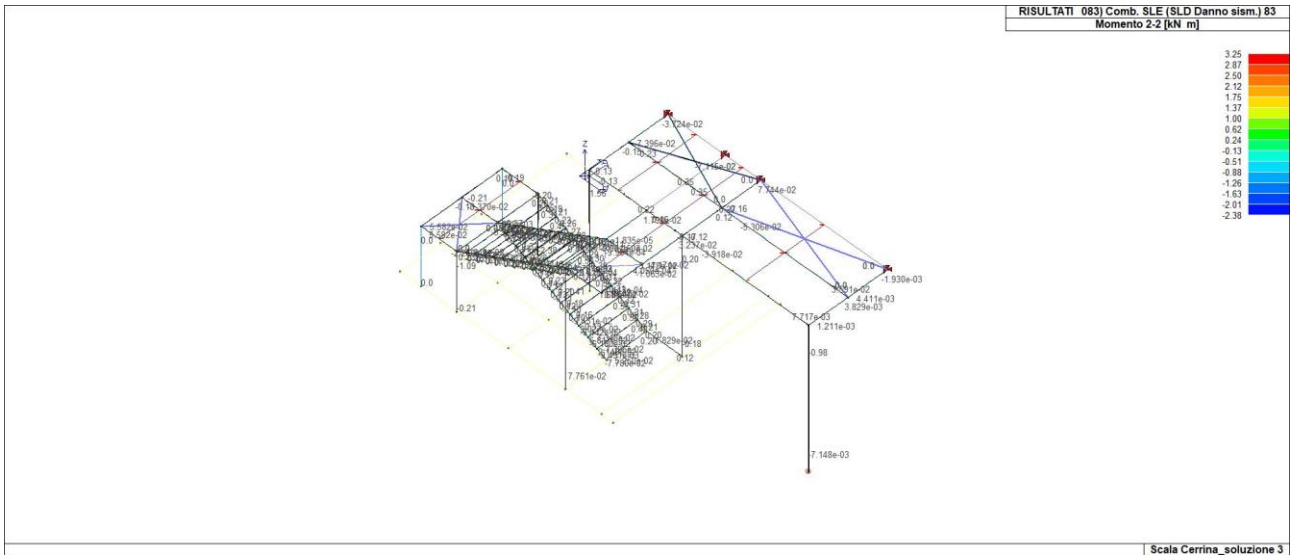

RISULTATI 121) Comb. SLE(perm.) 121
Azione F [kN]
45.78
43.35
40.91
38.48
36.04
33.60
31.17
28.73
26.30
23.86
21.43
18.99
16.55
14.12
11.68
9.25
11.31
6.25
9.25
5.78
Scala Cerrina_soluzione 3

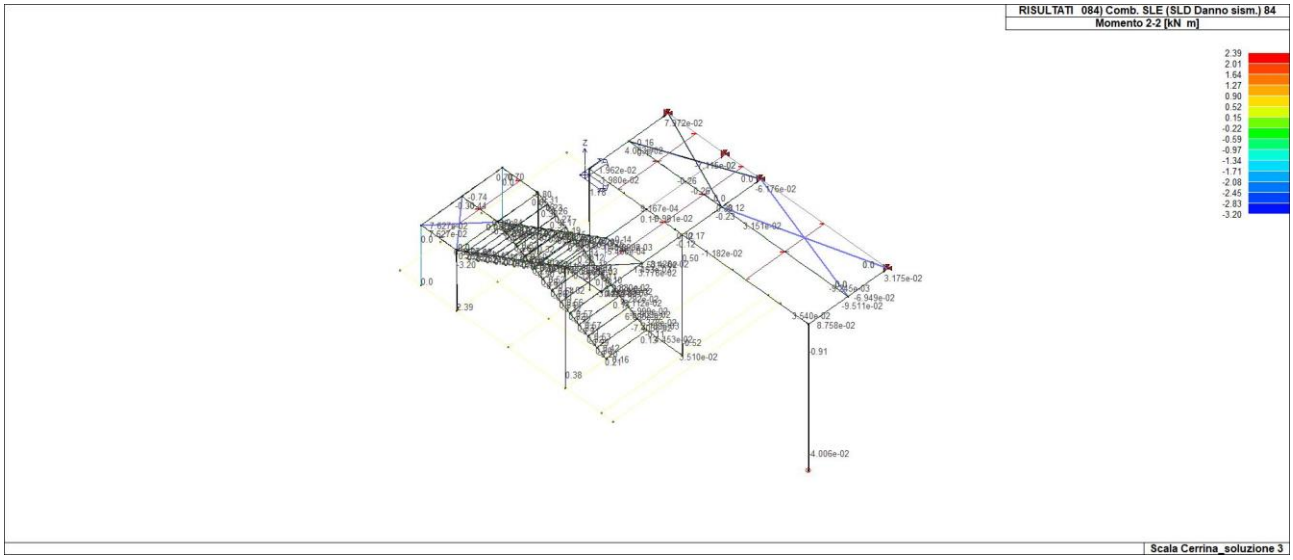

RISULTATI 030) Comb. SLU A1 30
Momento 2-2 [kN m]
4.07
3.56
3.06
2.55
2.04
1.54
1.03
0.52
1.578e-02
-0.49
-1.00
-1.50
-2.01
-2.52
-3.03
-3.53
1.610e-02
Scala Cerrina_soluzione 3

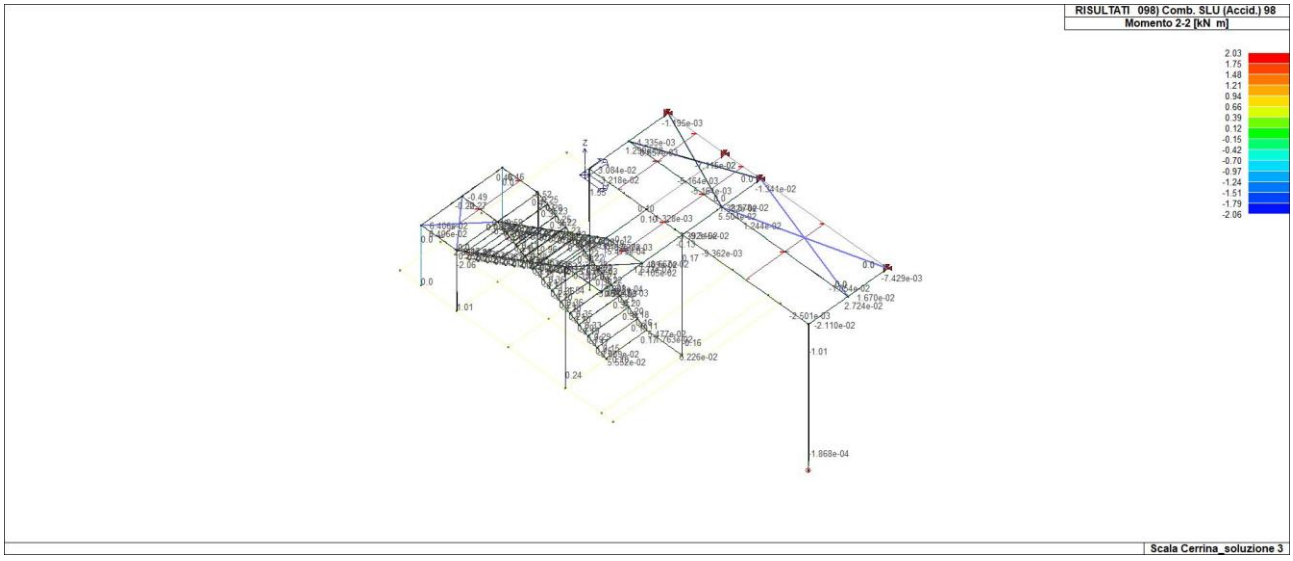

RISULTATI 031) Comb. SLU A1 31
Momento 2-2 [kN m]
4.08
3.66
3.23
2.81
2.38
1.96
1.53
1.11
0.68
0.26
-0.17
-0.59
-1.02
-1.44
-1.87
-2.29
Scala Cerrina_soluzione 3

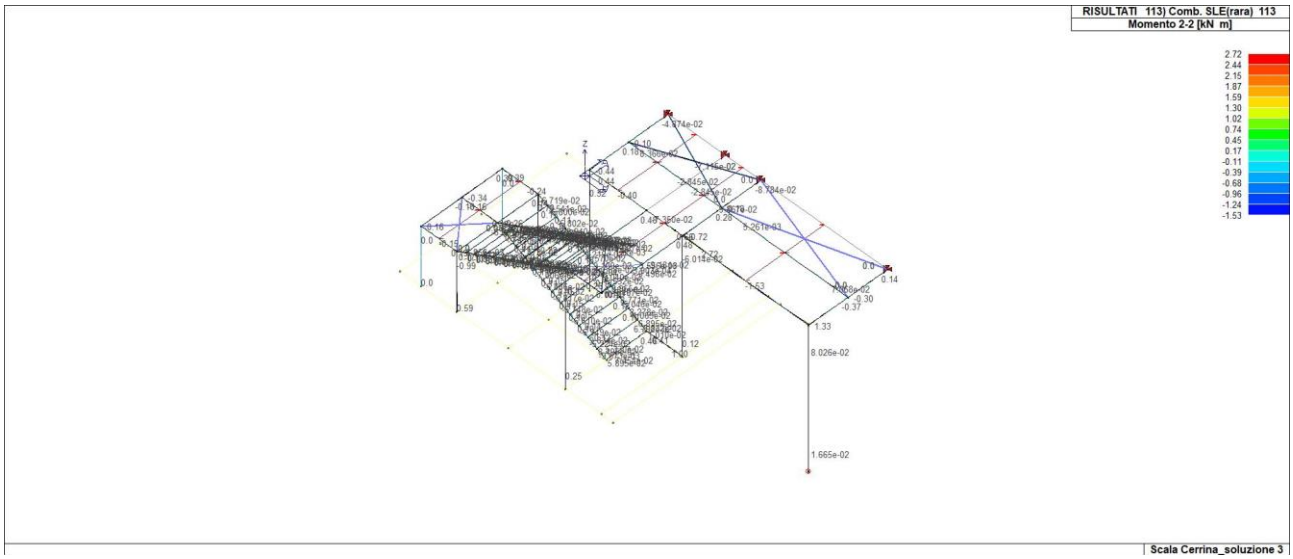

RISULTATI 051) Comb. SLU A1 (SLV sism.) 51
Momento 2-2 [kN m]
4.40
3.86
3.32
2.78
2.23
1.69
1.15
0.61
6.534e-02
-0.48
-1.02
-1.56
-2.10
-2.64
-3.19
-3.73
Scala Cerrina_soluzione 3

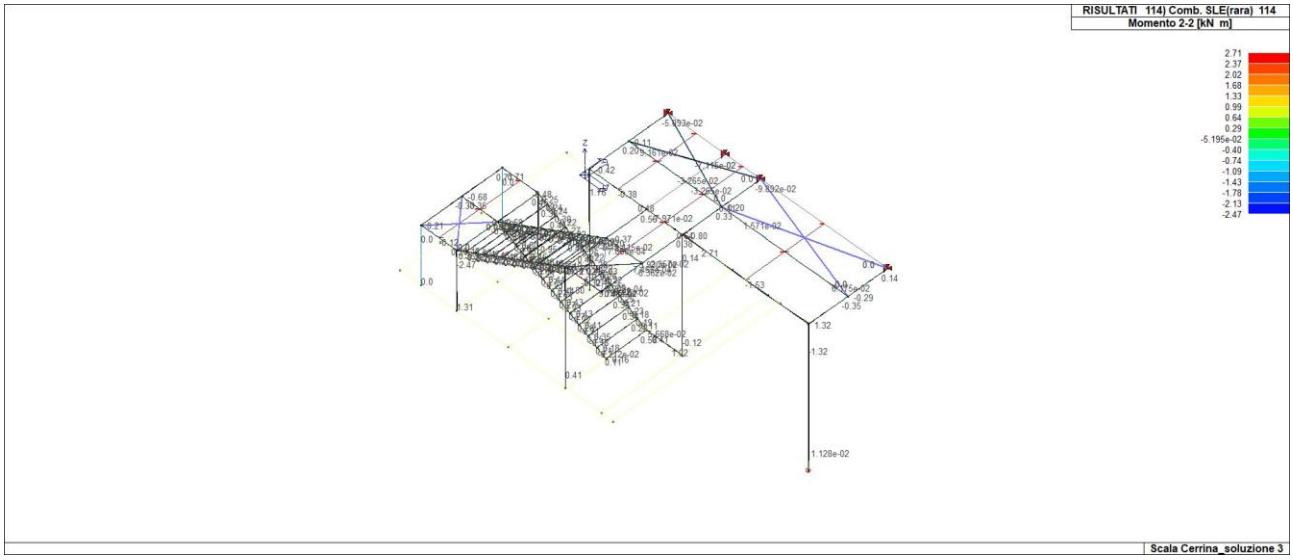

RISULTATI 052) Comb. SLU A1 (SLV sism.) 52
Momento 2-2 [kN m]
3.68
3.15
2.62
2.09
1.56
1.03
0.50
-2.857e-02
-0.56
-1.09
-1.62
-2.15
-2.67
-3.20
-3.73
-4.26
Scala Cerrina_soluzione 3

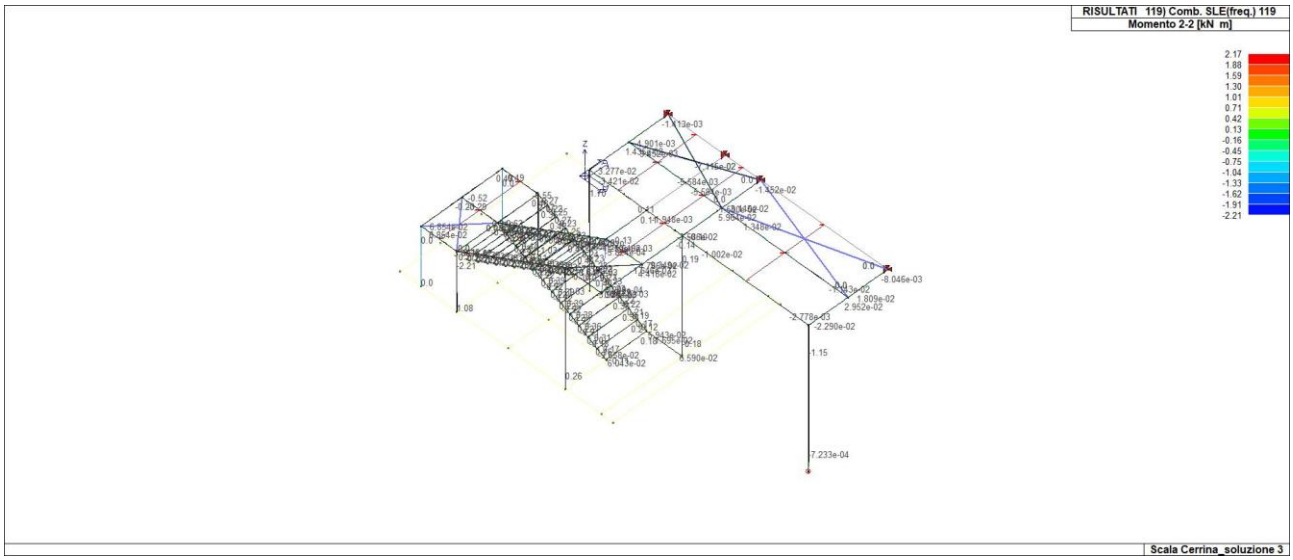

RISULTATI 083) Comb. SLE (SLD Danno sism.) 83
Momento 2-2 [kN m]
3.25
2.87
2.50
2.12
1.75
1.37
1.00
0.62
0.24
-0.13
-0.51
-0.88
-1.26
-1.63
-2.01
-2.38
Scala Cerrina_soluzione 3

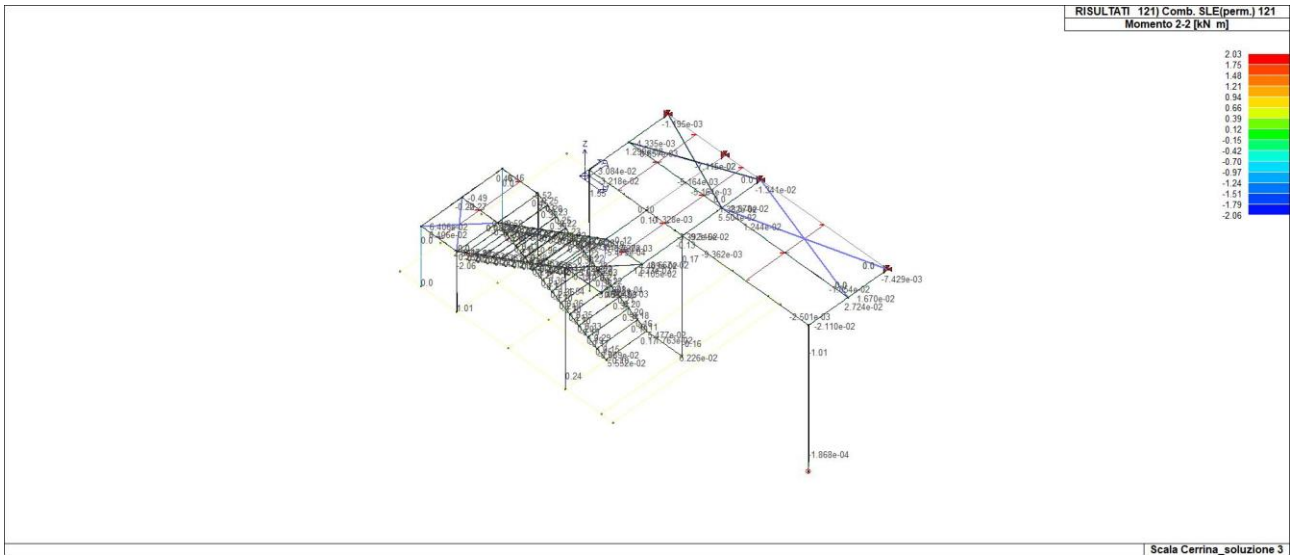

RISULTATI 084) Comb. SLE (SLD Danno sism.) 84
Momento 2-2 [kN m]
2.39
2.01
1.64
1.27
0.90
0.52
0.15
-0.22
-0.59
-0.97
-1.34
-1.71
-2.08
-2.45
-2.83
-3.20
Scala Cerrina_soluzione 3

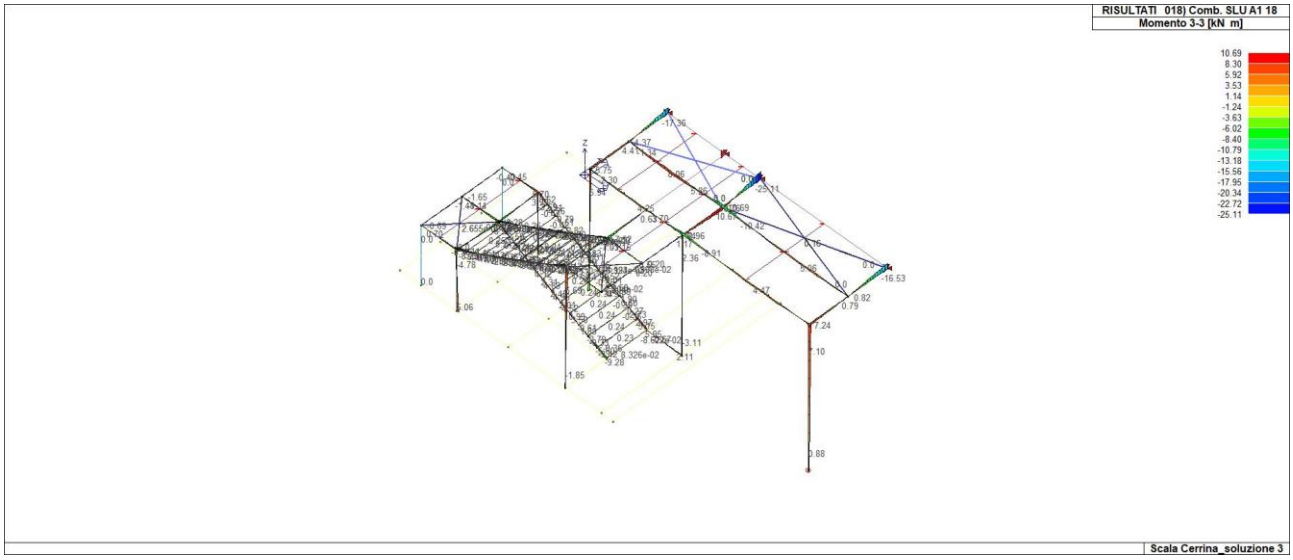

RISULTATI 098) Comb. SLU (Accid.) 98
Momento 2-2 [kN m]
2.03
1.75
1.48
1.21
0.94
0.66
0.39
0.12
-0.15
-0.42
-0.70
-0.97
-1.24
-1.51
-1.79
-2.06
Scala Cerrina_soluzione 3

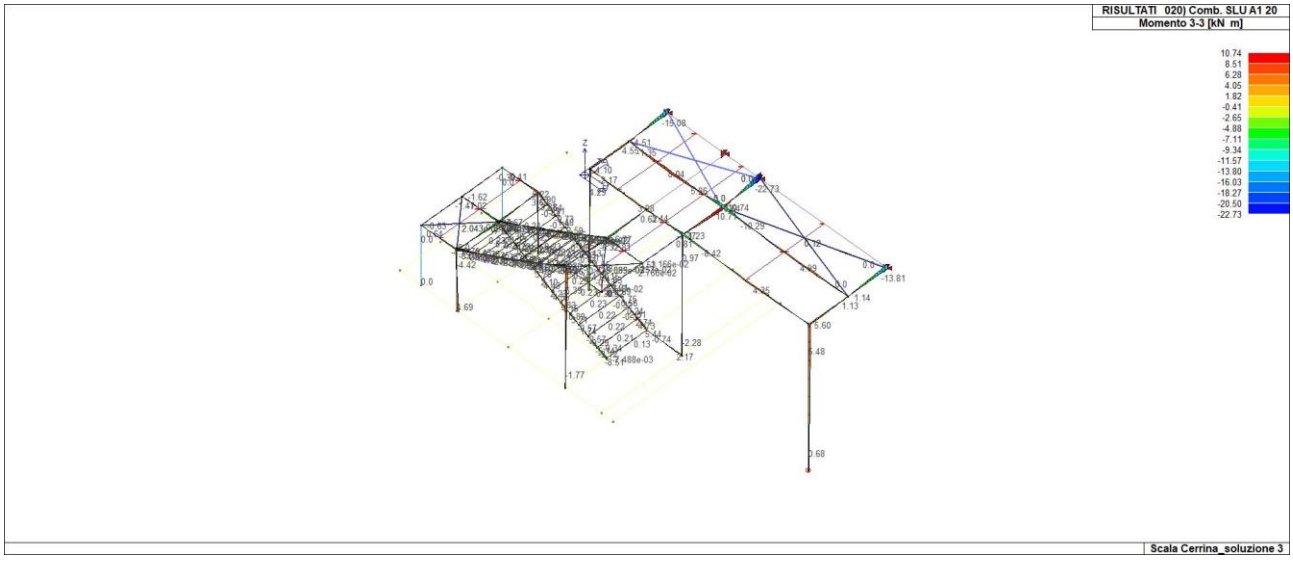

RISULTATI 113) Comb. SLE(rara) 113
Momento 2-2 [kN m]
2.72
2.44
2.15
1.87
1.59
1.30
1.02
0.74
0.45
0.17
-0.11
-0.39
-0.68
-0.96
-1.24
-1.53
1.665e-02
Scala Cerrina_soluzione 3

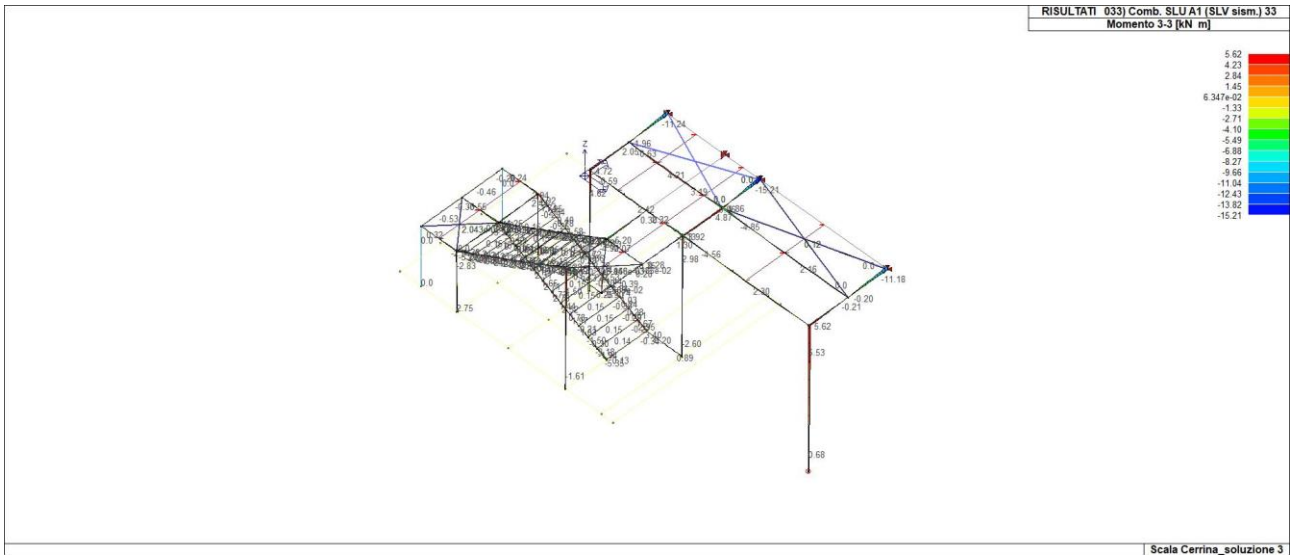

RISULTATI 114) Comb. SLE(rara) 114
Momento 2-2 [kN m]
2.71
2.37
2.02
1.68
1.33
0.99
0.64
0.29
-5.195e-02
-0.40
-0.74
-1.09
-1.43
-1.78
-2.13
-2.47
1.128e-02
Scala Cerrina_soluzione 3

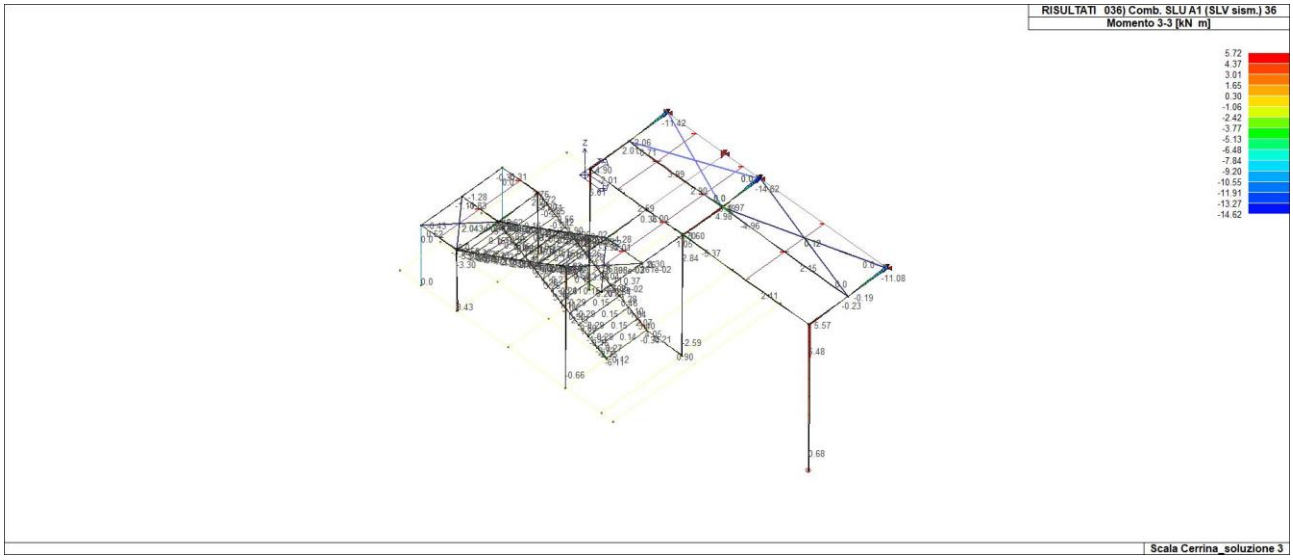

RISULTATI 119) Comb. SLE(freq.) 119
Momento 2-2 [kN m]
2.17
1.88
1.59
1.30
1.01
0.71
0.42
0.13
-0.16
-0.45
-0.75
-1.04
-1.33
-1.62
-1.91
-2.21
7.233e-04
Scala Cerrina_soluzione 3

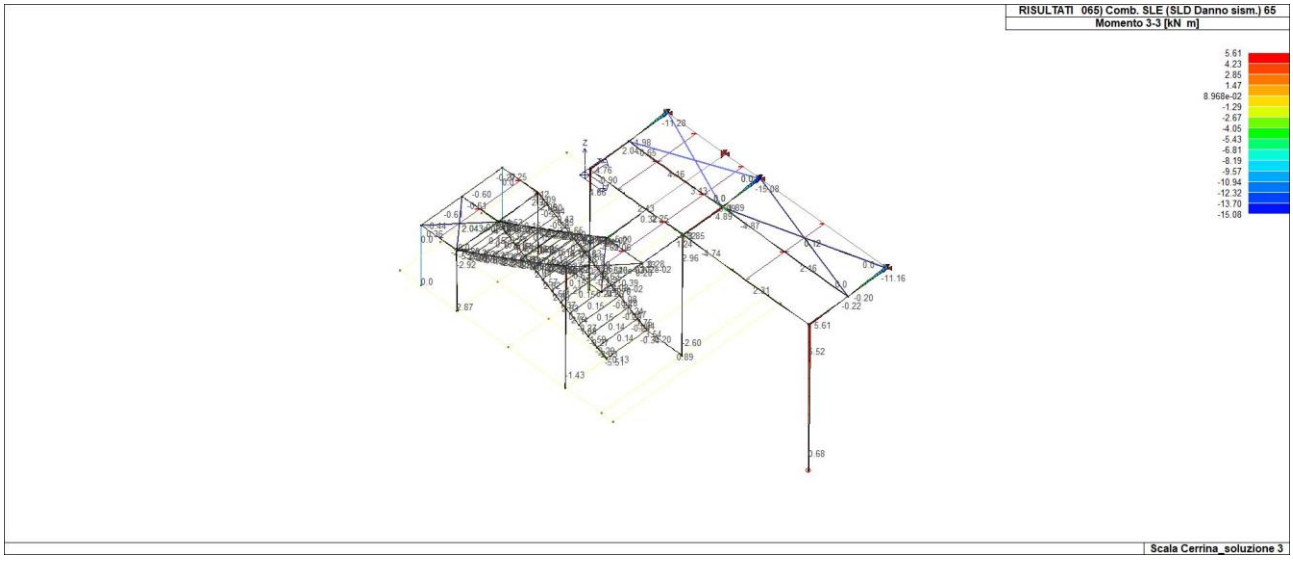

RISULTATI 121) Comb. SLE(perm.) 121
Momento 2-2 [kN m]
2.03
1.75
1.48
1.21
0.94
0.66
0.39
0.12
-0.15
-0.42
-0.70
-0.97
-1.24
-1.51
-1.79
-2.06
Scala Cerrina_soluzione 3

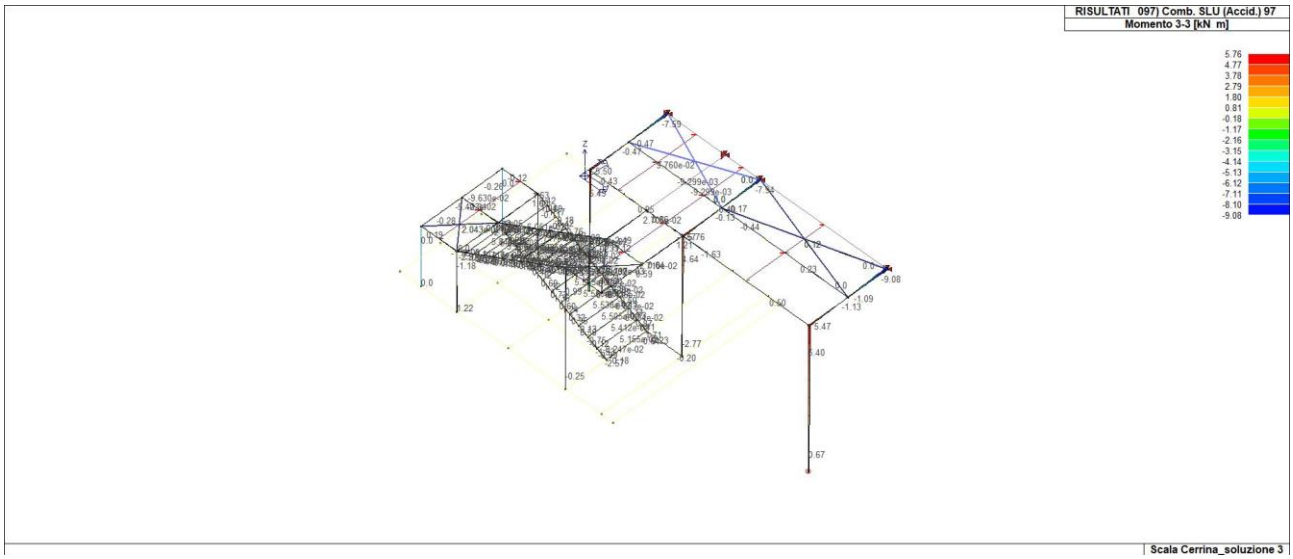

RISULTATI 018) Comb. SLU A1 18
Momento 3-3 [kN m]
10.69
8.30
5.92
3.53
1.14
-1.24
-3.63
-6.02
-8.40
-10.79
-13.18
-15.56
-17.95
-20.34
-22.72
-25.11
Scala Cerrina_soluzione 3

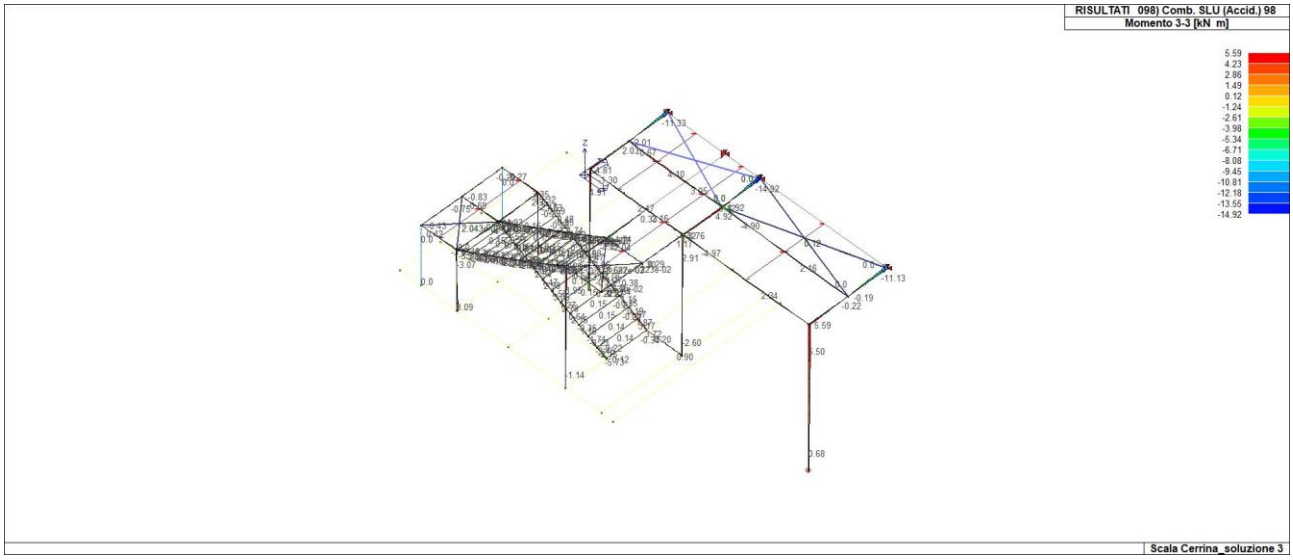

RISULTATI 020) Comb. SLU A1 20
Momento 3-3 [kN m]
10.74
8.51
6.28
4.05
1.82
-0.41
-2.65
-4.88
-7.11
-9.34
-11.57
-13.80
-16.03
-18.27
-20.50
-22.73
Scala Cerrina_soluzione 3

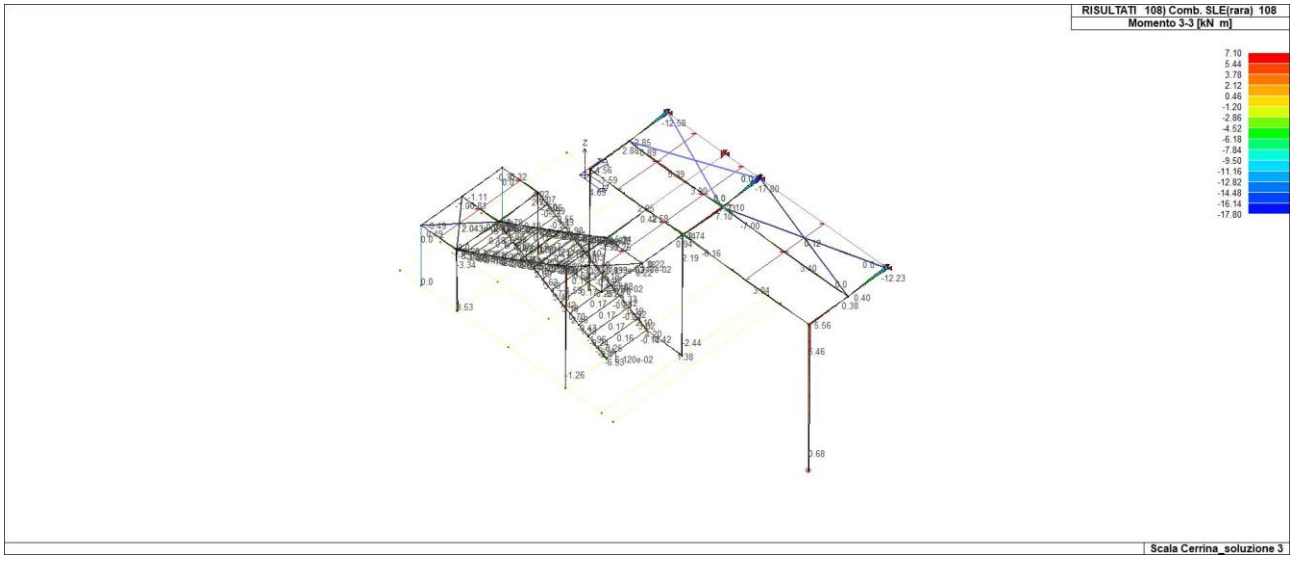

RISULTATI 033) Comb. SLU A1 (SLV sism.) 33
Momento 3-3 [kN m]
5.62
4.23
2.84
1.45
6.347e-02
-1.33
-2.71
-4.10
-5.49
-6.88
-8.27
-9.66
-11.04
-12.43
-13.82
-15.21
Scala Cerrina_soluzione 3

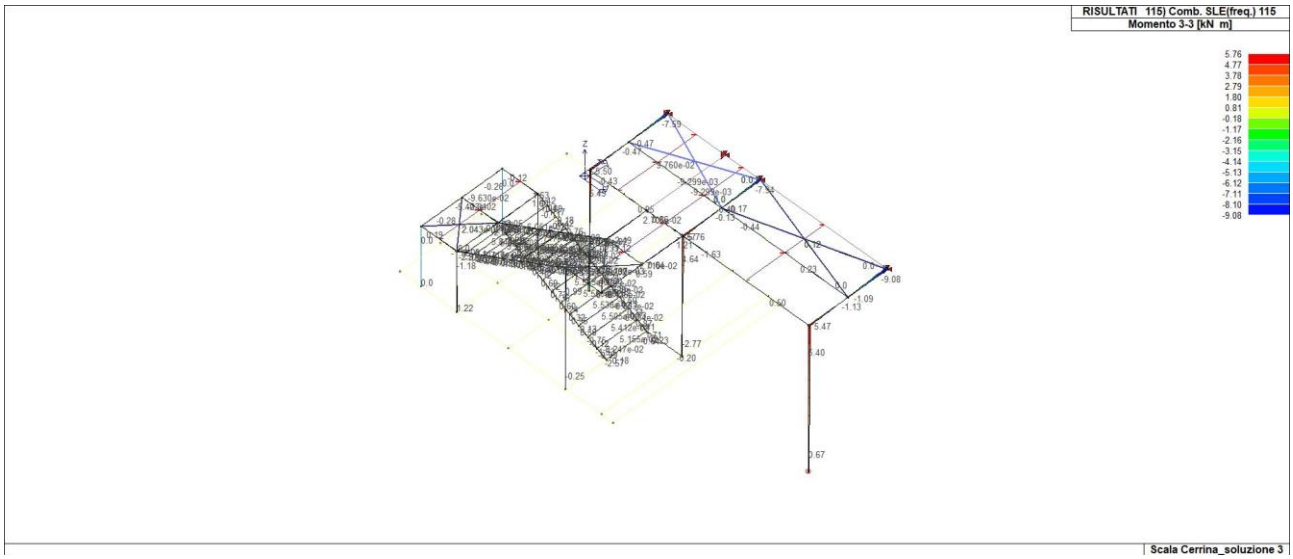

RISULTATI 036) Comb. SLU A1 (SLV sism.) 36
Momento 3-3 [kN m]
5.72
4.37
3.01
1.65
0.30
-1.06
-2.42
-3.77
-5.13
-6.48
-7.84
-9.20
-10.55
-11.91
-13.27
-14.62
Scala Cerrina_soluzione 3

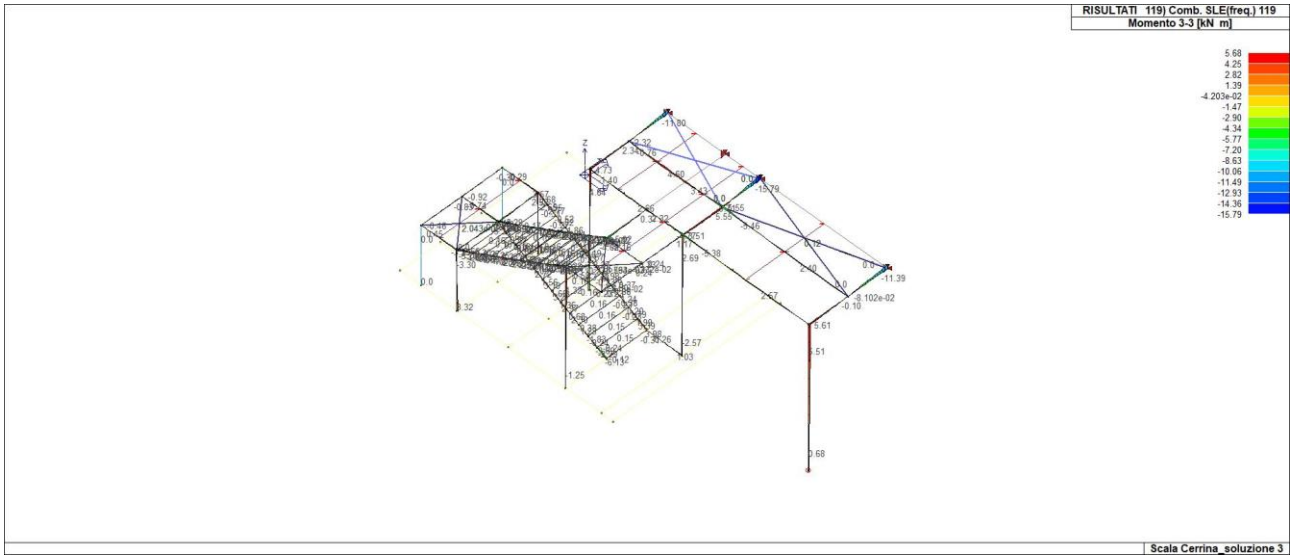

RISULTATI 065) Comb. SLE (SLD Danno sism.) 65
Momento 3-3 [kN m]
5.61
4.23
2.85
1.47
8.968e-02
-1.29
-2.67
-4.05
-5.43
-6.81
-8.19
-9.57
-10.94
-12.32
-13.70
-15.08
Scala Cerrina_soluzione 3

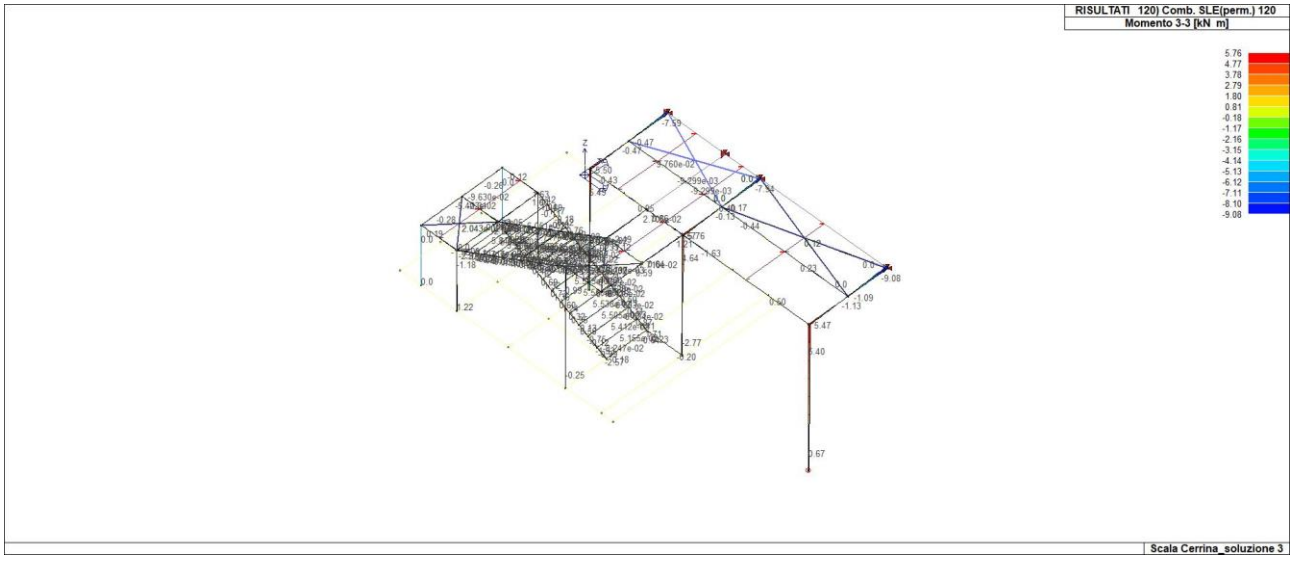

RISULTATI 097) Comb. SLU (Accid.) 97
Momento 3-3 [kN m]
Scala Cerrina_soluzione 3

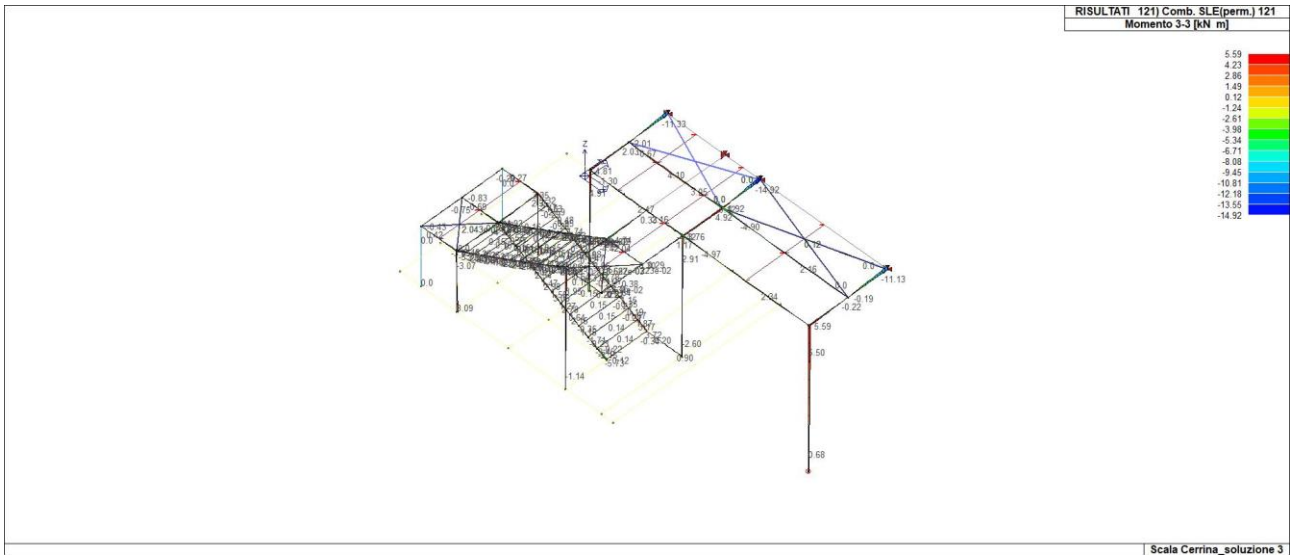

RISULTATI 098) Comb. SLU (Accid.) 98
Momento 3-3 [kN m]
Scala Cerrina_soluzione 3

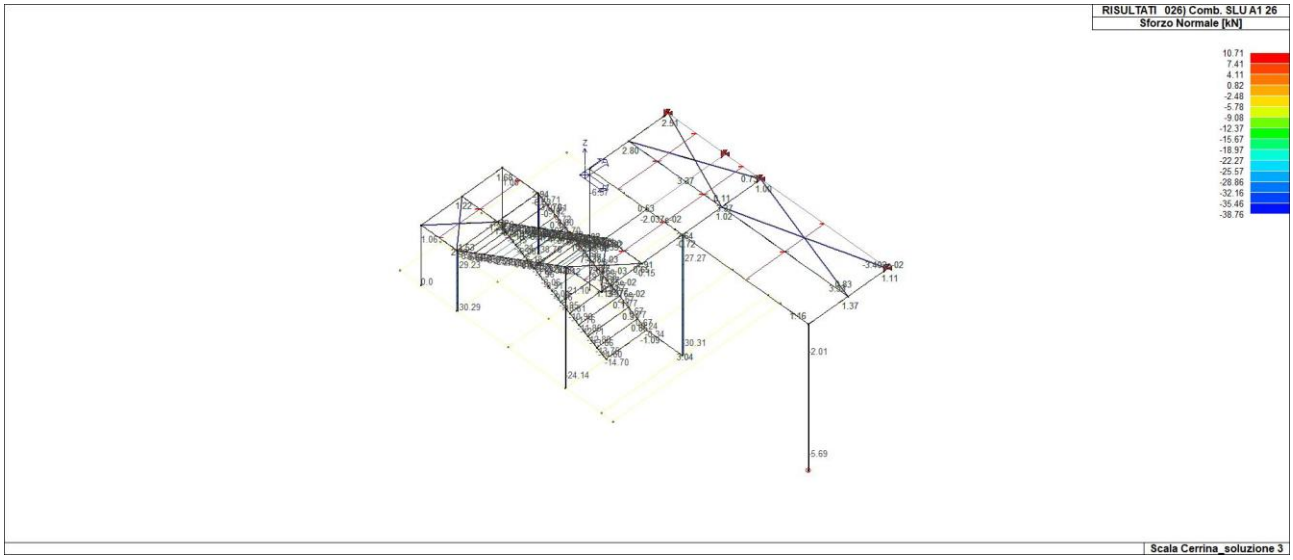

RISULTATI 108) Comb. SLE(rara) 108
Momento 3-3 [kN m]
Scala Cerrina_soluzione 3

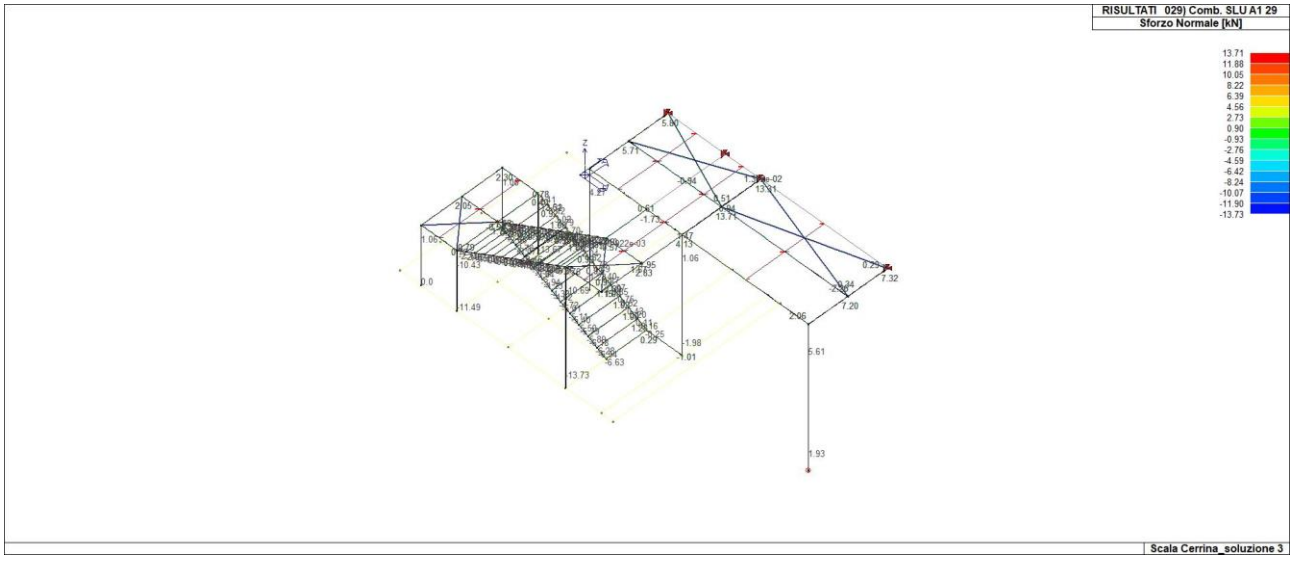

RISULTATI 115) Comb. SLE(freq.) 115
Momento 3-3 [kN m]
5.76
4.77
3.78
2.79
1.80
0.81
-0.18
-1.17
-2.16
-3.15
-4.14
-5.13
-6.12
-7.11
-8.10
-9.08
Scala Cerrina_soluzione 3

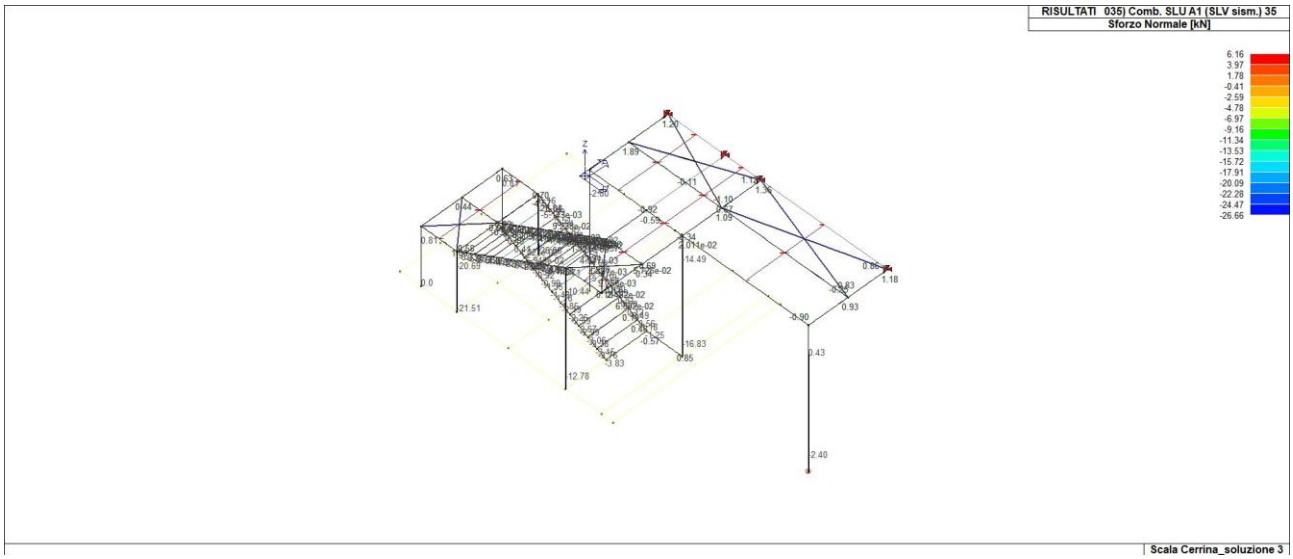

RISULTATI 119) Comb. SLE(freq.) 119
Momento 3-3 [kN m]
5.68
4.25
2.82
1.39
-4.203e-02
-1.47
-2.90
-4.34
-5.77
-7.20
-8.63
-10.06
-11.49
-12.93
-14.36
-15.79
Scala Cerrina_soluzione 3

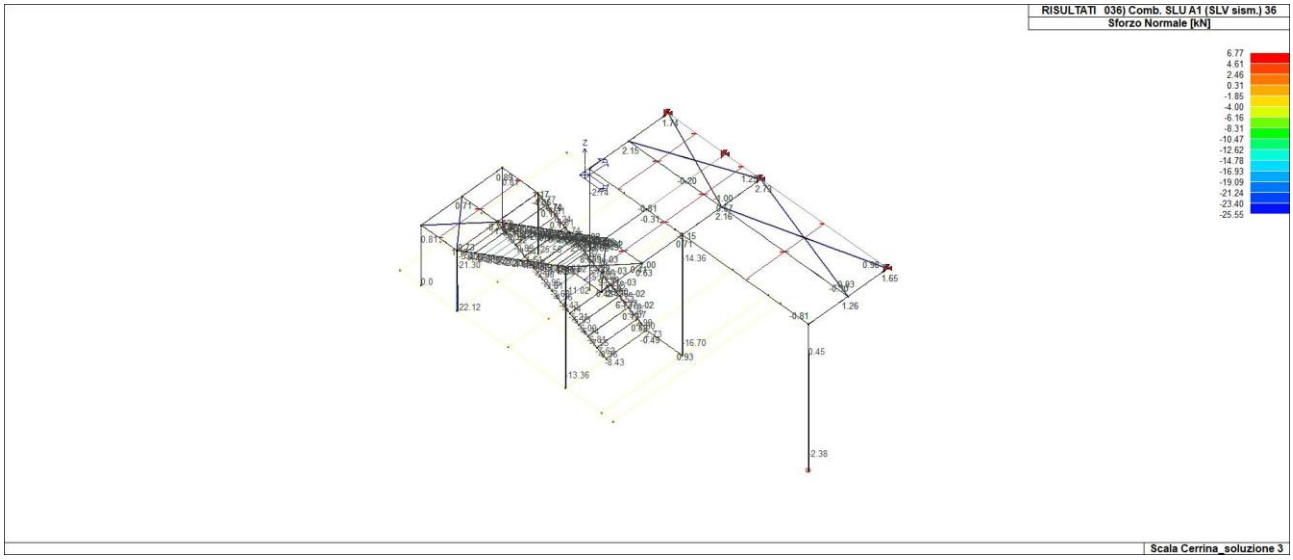

RISULTATI 120) Comb. SLE(perm.) 120
Momento 3-3 [kN m]
5.76
4.77
3.78
2.79
1.80
0.81
-0.18
-1.17
-2.16
-3.15
-4.14
-5.13
-6.12
-7.11
-8.10
-9.08
Scala Cerrina_soluzione 3

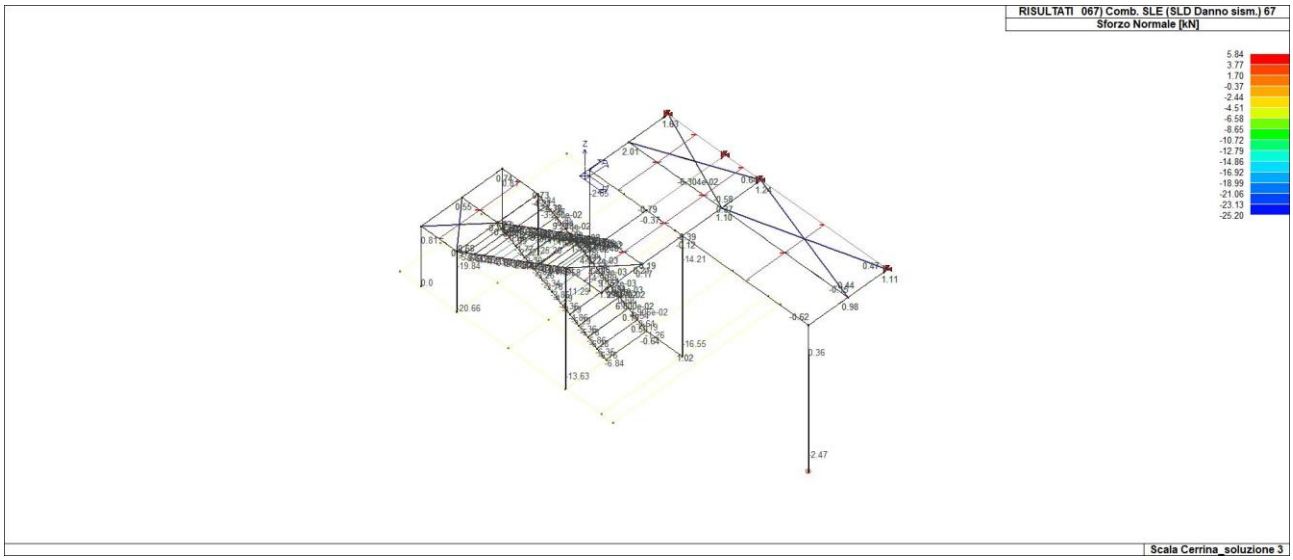

RISULTATI 121) Comb. SLE(perm.) 121
Momento 3-3 [kN m]
5.59
4.23
2.86
1.49
0.12
-1.24
-2.61
-3.98
-5.34
-6.71
-8.08
-9.45
-10.81
-12.18
-13.55
-14.92
Scala Cerrina_soluzione 3

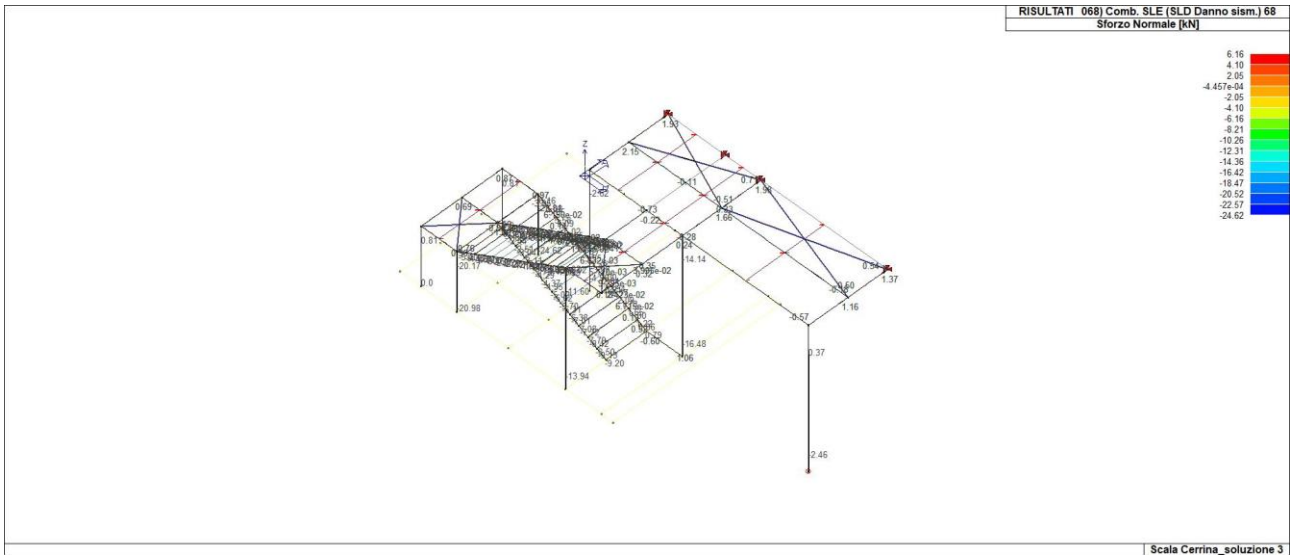

RISULTATI 026) Comb. SLU A1 26
Sforzo Normale [kN]
10.71
7.41
4.11
0.82
-2.48
-5.78
-9.08
-12.37
-15.67
-18.97
-22.27
-25.57
-28.86
-32.16
-35.46
-38.76
Scala Cerrina_soluzione 3

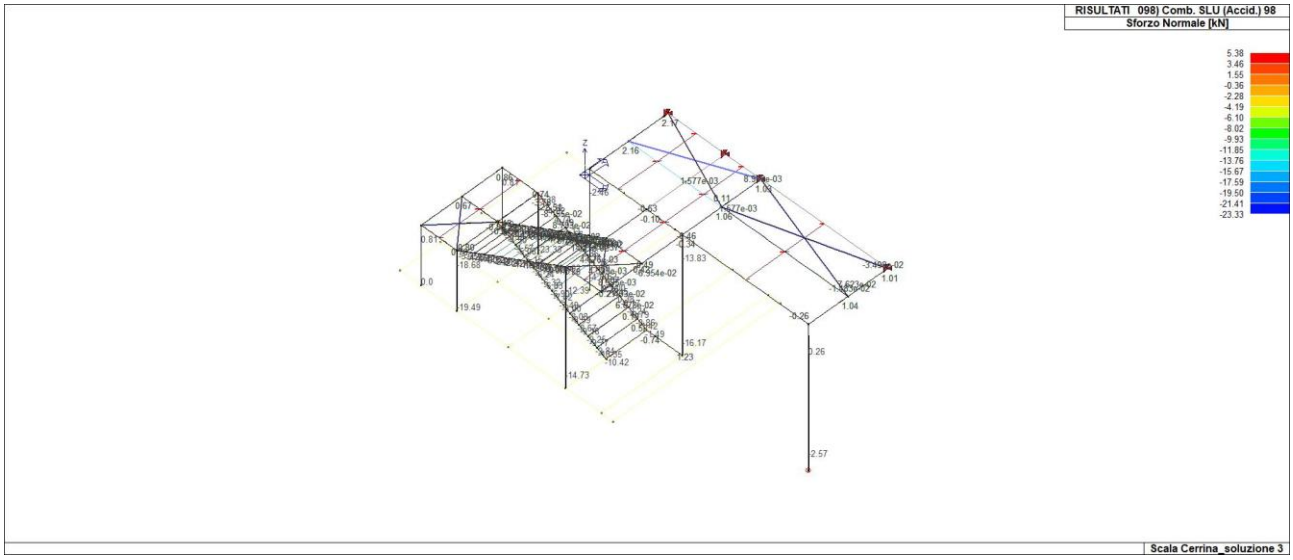

RISULTATI 029) Comb. SLU A1 29
Sforzo Normale [kN]
13.71
11.88
10.05
8.22
6.39
4.56
2.73
0.90
-0.93
-2.76
-4.59
-6.42
-8.24
-10.07
-11.90
-13.73
Scala Cerrina_soluzione 3

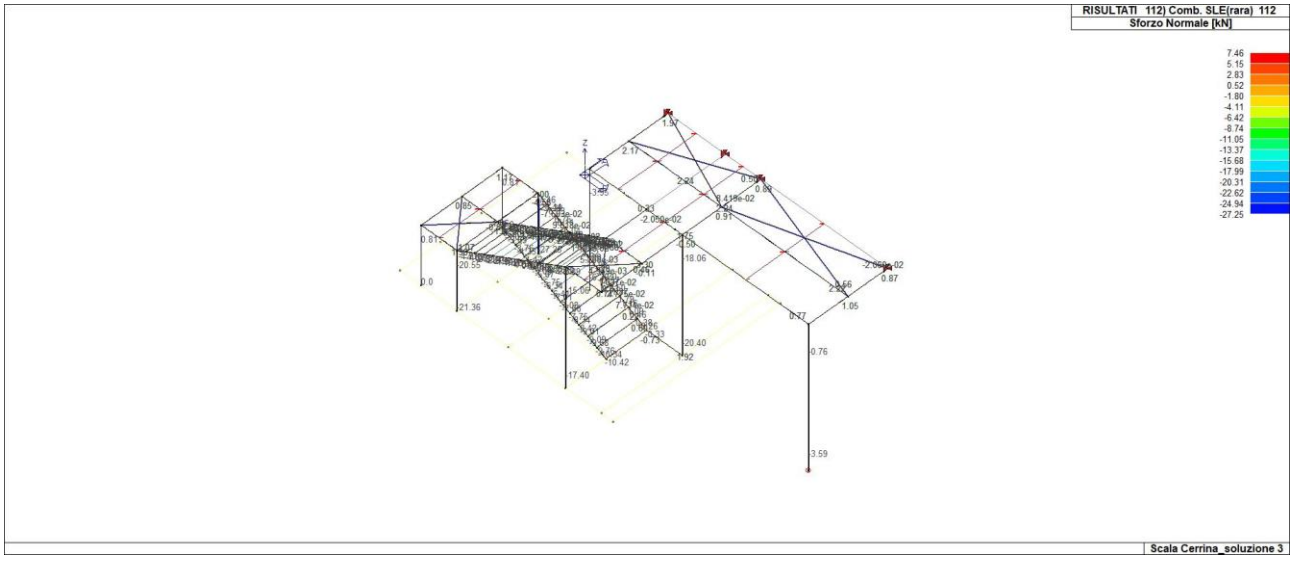

RISULTATI 036) Comb. SLU A1 (SLV sism.) 35
Sforzo Normale [kN]
6.16
3.97
1.78
-0.41
-2.59
-4.78
-6.97
-9.16
-11.34
-13.53
-15.72
-17.91
-20.09
-22.28
-24.47
-26.66
Scala Cerrina_soluzione 3

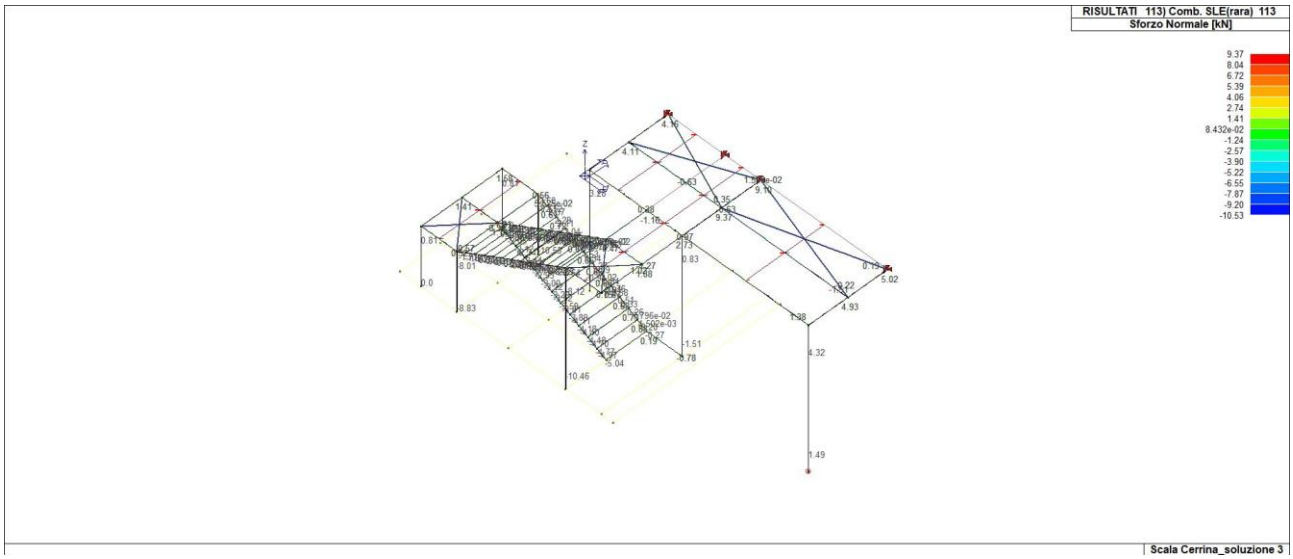

RISULTATI 036) Comb. SLU A1 (SLV sism.) 36
Sforzo Normale [kN]
6.77
4.61
2.46
0.31
-1.85
-4.00
-6.16
-8.31
-10.47
-12.62
-14.78
-16.93
-19.09
-21.24
-23.40
-25.55
Scala Cerrina_soluzione 3

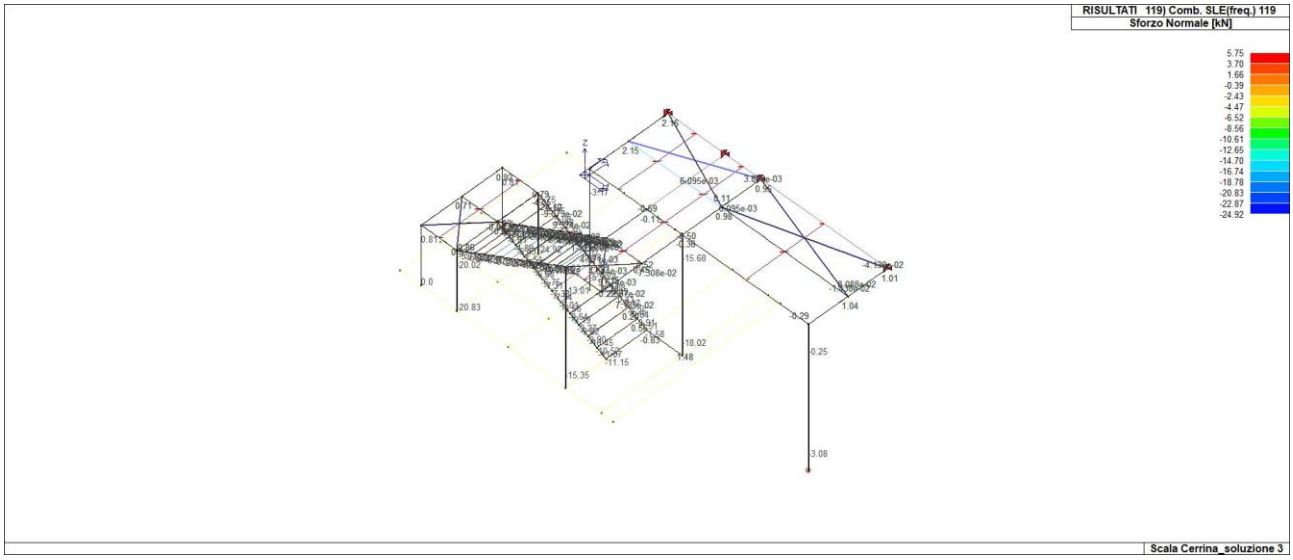

RISULTATI 067) Comb. SLE (SLD Danno sism.) 67
Sforzo Normale [kN]
5.84
3.77
1.70
-0.37
-2.44
-4.51
-6.58
-8.65
-10.72
-12.79
-14.86
-16.92
-18.99
-21.06
-23.13
-25.20
Scala Cerrina_soluzione 3

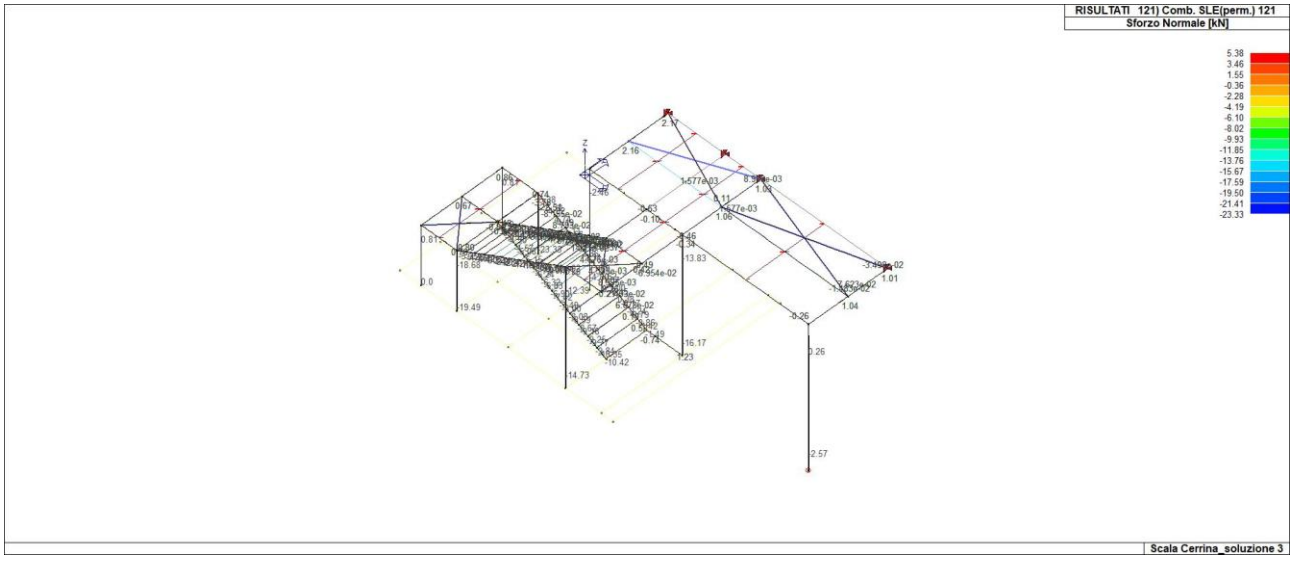

RISULTATI 068) Comb. SLE (SLD Danno sism.) 68
Sforzo Normale [kN]
6.16
4.10
2.05
-4.457e-04
-2.05
-4.10
-6.16
-8.21
-10.26
-12.31
-14.36
-16.42
-18.47
-20.52
-22.57
-24.62
Scala Cerrina_soluzione 3

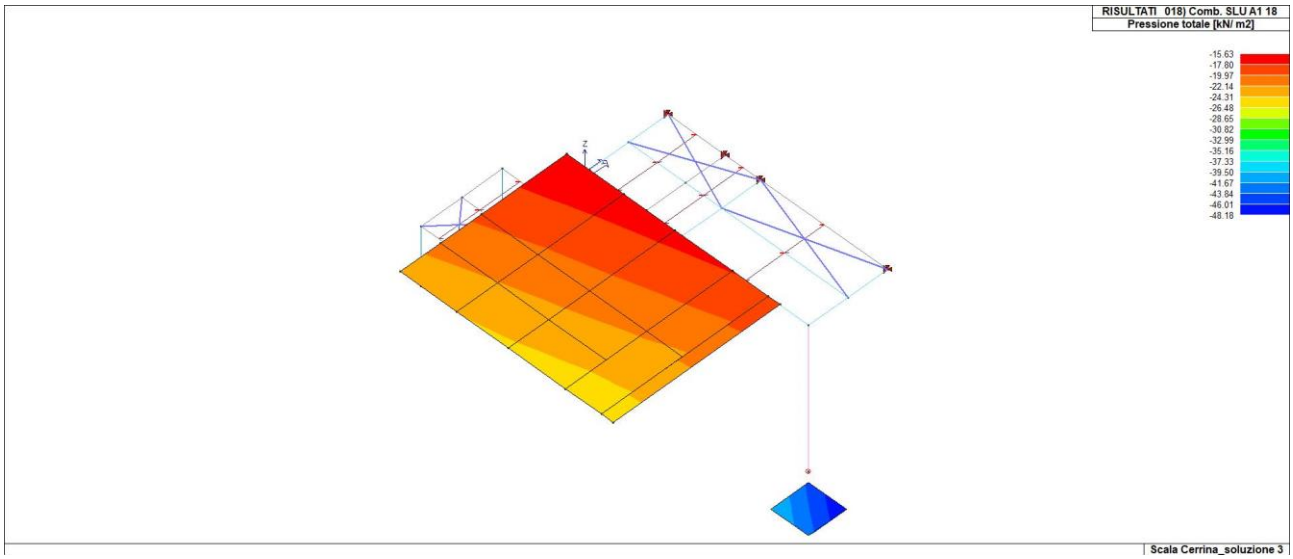

RISULTATI 098) Comb. SLU (Accid.) 98
Sforzo Normale [kN]
5.38
3.46
1.55
-0.36
-2.28
-4.19
-6.10
-8.02
-9.93
-11.85
-13.76
-15.67
-17.59
-19.50
-21.41
-23.33
Scala Cerrina_soluzione 3

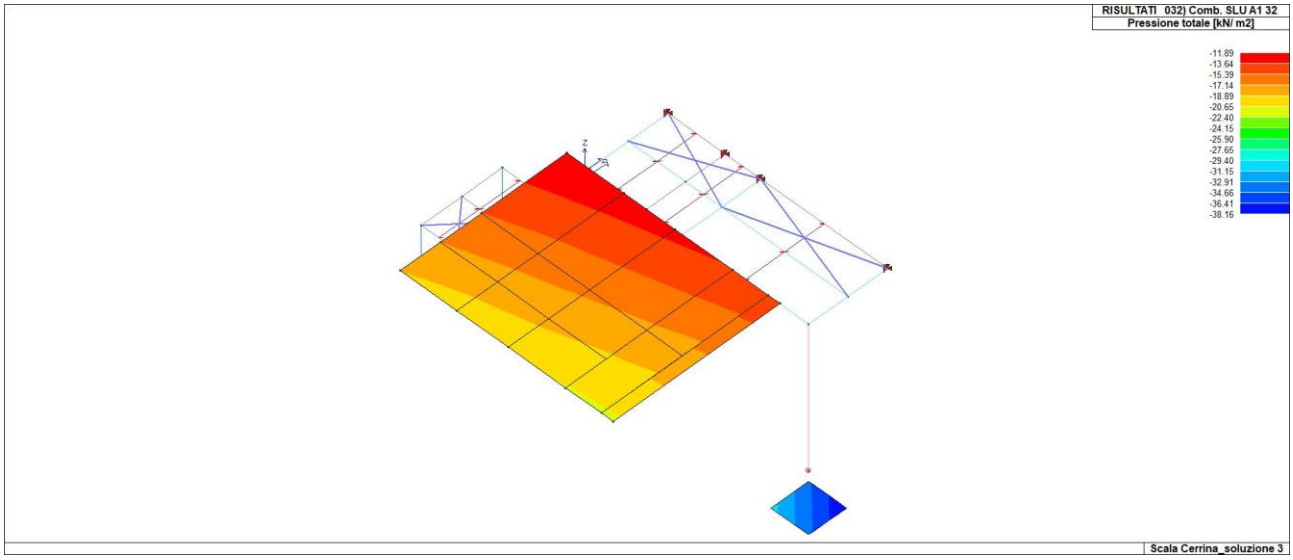

RISULTATI 112) Comb. SLE(rara) 112
Sforzo Normale [kN]
7.46
5.15
2.83
0.52
-1.80
-4.11
-6.42
-8.74
-11.05
-13.37
-15.68
-17.99
-20.31
-22.62
-24.94
-27.25
Scala Cerrina_soluzione 3

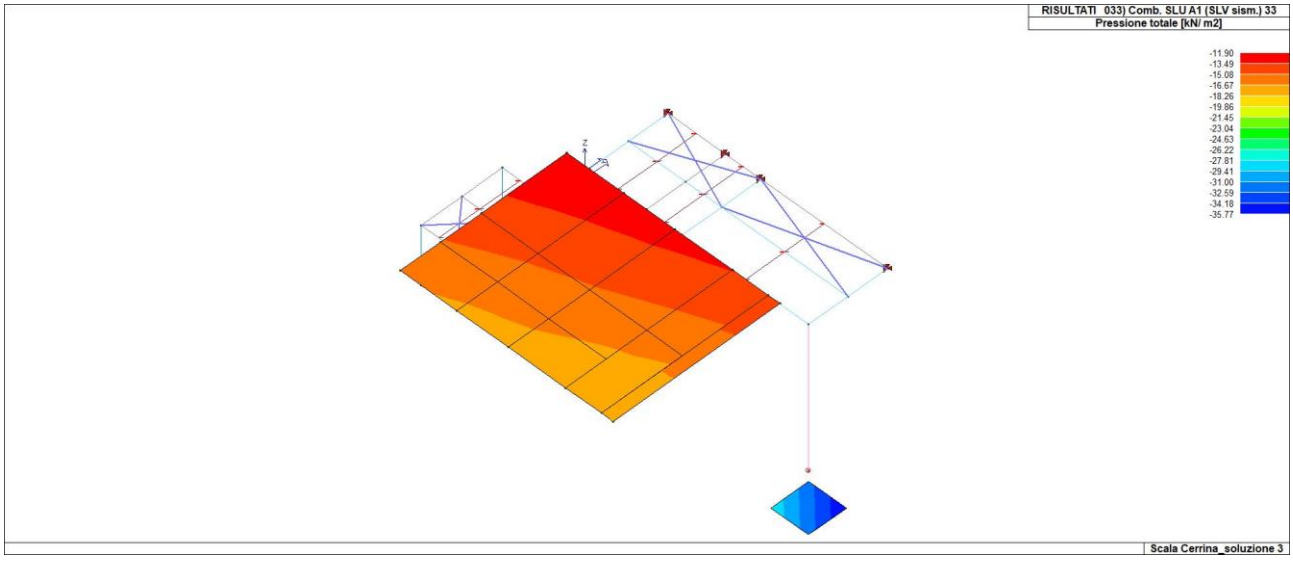

RISULTATI 113) Comb. SLE(rara) 113
Sforzo Normale [kN]
9.37
8.04
6.72
5.39
4.06
2.74
1.41
8.432e-02
-1.24
-2.57
-3.90
-5.22
-6.55
-7.87
-9.20
-10.53
Scala Cerrina_soluzione 3

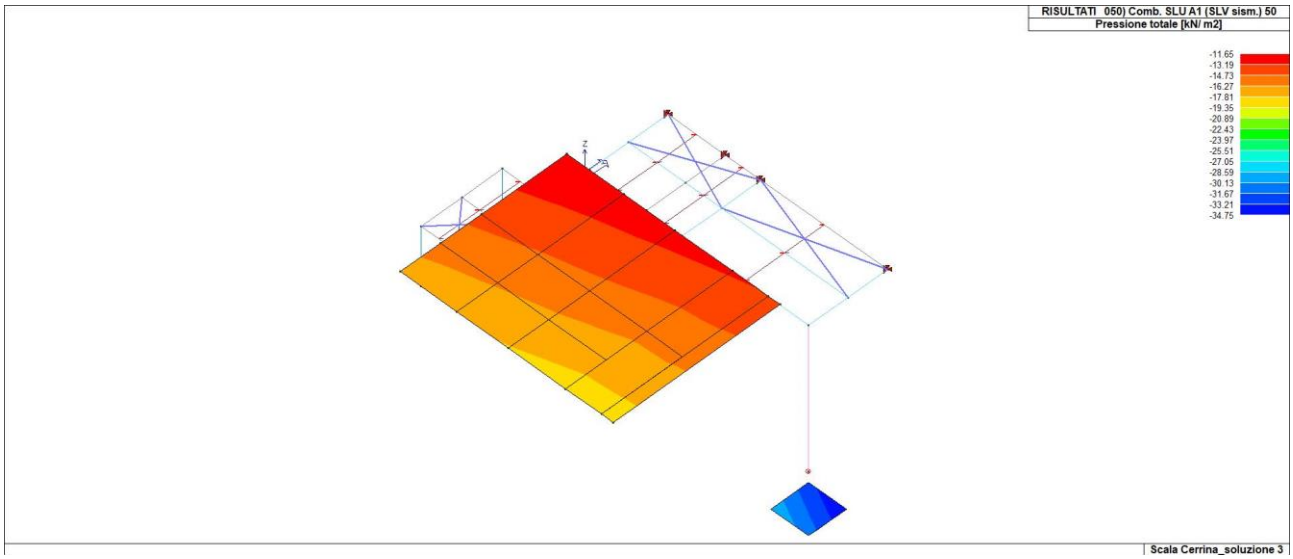

RISULTATI 119) Comb. SLE(freq.) 119
Sforzo Normale [kN]
5.75
3.70
1.66
-0.39
-2.43
-4.47
-6.52
-8.56
-10.61
-12.65
-14.70
-16.74
-18.78
-20.83
-22.87
-24.92
Scala Cerrina_soluzione 3

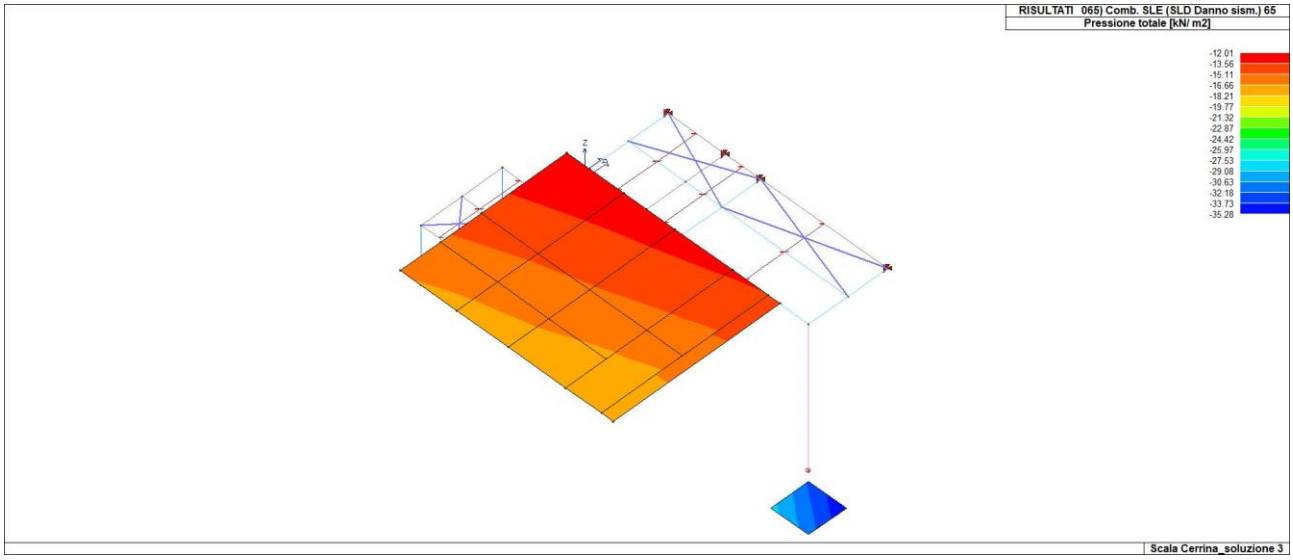

RISULTATI 121) Comb. SLE(perm.) 121
Sforzo Normale [kN]
5.38
3.46
1.55
-0.36
-2.28
-4.19
-6.10
-8.02
-9.93
-11.85
-13.76
-15.67
-17.59
-19.50
-21.41
-23.33
Scala Cerrina_soluzione 3

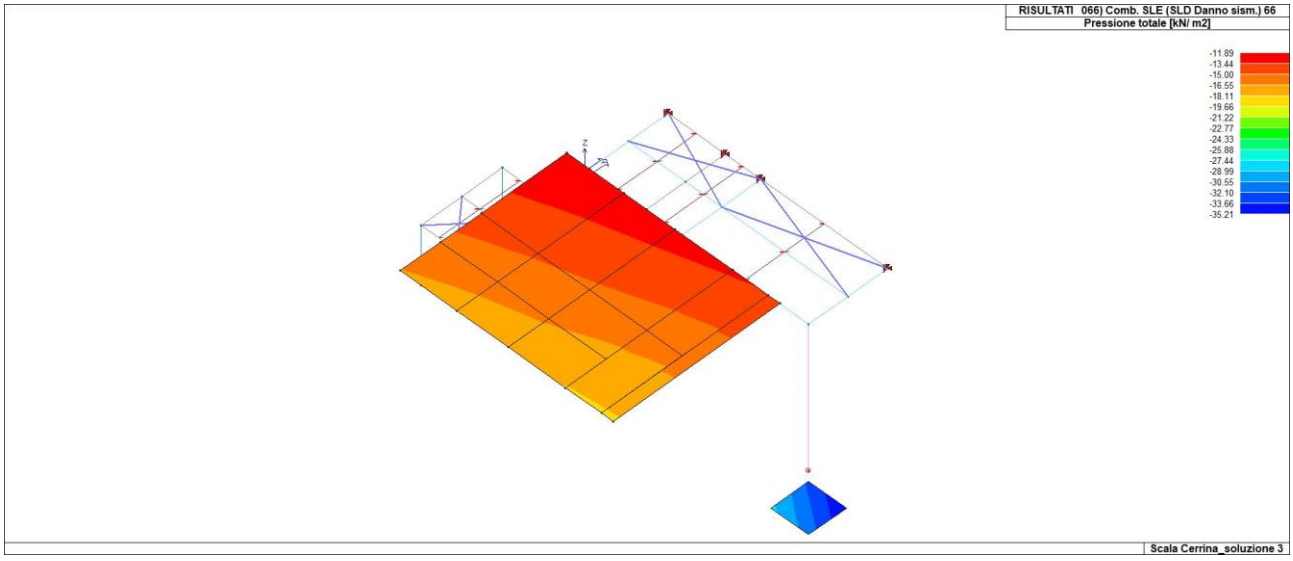

RISULTATI 018) Comb. SLU A1 18
Pressione totale [kN/ m2]
-15.63
-17.80
-19.97
-22.14
-24.31
-26.48
-28.65
-30.82
-32.99
-35.16
-37.33
-39.50
-41.67
-43.84
-46.01
-48.18
Scala Cerrina_soluzione 3

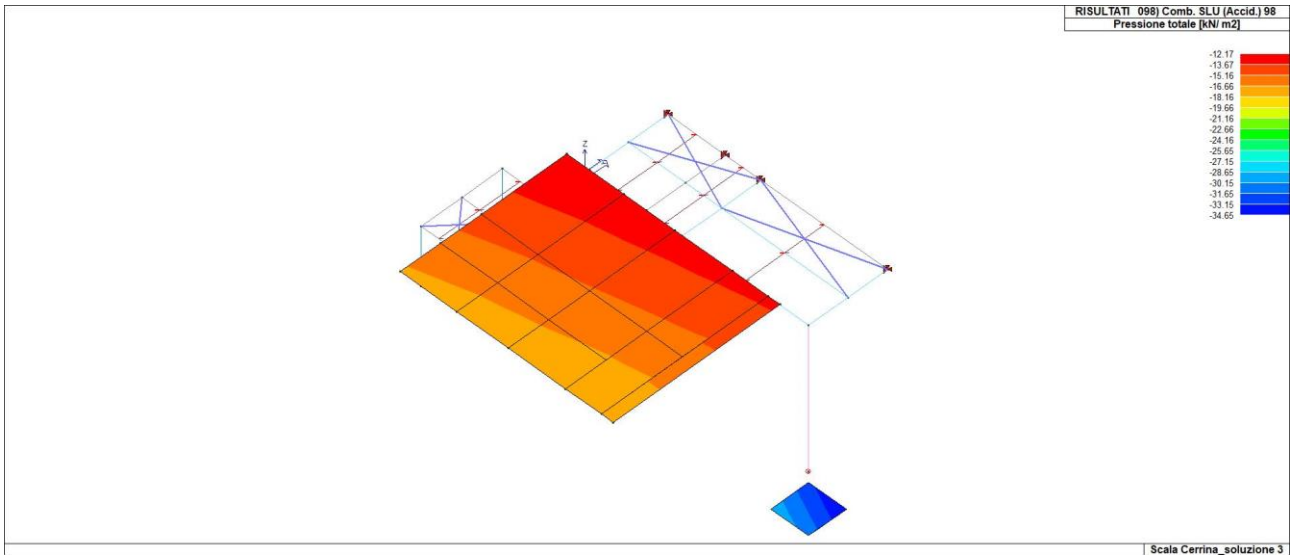

RISULTATI 032) Comb. SLU A1 32
Pressione totale [kN/ m2]
-11.89
-13.64
-15.39
-17.14
-18.89
-20.65
-22.40
-24.15
-25.90
-27.65
-29.40
-31.15
-32.91
-34.66
-36.41
-38.16
Scala Cerrina_soluzione 3

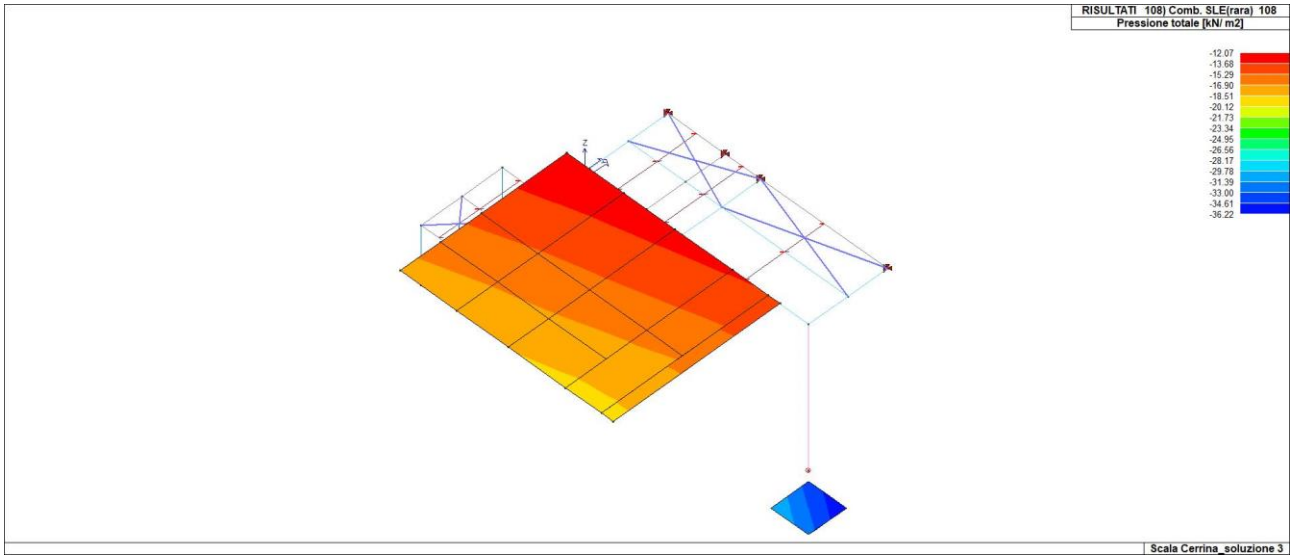

RISULTATI 033) Comb. SLU A1 (SLV sism.) 33
Pressione totale [kN/ m2]
-11.90
-13.49
-15.08
-16.67
-18.26
-19.86
-21.45
-23.04
-24.63
-26.22
-27.81
-29.41
-31.00
-32.59
-34.18
-35.77
Scala Cerrina_soluzione 3

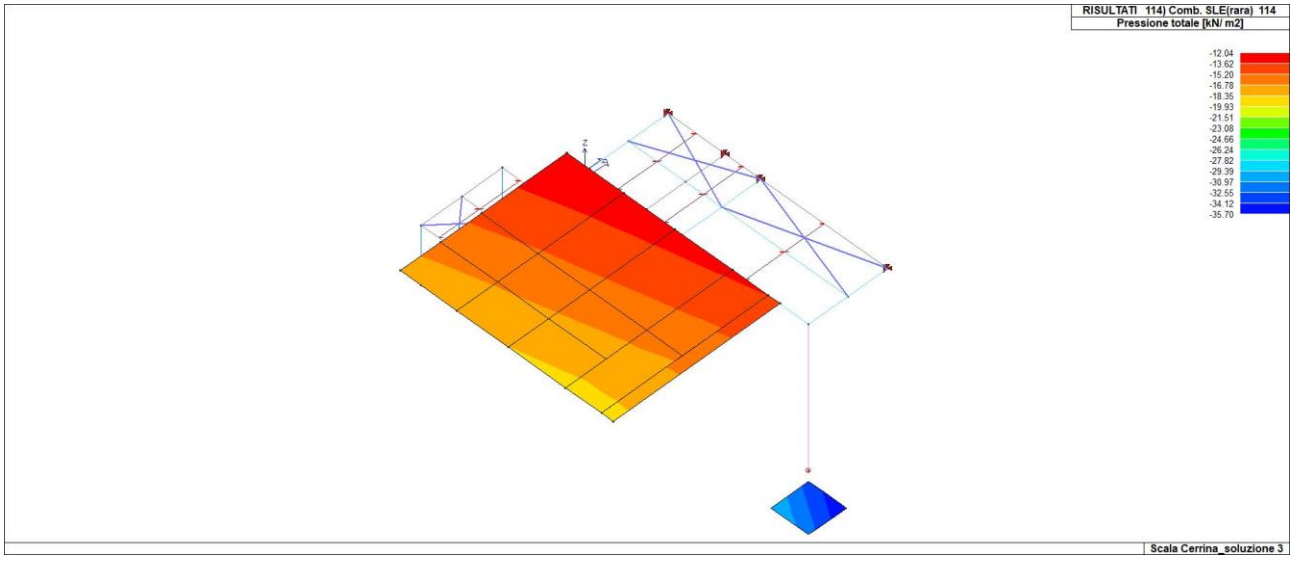

RISULTATI 050) Comb. SLU A1 (SLV sism.) 50
Pressione totale [kN/ m2]
-11.65
-13.19
-14.73
-16.27
-17.81
-19.35
-20.89
-22.43
-23.97
-25.51
-27.05
-28.59
-30.13
-31.67
-33.21
-34.75
Scala Cerrina_soluzione 3

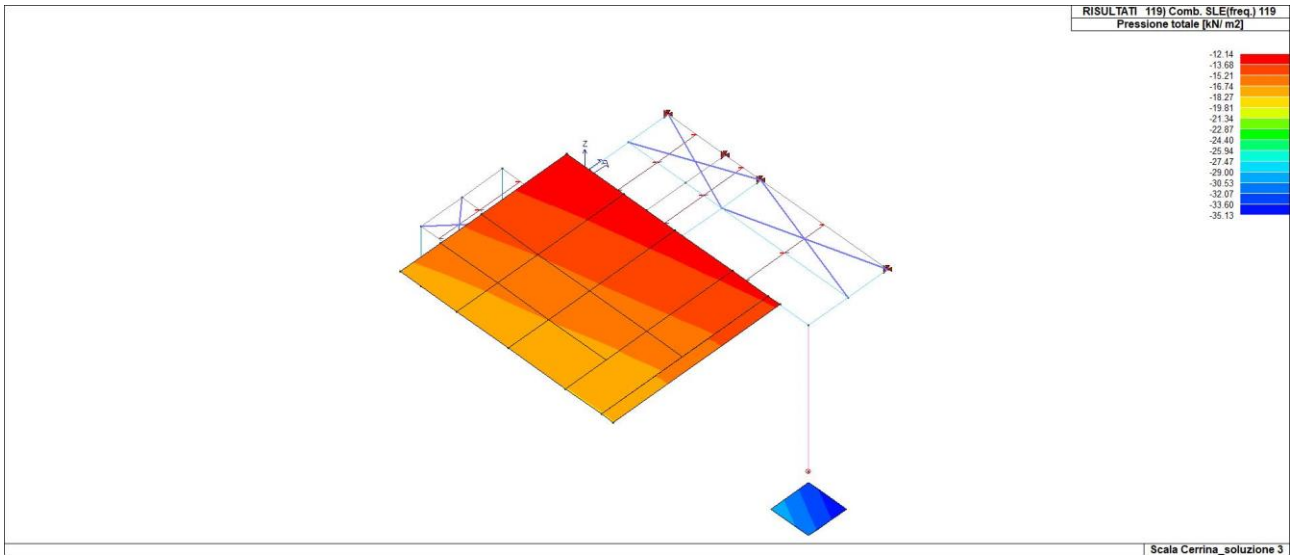

RISULTATI 065) Comb. SLE (SLD Danno sism.) 65
Pressione totale [kN/ m2]
-12.01
-13.56
-15.11
-16.66
-18.21
-19.77
-21.32
-22.87
-24.42
-25.97
-27.53
-29.08
-30.63
-32.18
-33.73
-35.28
Scala Cerrina_soluzione 3

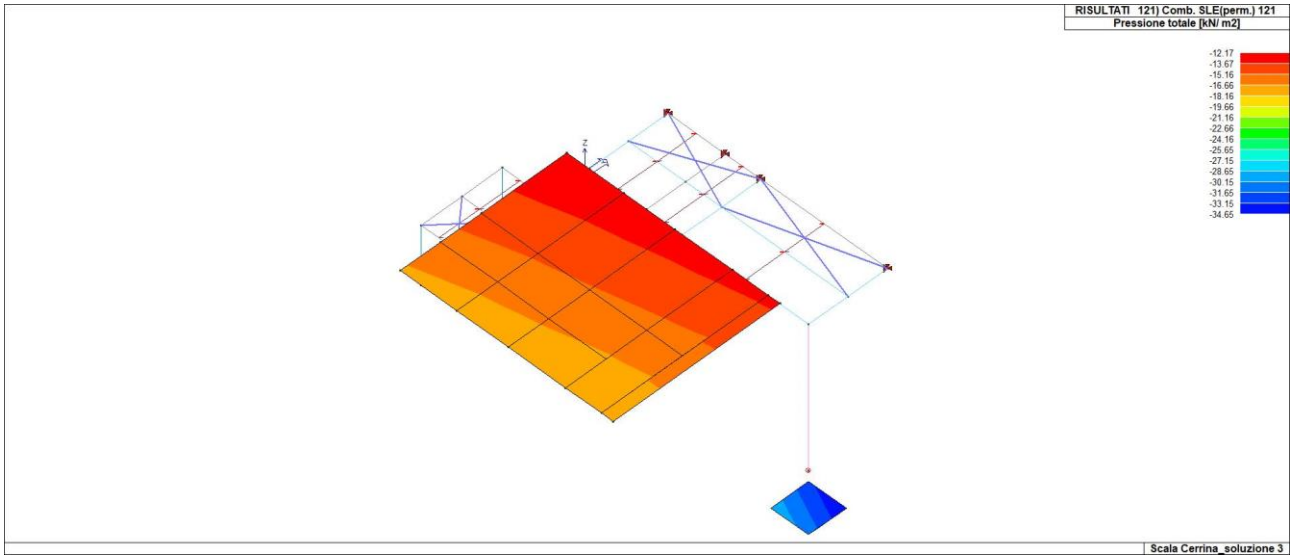

RISULTATI 066) Comb. SLE (SLD Danno sism.) 66
Pressione totale [kN/ m2]
-11.89
-13.44
-15.00
-16.55
-18.11
-19.66
-21.22
-22.77
-24.33
-25.88
-27.44
-28.99
-30.55
-32.10
-33.66
-35.21
Scala Cerrina_soluzione 3


RISULTATI 098) Comb. SLU (Accid.) 98
Pressione totale [kN/ m2]
-12.17
-13.67
-15.16
-16.66
-18.16
-19.66
-21.16
-22.66
-24.16
-25.65
-27.15
-28.65
-30.15
-31.65
-33.15
-34.65
Scala Cerrina_soluzione 3


RISULTATI 108) Comb. SLE(rara) 108
Pressione totale [kN/ m2]
-12.07
-13.68
-15.29
-16.90
-18.51
-20.12
-21.73
-23.34
-24.95
-26.56
-28.17
-29.78
-31.39
-33.00
-34.61
-36.22
Scala Cerrina_soluzione 3


RISULTATI 114) Comb. SLE(rara) 114
Pressione totale [kN/ m2]
-12.04
-13.62
-15.20
-16.78
-18.35
-19.93
-21.51
-23.08
-24.66
-26.24
-27.82
-29.39
-30.97
-32.55
-34.12
-35.70
Scala Cerrina_soluzione 3


RISULTATI 119) Comb. SLE(freq.) 119
Pressione totale [kN/ m2]
-12.14
-13.68
-15.21
-16.74
-18.27
-19.81
-21.34
-22.87
-24.40
-25.94
-27.47
-29.00
-30.53
-32.07
-33.60
-35.13
Scala Cerrina_soluzione 3

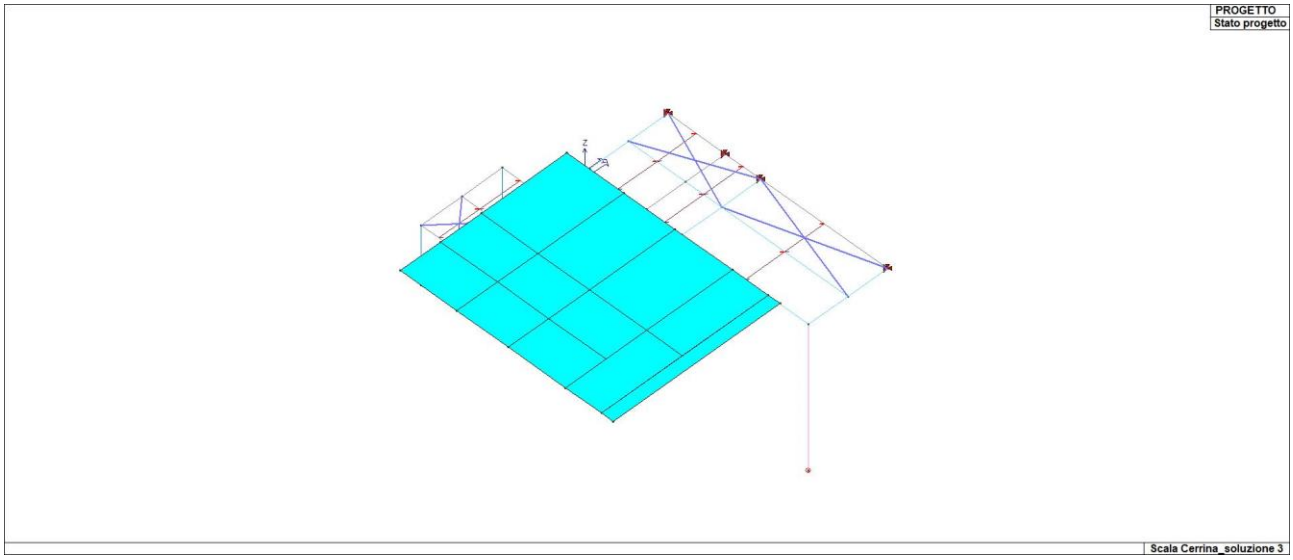

RISULTATI 121) Comb. SLE(perm.) 121
Pressione totale [kN/ m2]
-12.17
-13.67
-15.16
-16.66
-18.16
-19.66
-21.16
-22.66
-24.16
-25.65
-27.15
-28.65
-30.15
-31.65
-33.15
-34.65
Scala Cerrina_soluzione 3

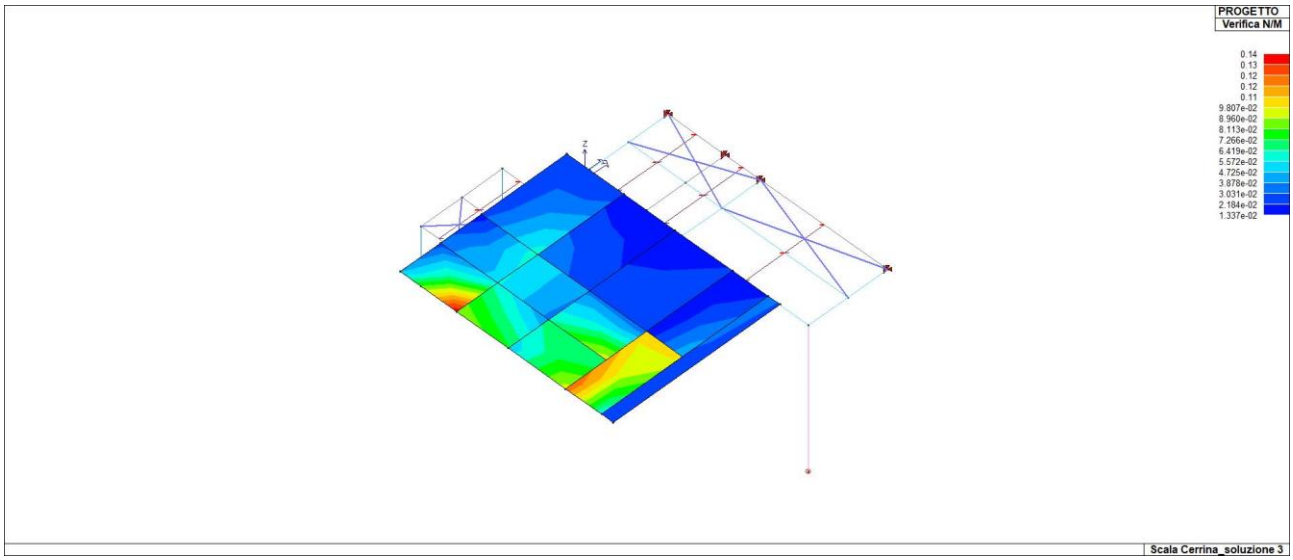
6. SUMMARY OF SAFETY VERIFICATIONS

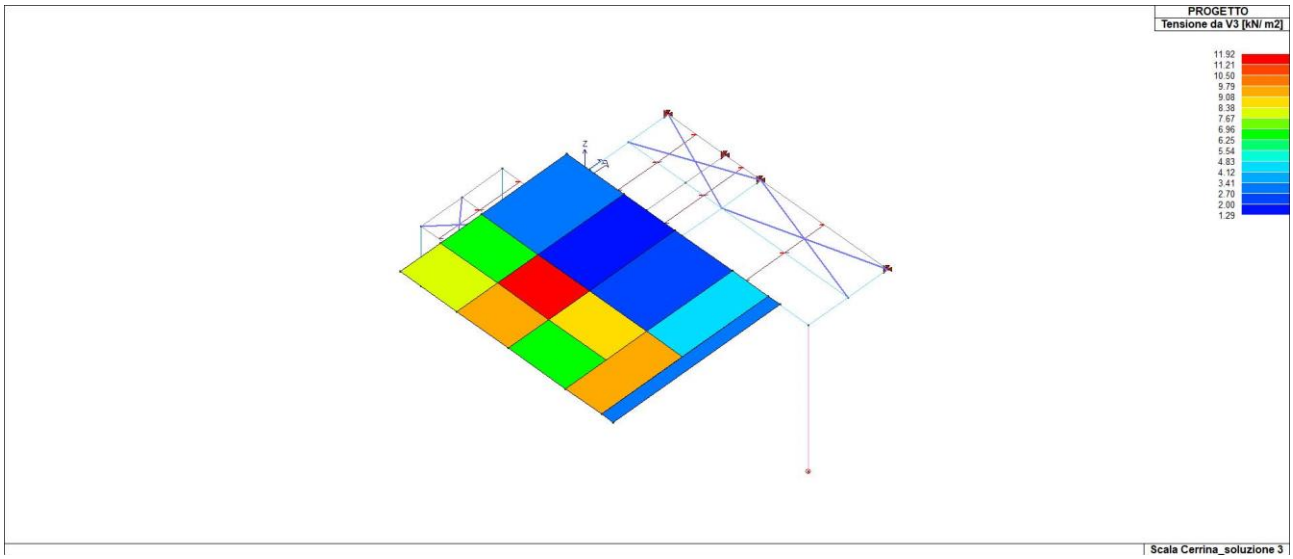
The results of the design and verifications carried out are shown below.

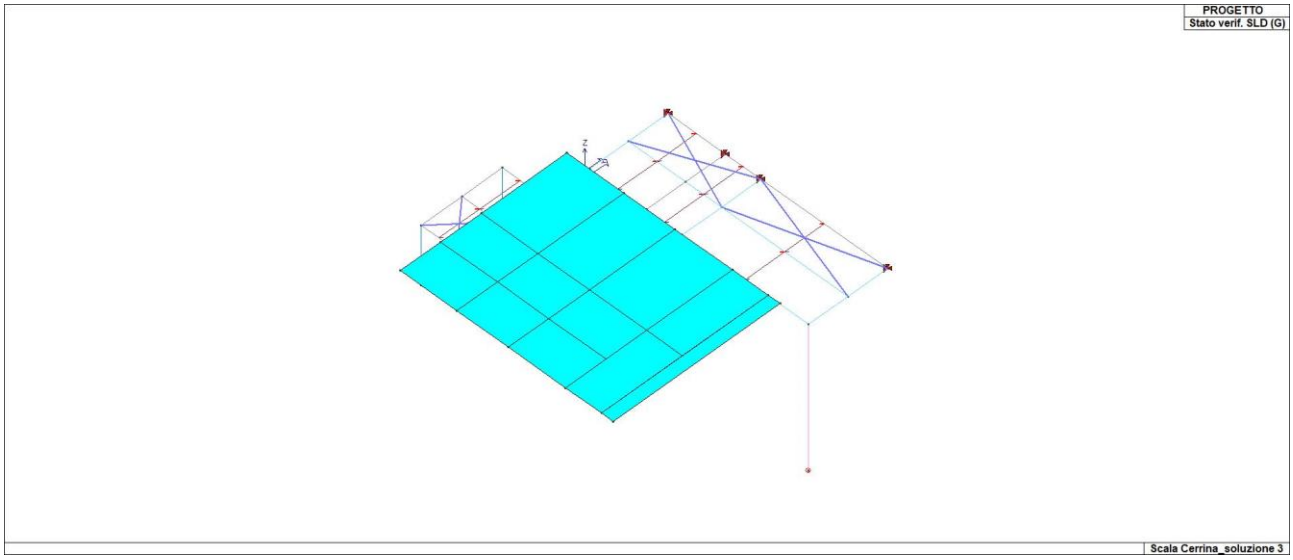
Cyan or green design states indicate that the verifications performed are fully satisfied; red design states, on the contrary, indicate that the verifications are not satisfied.

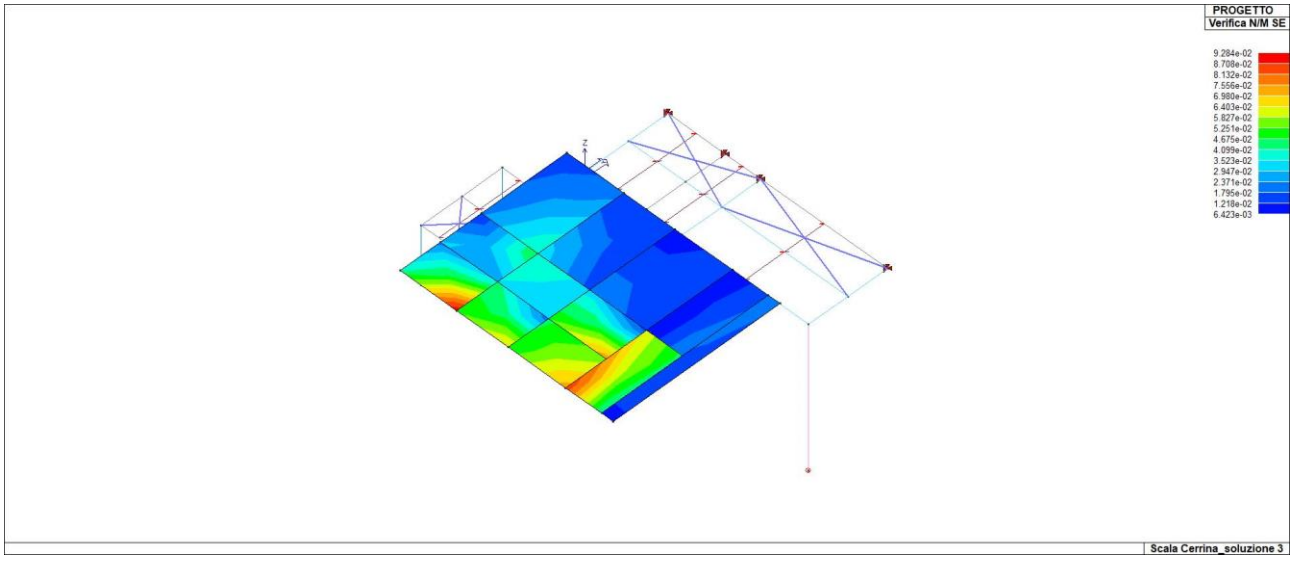
Where possible, the verifications have been normalized. It means that if the values shown in the map are less than unity, the verification can be considered satisfied.
For all other verifications, the values given should be compared with the limit values given by Normative.

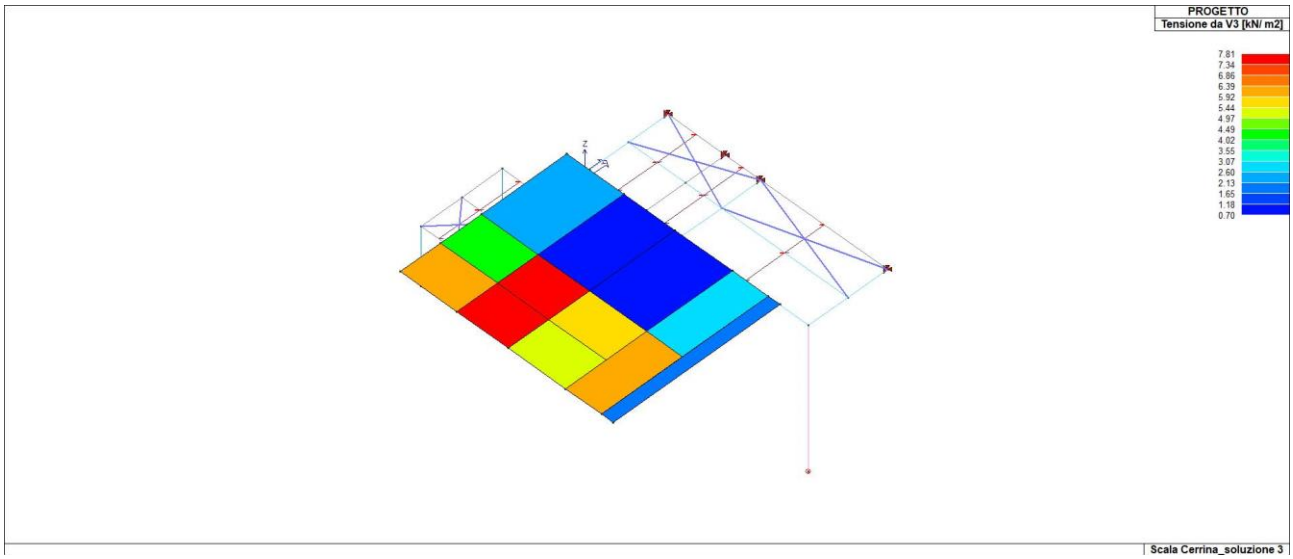


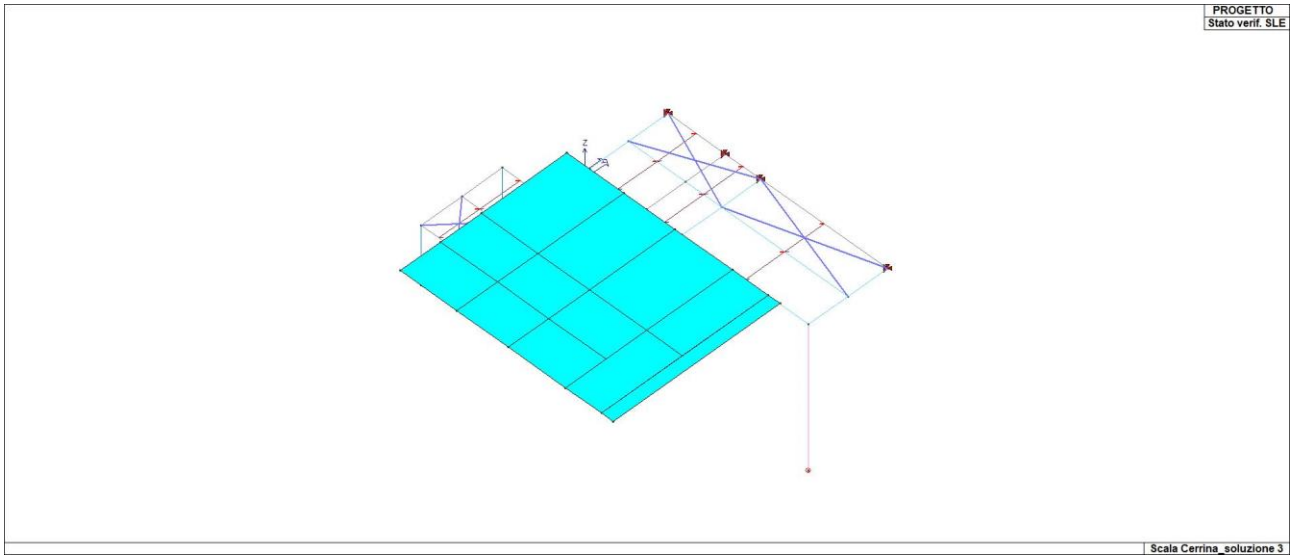


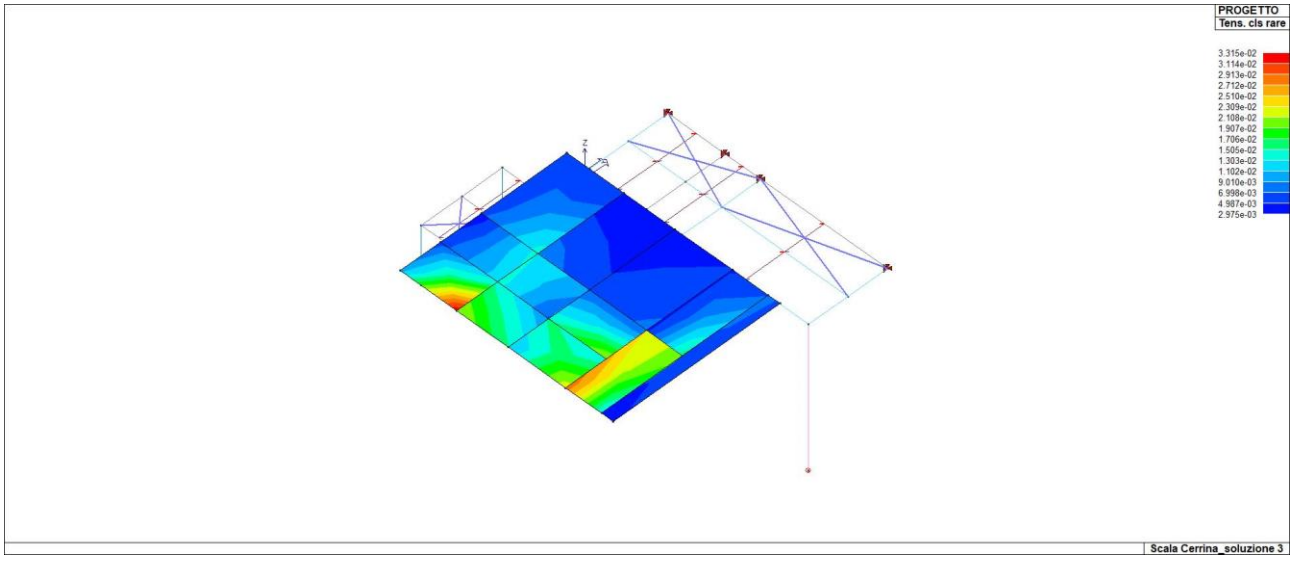

PROGETTO
Tensione da V3 [kN/ m2]
11.92
11.21
10.50
9.79
9.08
8.38
7.67
6.96
6.25
5.54
4.83
4.12
3.41
2.70
2.00
1.29
Scala Cerrina_soluzione 3

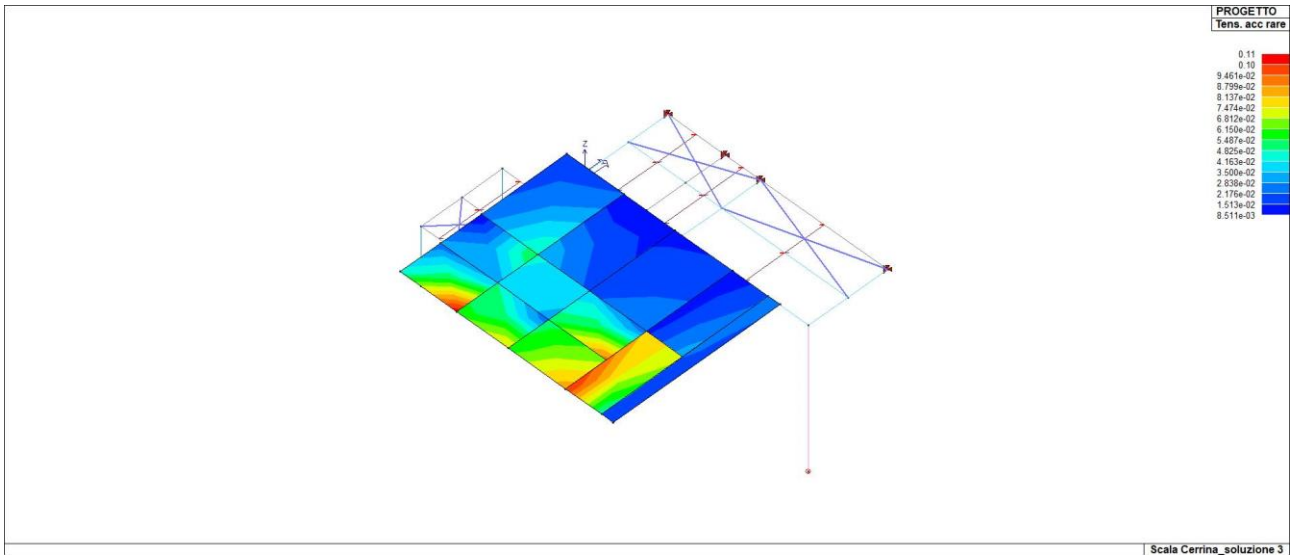

PROGETTO
Stato verif. SLD (G)
Scala Cerrina_soluzione 3

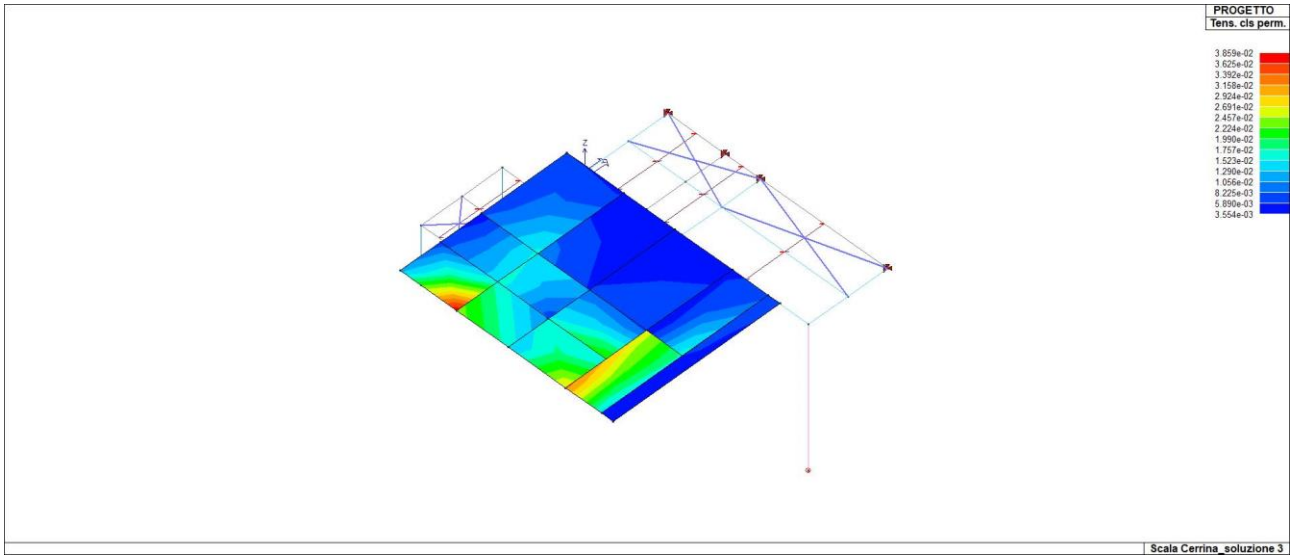

PROGETTO
Verifica N/M SE
9.284e-02
8.708e-02
8.132e-02
7.556e-02
6.980e-02
6.403e-02
5.827e-02
5.251e-02
4.675e-02
4.099e-02
3.523e-02
2.947e-02
2.371e-02
1.795e-02
1.218e-02
6.423e-03
Scala Cerrina_soluzione 3

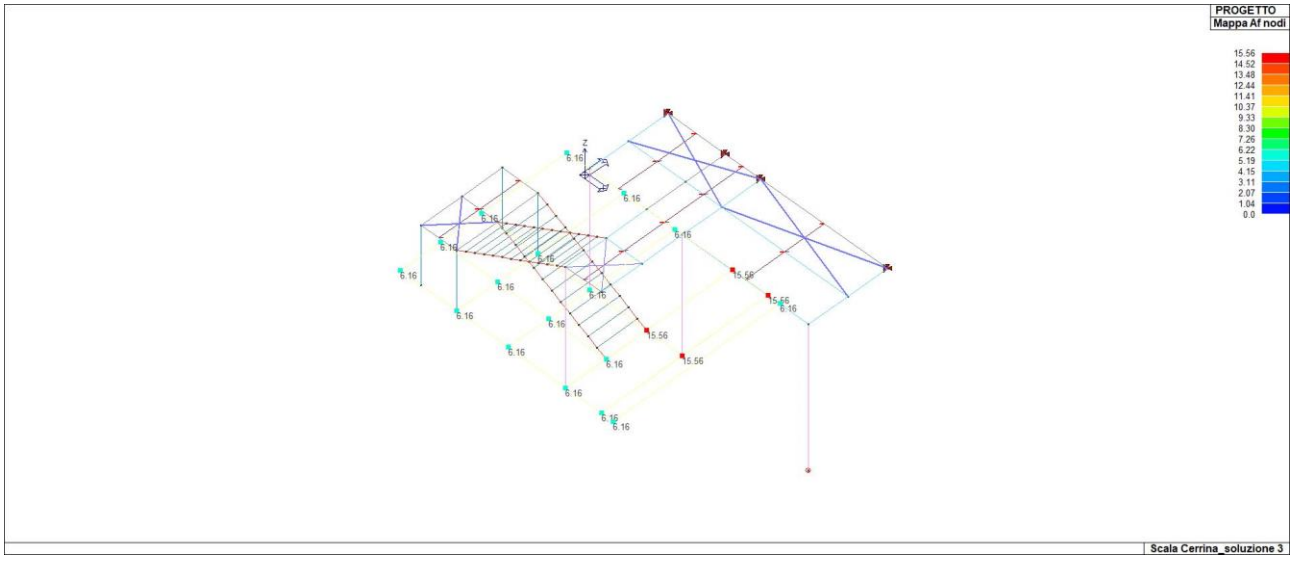

PROGETTO
Tensione da V3 [kN/ m2]
7.81
7.34
6.86
6.39
5.92
5.44
4.97
4.49
4.02
3.55
3.07
2.60
2.13
1.65
1.18
0.70
Scala Cerrina_soluzione 3

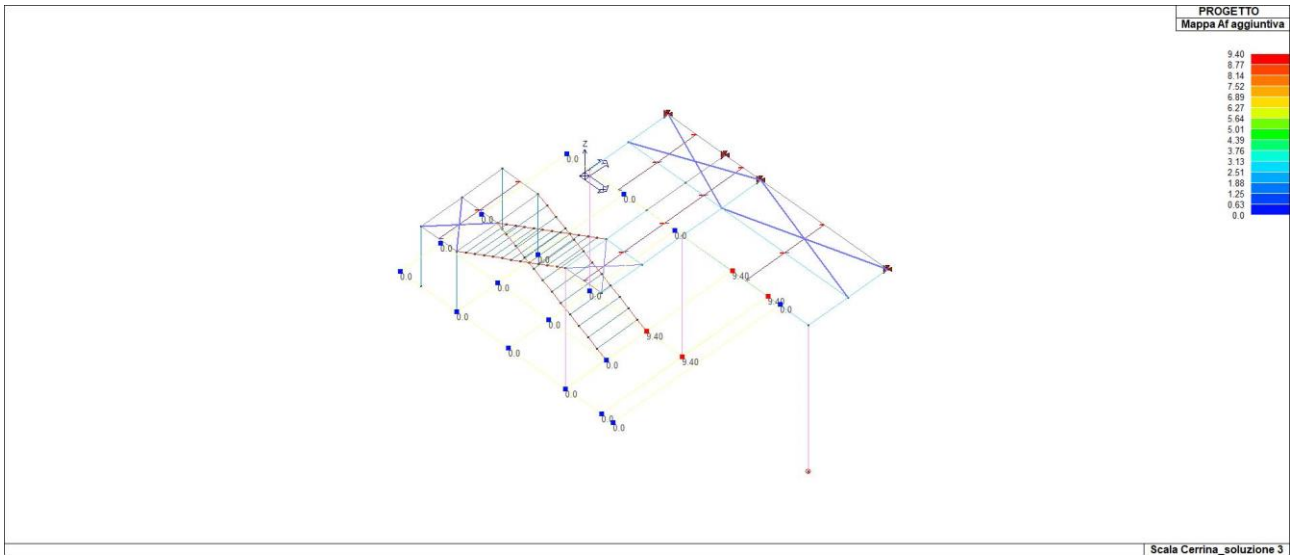

PROGETTO
Stato verif. SLE
Scala Cerrina_soluzione 3


PROGETTO
Tens. cls rare
3.315e-02
3.114e-02
2.913e-02
2.712e-02
2.510e-02
2.309e-02
2.108e-02
1.907e-02
1.706e-02
1.505e-02
1.303e-02
1.102e-02
9.010e-03
6.998e-03
4.987e-03
2.975e-03
Scala Cerrina_soluzione 3


PROGETTO
Tens. acc rare
0.11
0.10
9.461e-02
8.799e-02
8.137e-02
7.474e-02
6.812e-02
6.150e-02
5.487e-02
4.825e-02
4.163e-02
3.500e-02
2.838e-02
2.176e-02
1.513e-02
8.511e-03
Scala Cerrina_soluzione 3

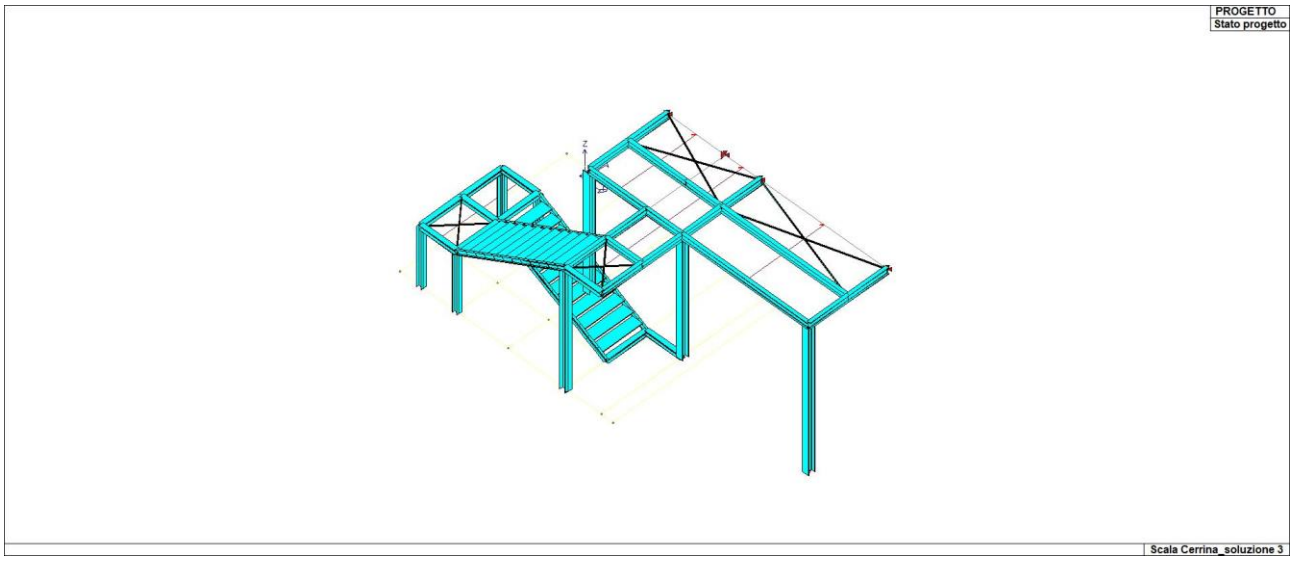

PROGETTO
Tens. cls perm.
3.859e-02
3.625e-02
3.392e-02
3.158e-02
2.924e-02
2.691e-02
2.457e-02
2.224e-02
1.990e-02
1.757e-02
1.523e-02
1.290e-02
1.056e-02
8.225e-03
5.890e-03
3.554e-03
Scala Cerrina_soluzione 3

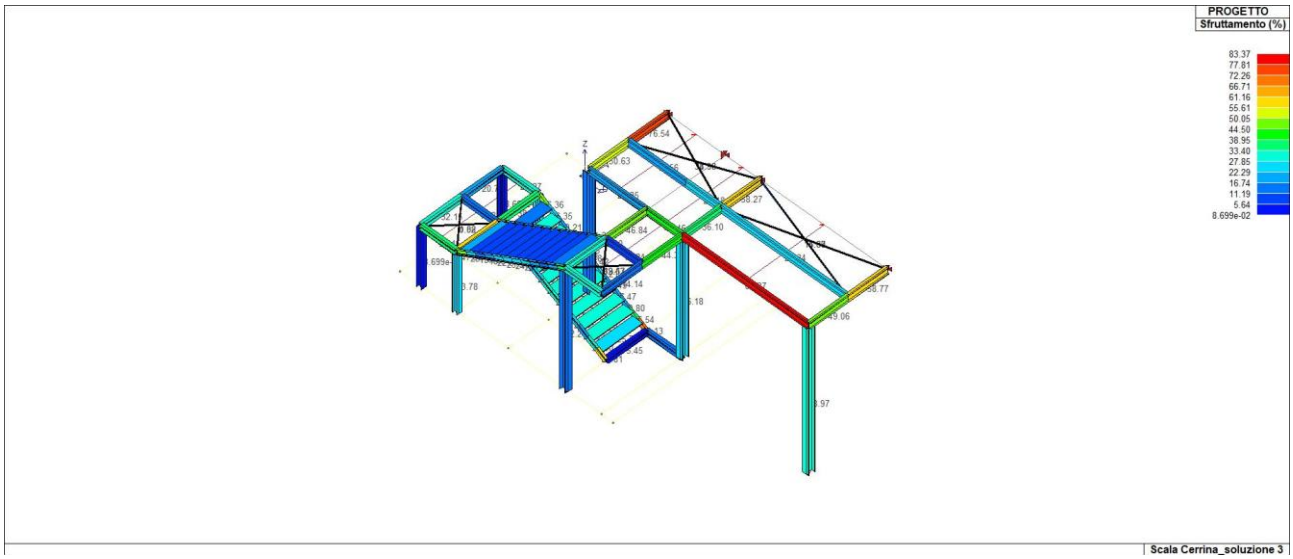

PROGETTO
Mappa Af nodi
15.56
14.52
13.48
12.44
11.41
10.37
9.33
8.30
7.26
6.22
5.19
4.15
3.11
2.07
1.04
0.0
6.16
15.56
Scala Cerrina_soluzione 3

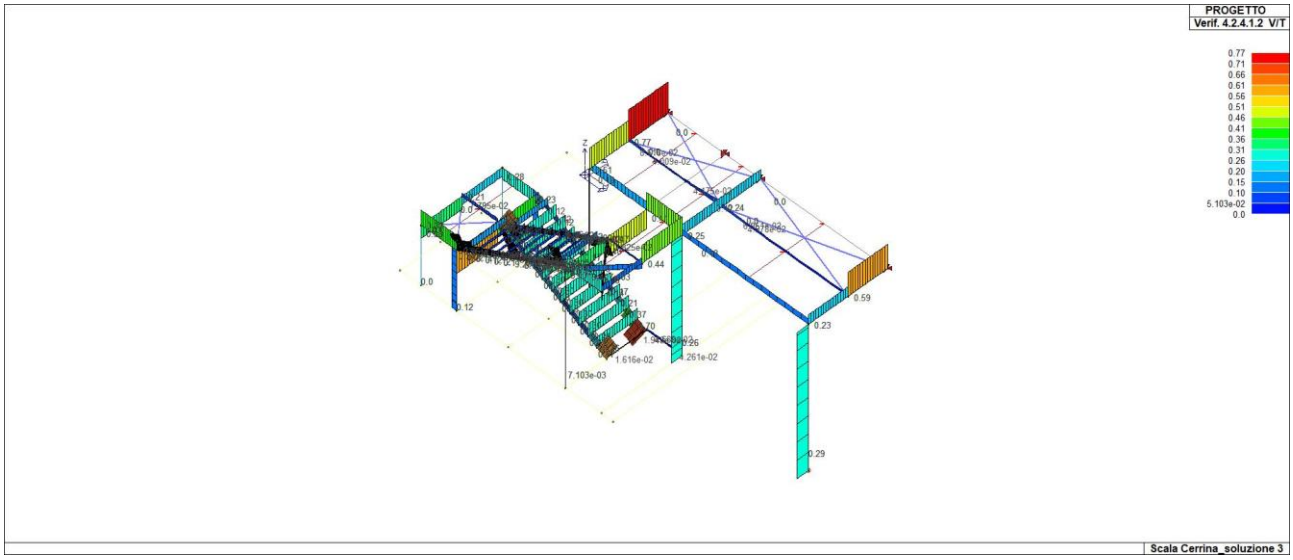


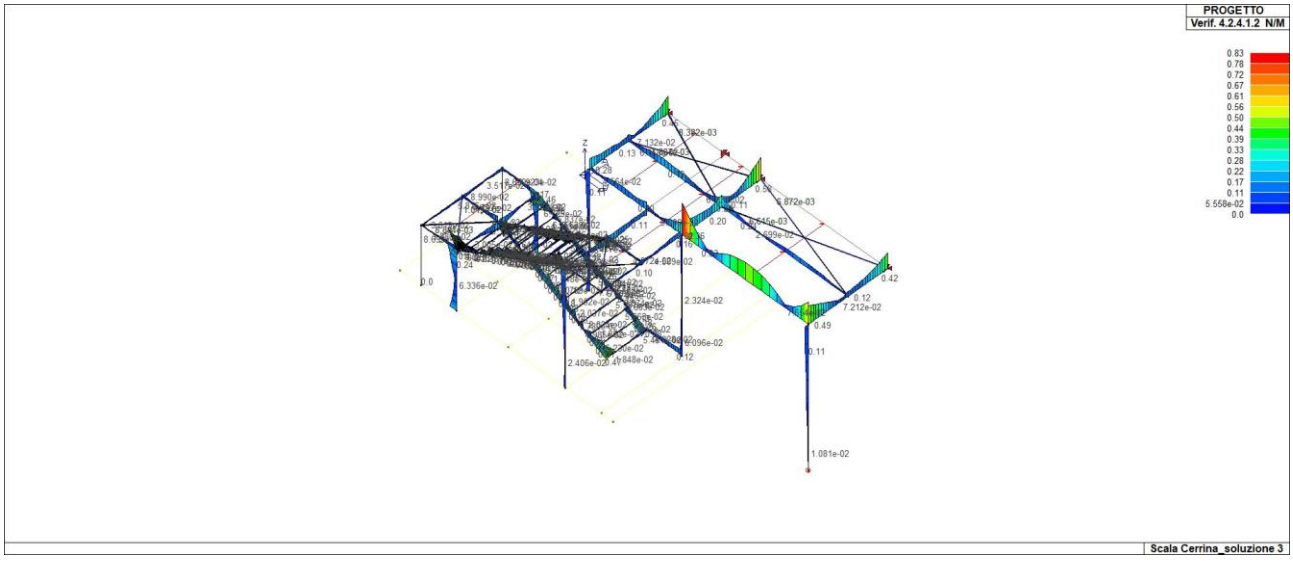
Elementi D3 singoli

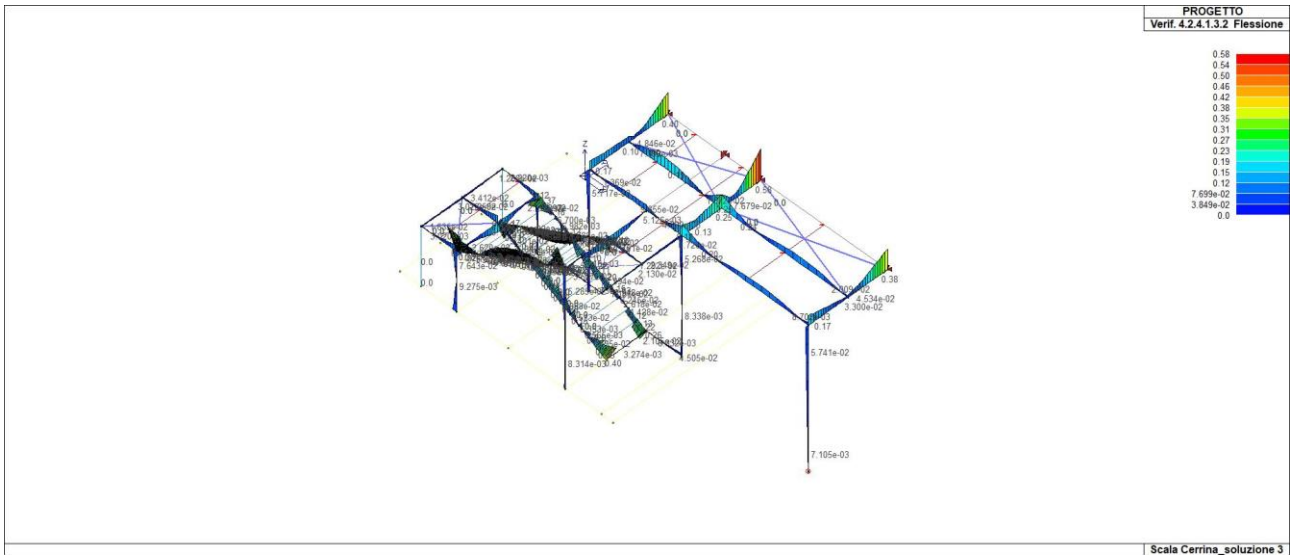
Elementi D3 singoli	Valore minimo	Valore massimo
Verifica N/M	0.01	0.14
Tensione da V3 [kN/ m2]	1.29	11.92
Verifica N/M SE	6.42e-03	0.09
Tensione da V3 [kN/ m2]	0.70	7.81
Tens. cls rare	2.97e-03	0.03
Tens. acc rare	8.51e-03	0.11
Tens. cls perm.	3.55e-03	0.04
Mappa Af nodi	0.0	15.56
Mappa Af aggiuntiva	0.0	9.40

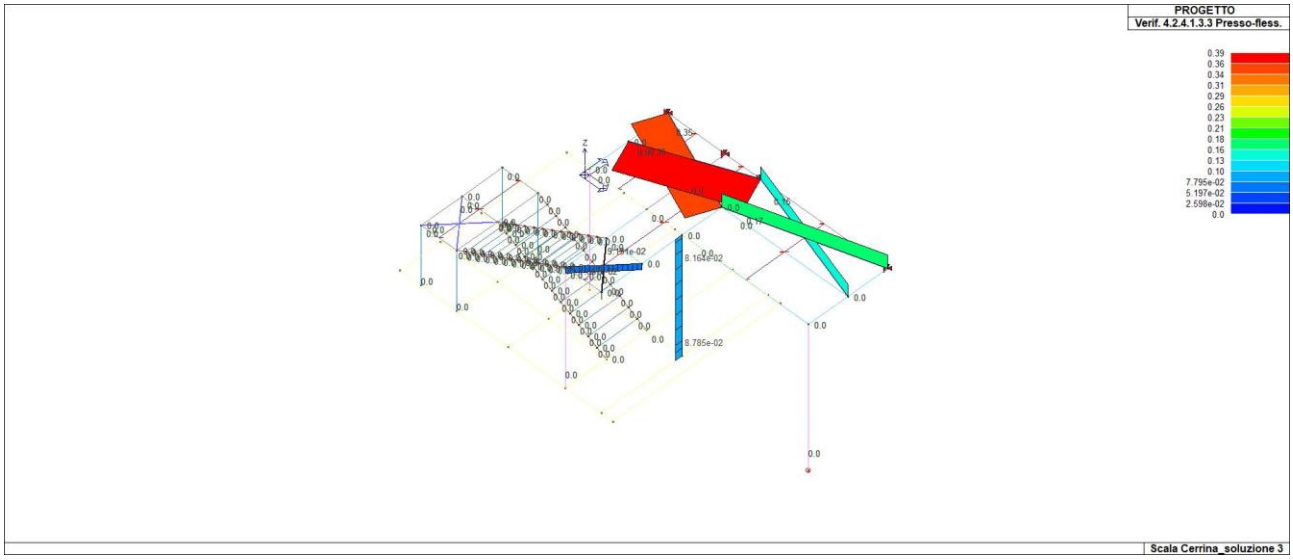


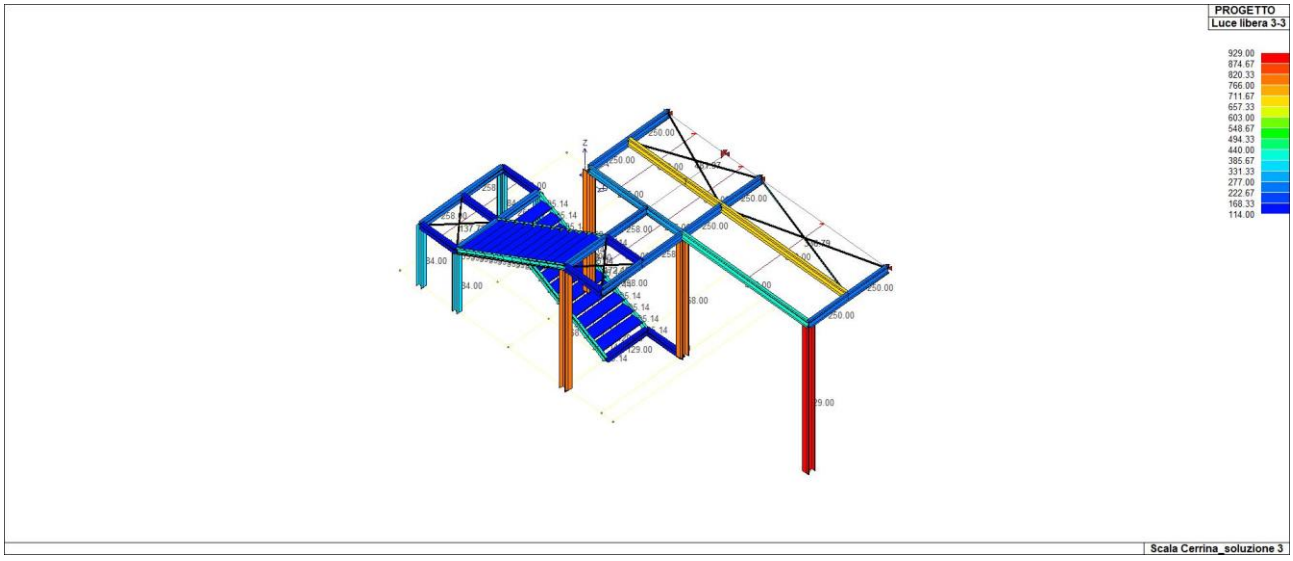

PROGETTO
Sfruttamento (%)
83.37
77.81
72.26
66.71
61.16
55.61
50.05
44.50
38.95
33.40
27.85
22.29
16.74
11.19
5.64
8.699e-02
Scala Cerrina_soluzione 3

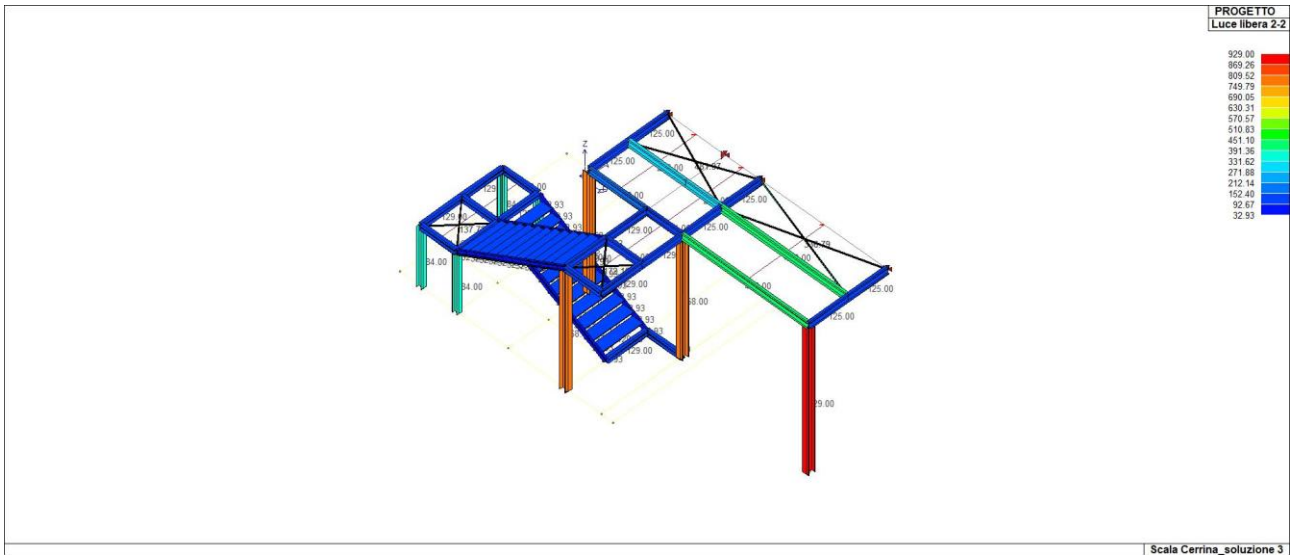

PROGETTO
Verif. 4.2.4.1.2 V/T
0.77
0.71
0.66
0.61
0.56
0.51
0.46
0.41
0.36
0.31
0.26
0.20
0.15
0.10
5.103e-02
0.0
Scala Cerrina_soluzione 3

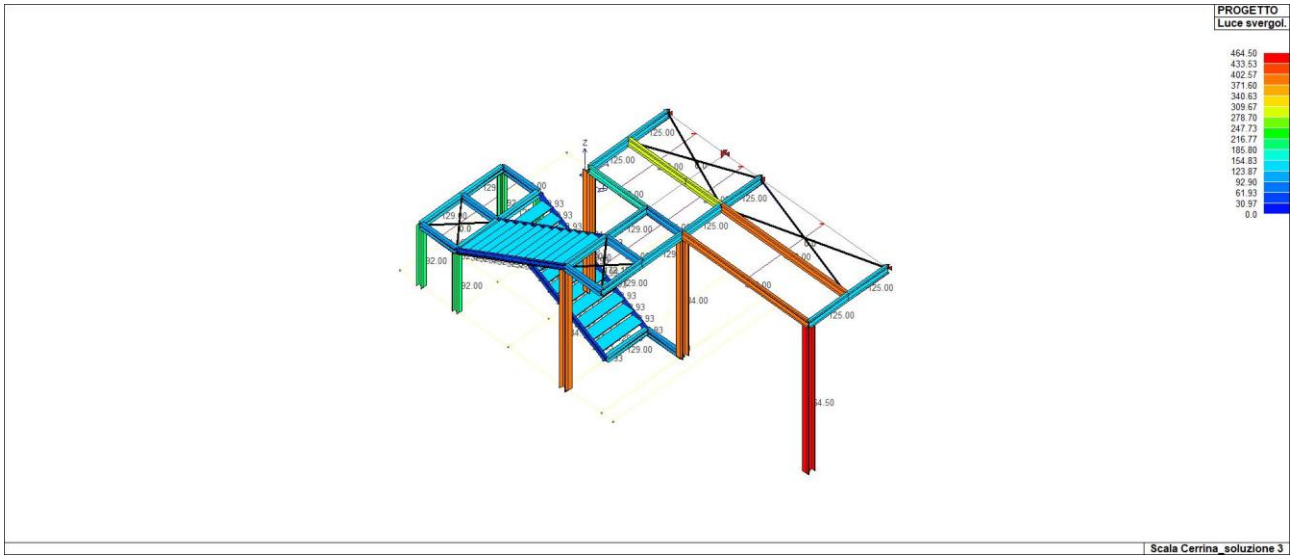

PROGETTO
Verif. 4.2.4.1.2 N/M
0.83
0.78
0.72
0.67
0.61
0.56
0.50
0.44
0.39
0.33
0.28
0.22
0.17
0.11
5.558e-02
0.0
Scala Cerrina_soluzione 3


PROGETTO
Verif. 4.2.4.1.3.2 Flessione
0.58
0.54
0.50
0.46
0.42
0.38
0.35
0.31
0.27
0.23
0.19
0.15
0.12
7.699e-02
3.849e-02
0.0
Scala Cerrina_soluzione 3


PROGETTO
Verif. 4.2.4.1.3.3 Presso-fless.
0.39
0.36
0.34
0.31
0.29
0.26
0.23
0.21
0.18
0.16
0.13
0.10
7.795e-02
5.197e-02
2.598e-02
0.0
Scala Cerrina_soluzione 3


PROGETTO
Luce libera 3-3
929.00
874.67
820.33
766.00
711.67
657.33
603.00
548.67
494.33
440.00
385.67
331.33
277.00
222.67
168.33
114.00
Scala Cerrina_soluzione 3





Elementi in acciaio

Elementi in acciaio	Valore minimo	Valore massimo
Sfruttamento (%)	0.09	83.37
Verif. 4.2.4.1.2 V/T	0.0	0.77
Verif. 4.2.4.1.2 N/M	0.0	0.83
Verif. 4.2.4.1.3.2 Flessione	0.0	0.58
Verif. 4.2.4.1.3.3 Presso-fless.	0.0	0.39
Luce libera 3-3	114.00	929.00
Luce libera 2-2	32.93	929.00
Luce svergol.	0.0	464.50

7. REASONED JUDGMENT OF ACCEPTABILITY OF RESULTS

The program provides a series of automatic checks (checks) that allow for the detection of modeling errors. At the end of the analysis, an automatic check identifies the presence of abnormal displacements or rotations. It can therefore be assumed that the 'processing is correct and complete. The processing results were subjected to checks to substantiate their reliability. This evaluation included comparison with the results of simple calculations, performed by traditional methods and adopted, even at the initial proportioning stage of the structure. In addition, based on considerations regarding the tensional and deformational states determined, the validity of the choices made in the schematization and modeling of the structure and actions was evaluated. Attached at the end of this report is a summary list of the checks performed (checks of equilibrium between constraining reactions and applied loads, comparisons between the results of the analyses and those of simplified evaluations, etc.) .