



I Metodi della Fire Safety Engineering alla luce del Codice di Prevenzione Incendi 2015

Politecnico di Milano – Aula Rogers 7 aprile 2016

Structural Fire Engineering oltre i limiti dell'approccio prescrittivo

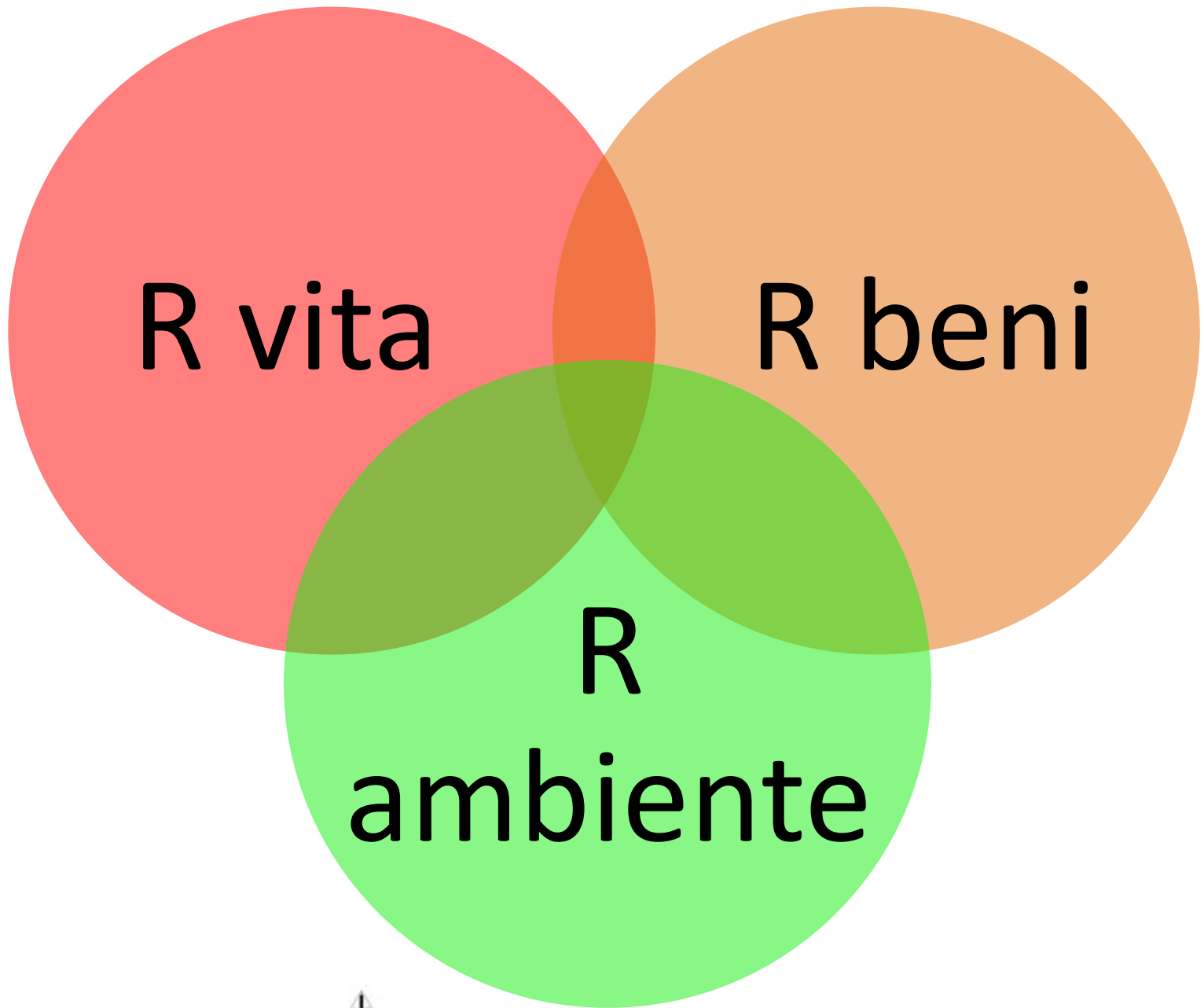
Relatori :

Prof. Ing. Paolo Setti

Politecnico di Milano/ FSC Engineering srl

Ing. Samuele Sassi

FSC Engineering srl



R vita

R beni

R
ambiente

R vita

R beni

SFS

SFS

Structural **F**ire **S**afety

SCENARIO E OBIETTIVO

Definizione dello scenario di incendio

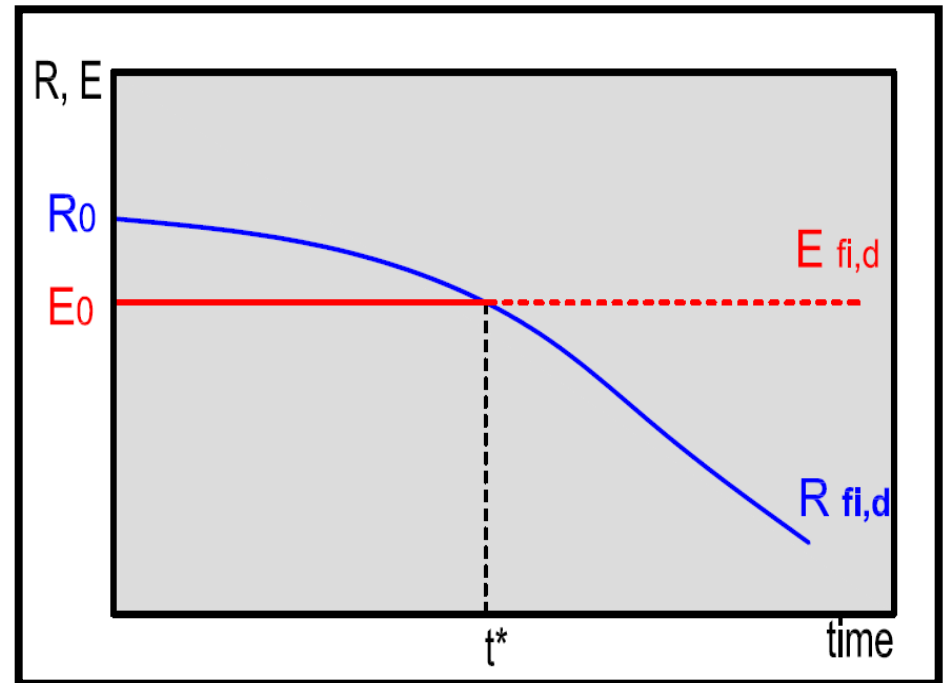
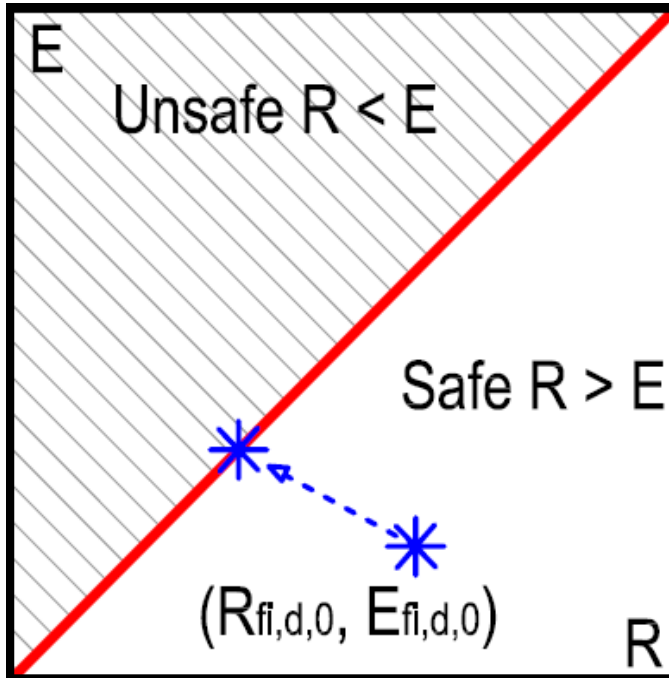
Definizione degli obiettivi

Definizione dello schema statico



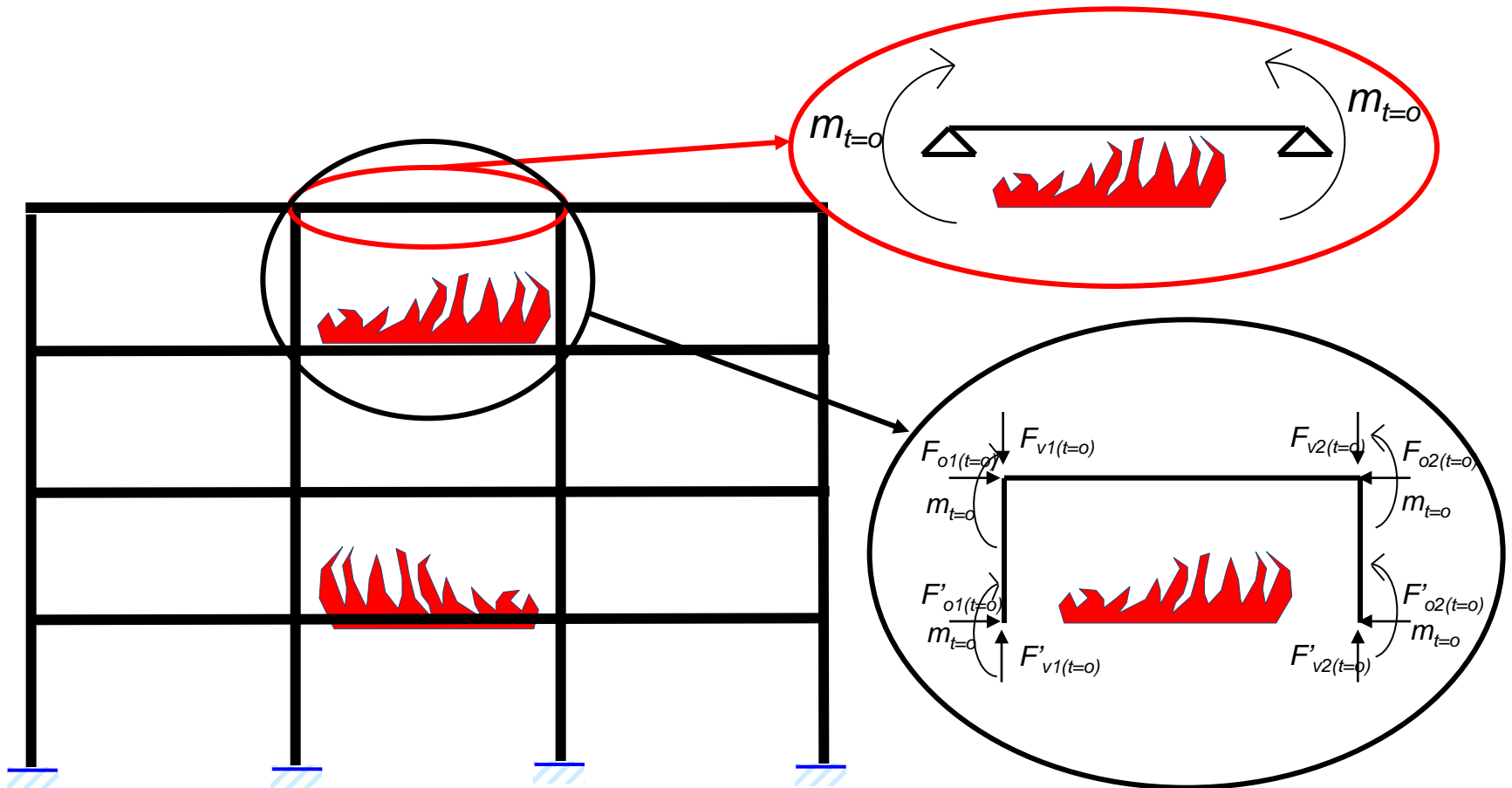
Criterio di verifica – EN 199x – 1.2

$$E_{fi,d} < R_{fi,d,t}$$



$t^* = \text{tempo di resistenza al fuoco}$

ANALISI PER SINGOLI ELEMENTI O PER SOTTOSTRUTTURE



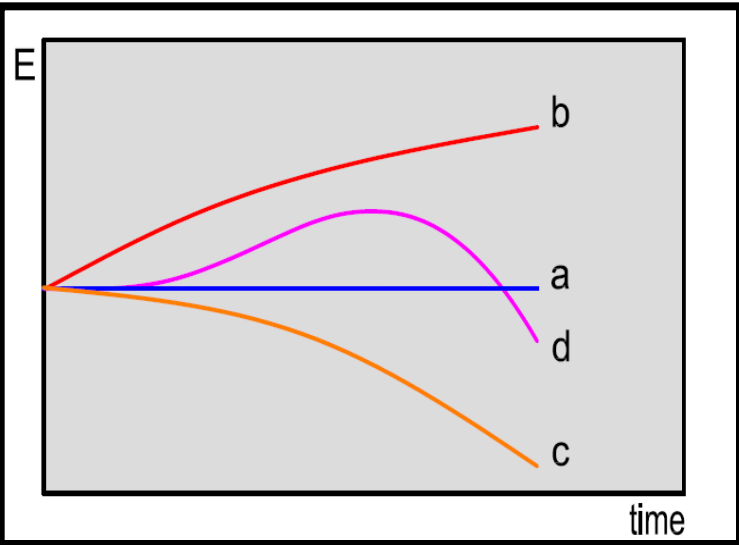
Variazione dell'azione sollecitante $E_{fi,t}$ in funzione del tempo

a) $E_{fi,t} = E_{fi,t+\Delta t}$
(sistemi isostatici, senza gradienti di temperatura)

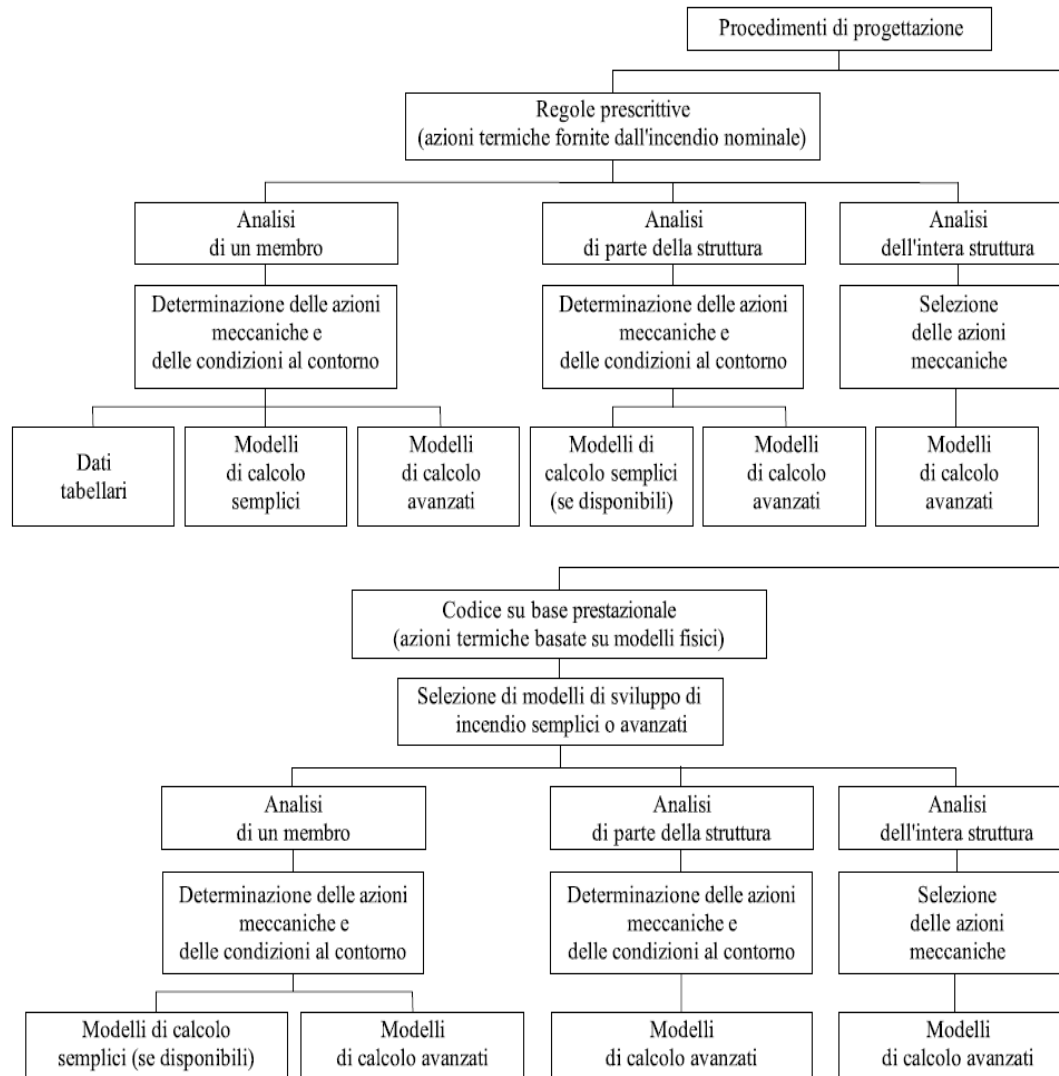
b) $E_{fi,t} < E_{fi,t+\Delta t}$
(sollecitazioni indotte da dilatazione termica)

c) $E_{fi,t} > E_{fi,t+\Delta t}$
(sollecitazione decrescente)

d) $E_{fi,t} = E_{fi,t}(t)$
(sollecitazione variabile con legge qualunque)



EN 1991. 1-2 Procedimenti di progettazione



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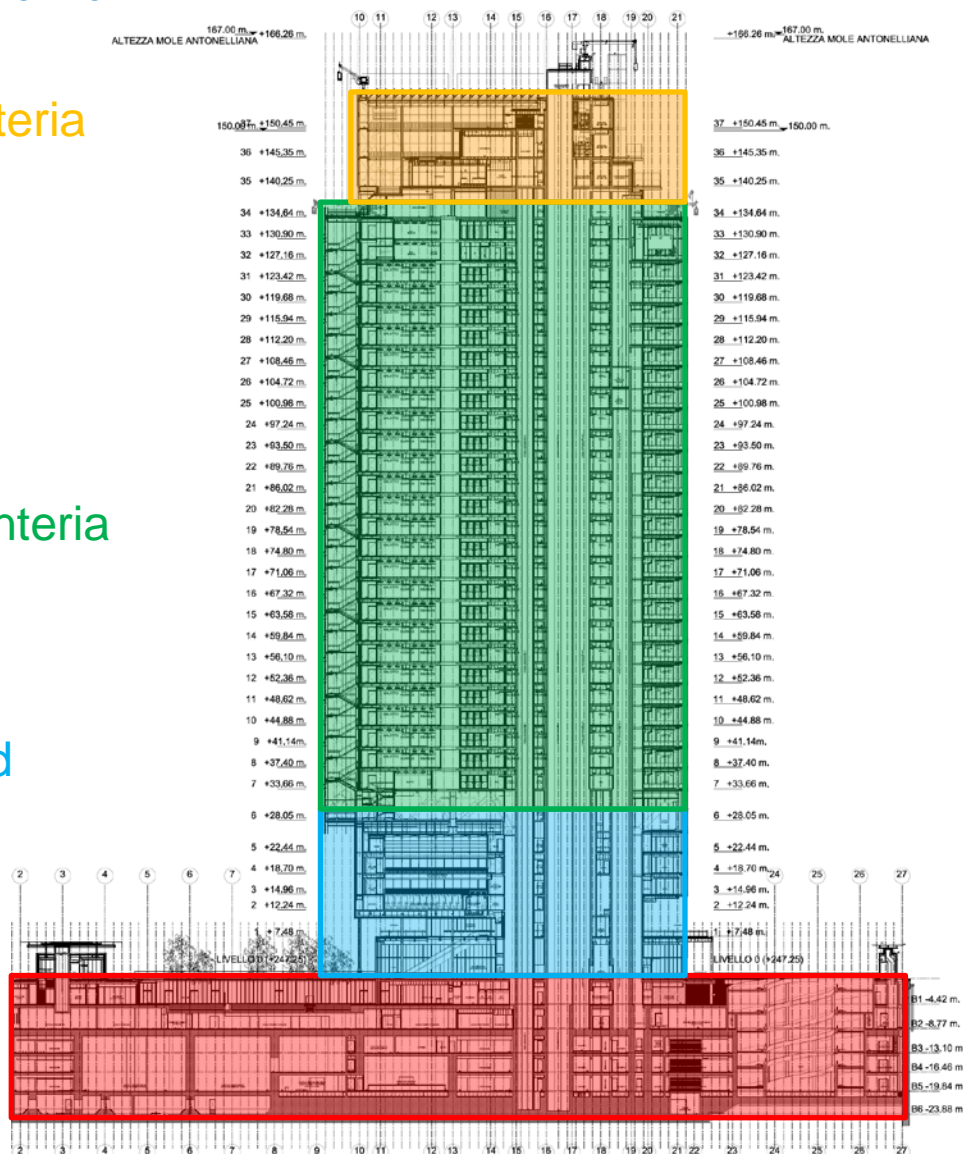
Torre Intesa San Paolo - Torino

Serra :
Elementi in carpenteria
metallica

Corpo torre :
- MC
- elementi in carpenteria
- elementi in ca

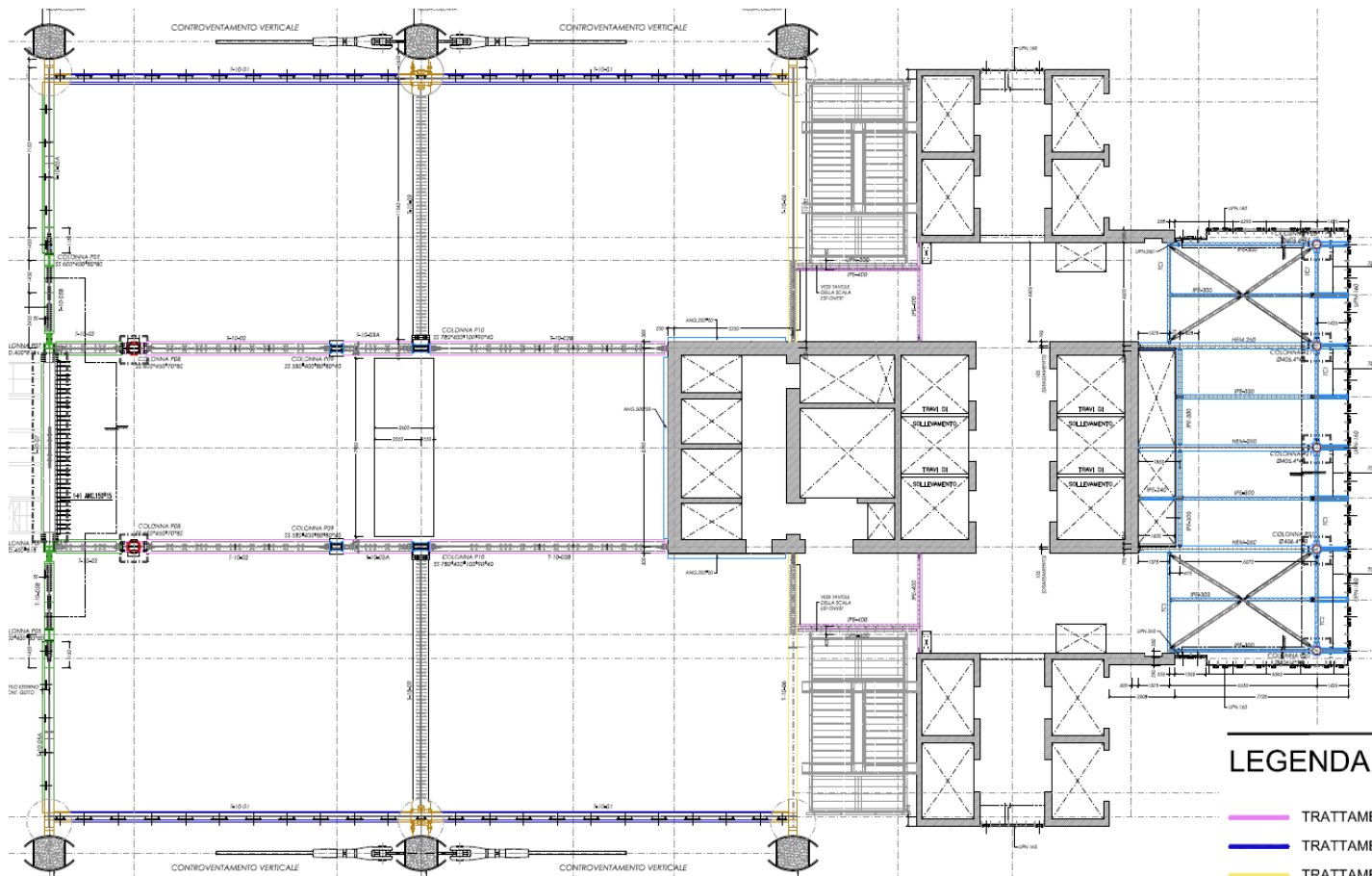
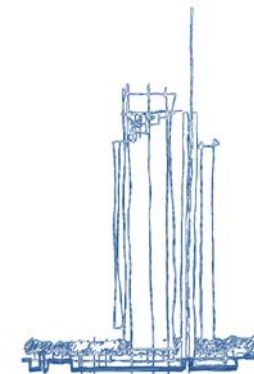
Transfer nord e sud
MC

INTERRATI:
C.A.



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Torre Intesa San Paolo - Torino

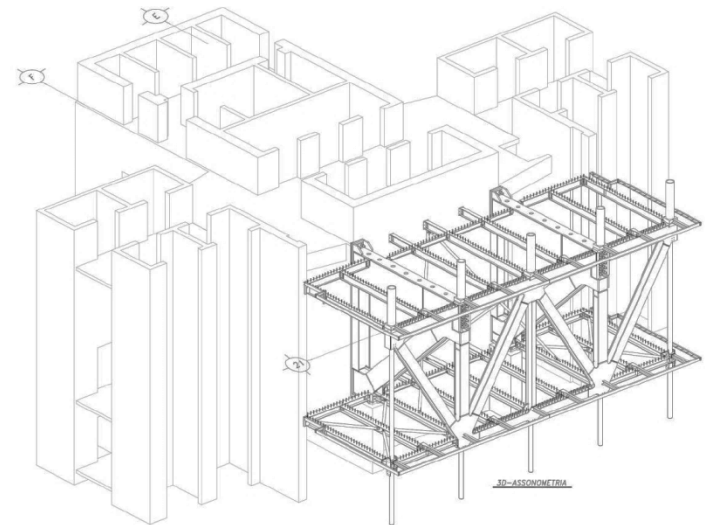
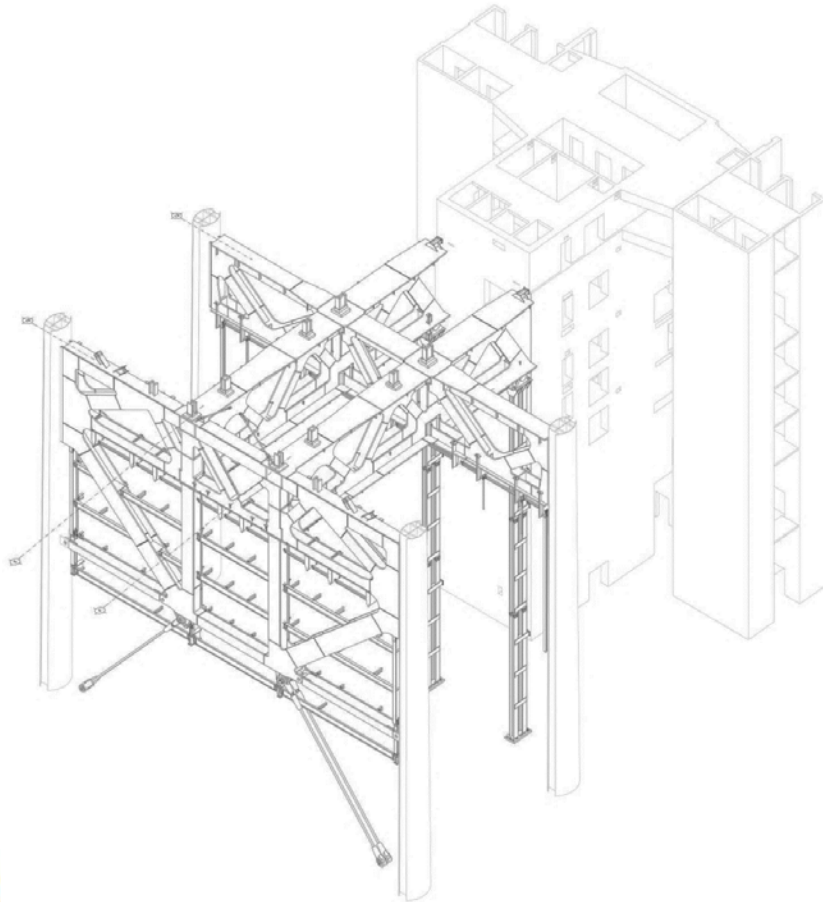
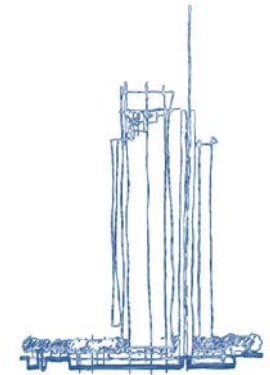


LEGENDA:

- TRATTAMENTO CON LASTRE FIRELINE _ R120
- TRATTAMENTO CON LASTRE PROMATECT H + FIRELINE _ R120
- TRATTAMENTO CON LASTRE PROMATECT H _ R120
- TRATTAMENTO CON INTONACO ISOLANTE IGNIVER VIC _ R120
- TRATTAMENTO CON VERNICE INTUMESCENTE INTERCHAR 1120 _ R120
- TRATTAMENTO CON VERNICE INTUMESCENTE STEELGUARD 564 _ R120
- TRATTAMENTO CON VERNICE INTUMESCENTE INTERCHAR 212 _ R120

Torre Intesa San Paolo

Elementi caratterizzanti Struttura di trasferimento Nord e Sud



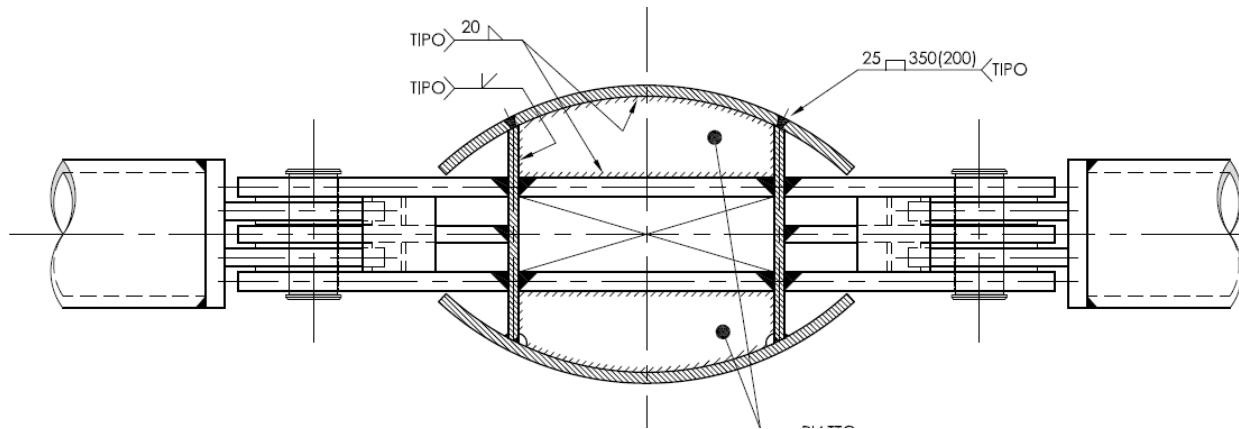
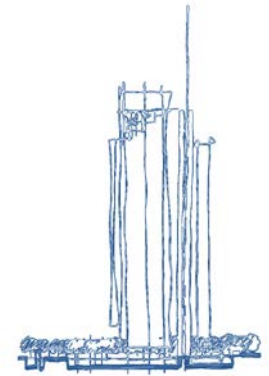
LA TORRE:

MECAGOLONNE

PROGETTO ESECUTIVO:

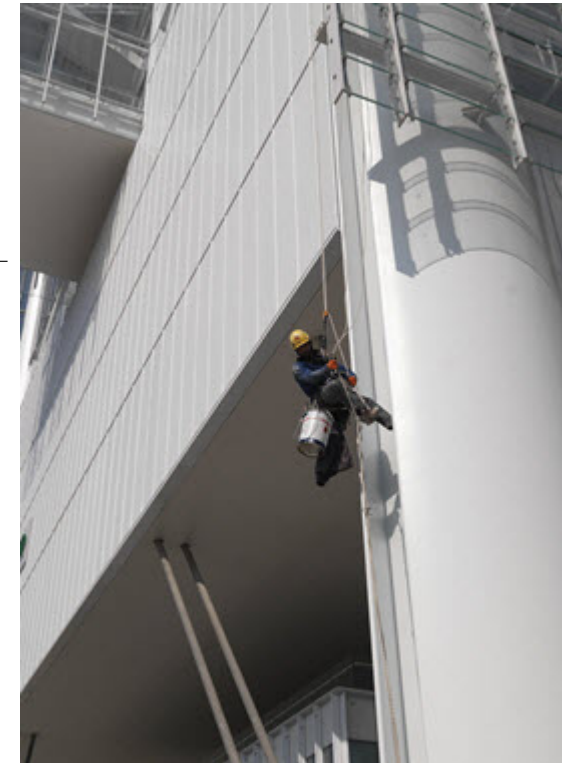
PROTEZIONE CON VERNICE INTUMESCENTE.

PROBLEMA DI DURABILITA'



NOTA:

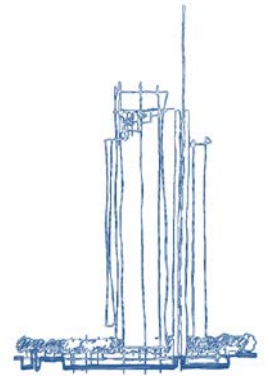
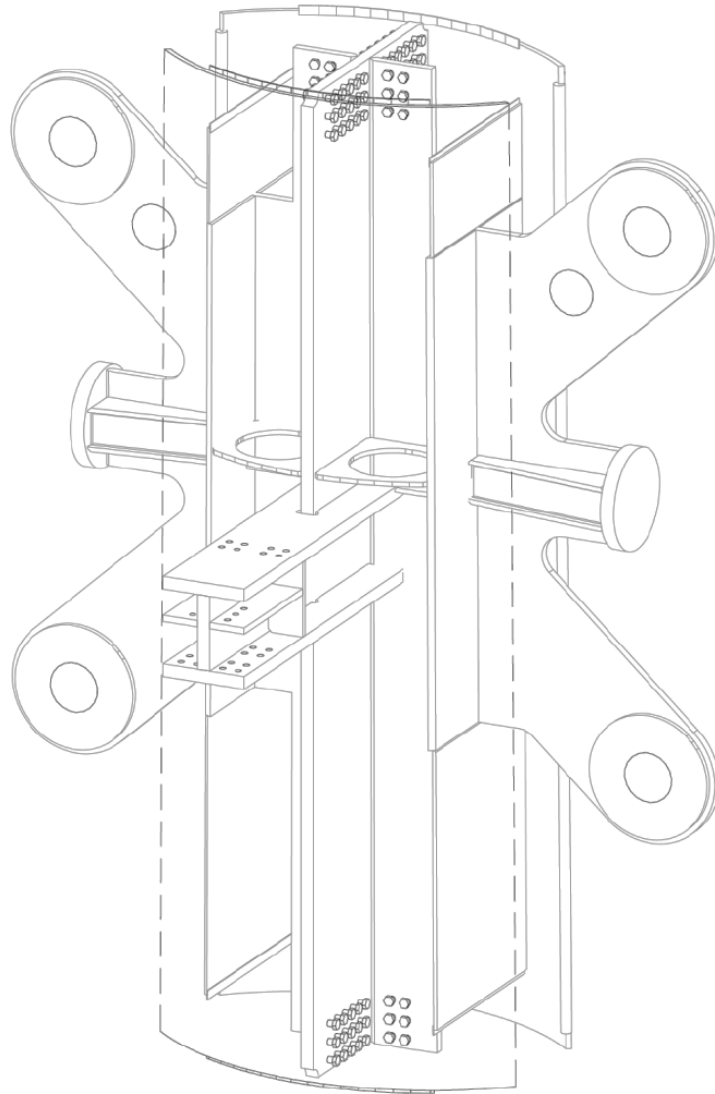
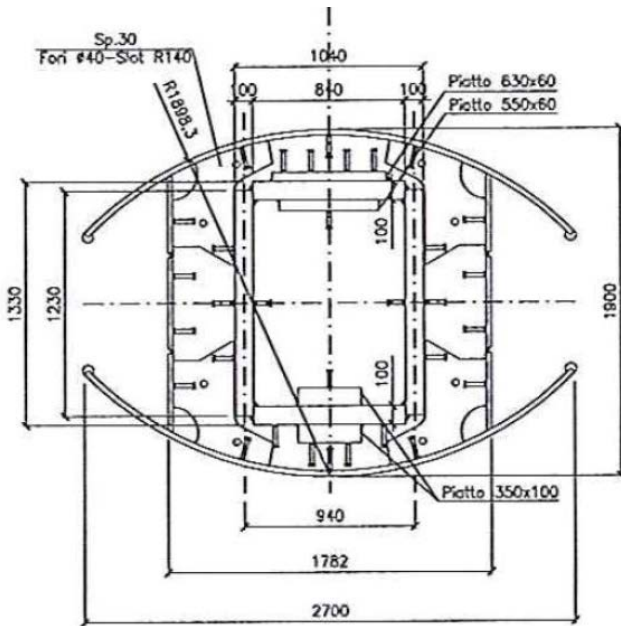
LE MEGACOLONNE SONO RIEMPITE CON CALCESTRUZZO PRIVO DI FUNZIONE STRUTTURALE MA CON ESCLUSIVO CONTRIBUTO PER LA PROTEZIONE AL FUOCO E COME "LIMITATORE" DEGLI EFFETTI DELL'IRRAGGIAMENTO TERMICO. CALCESTRUZZO TIPO SCC.



LA TORRE:

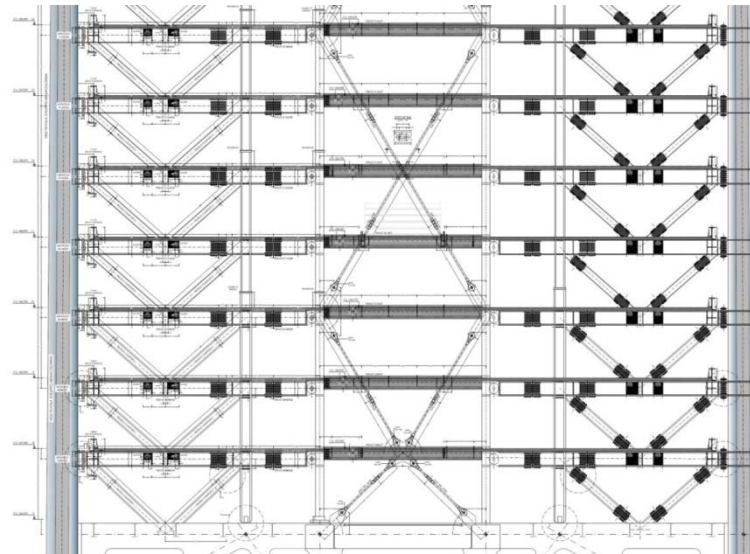
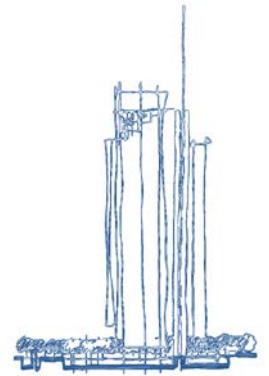
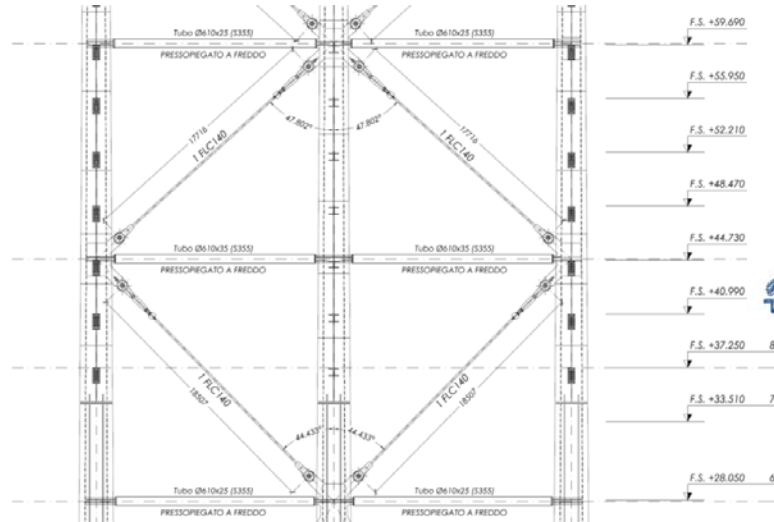
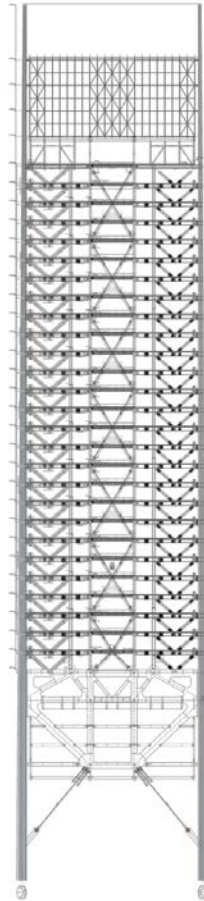
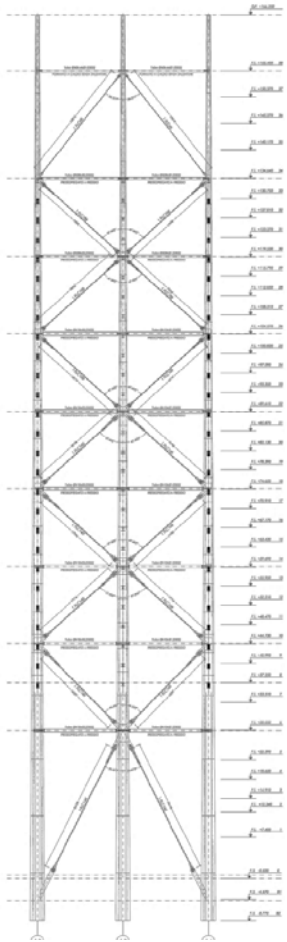
MECAGOLONNE

PROGETTO COSTRUTTIVO:
STRUTTURA MISTA ACCIAIO / C.A.



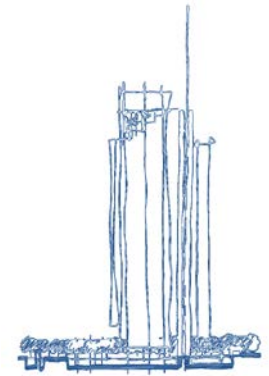
LA TORRE:

Prospetti Fili B/J Prospetto Asse 10



DESIGN CRITERIA

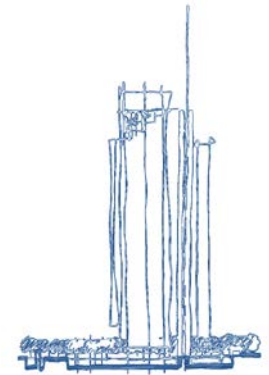
- ROTTURA DI MEGACOLONNE AI LIVELLI 8-9 SUGLI ASSI 10-13-16
- ASSENZA DELLA RETICOLARE SULL'ASSE 13
- ASSENZA DEL CONTRIBUTO DI RESISTENZA A TORSIONE DEL «CORE»
- ASSENZA DI CONTRIBUTO RESISTENTE DA PARTE DEL CONTROVENTO IN ASSE 10
- ROTTURA DI UNO DEI CAVI DELLA FACCIATA EST-OVEST
- UTILIZZO IMMEDIATO DELLA TORRE DOPO UN EVENTUALE INCENDIO



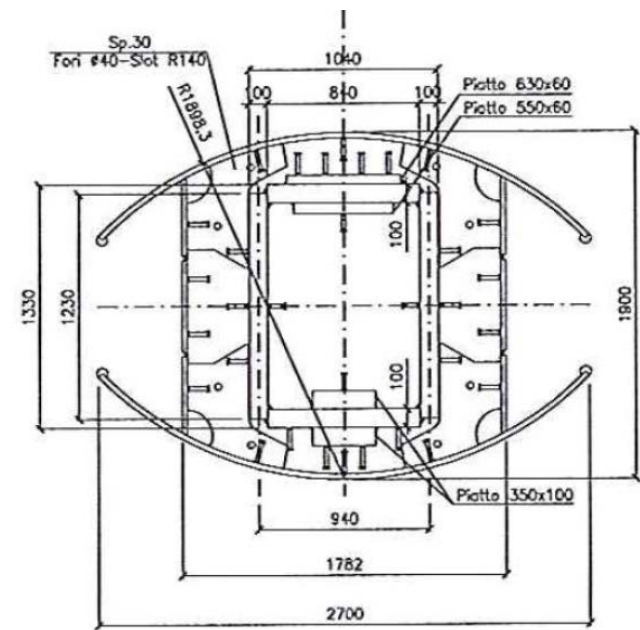
LA TORRE: MECAGOLONNE

1° scenario incremento di temperatura pari a 500 °C per un tratto di MC lungo 8 m (corrispondente ad un incendio localizzato alla base o alla sommità delle MC;

2° scenario incremento di temperatura media pari a 500 °C per l'intero sviluppo della MC compreso tra L0 e L7 (l=32,5 m)



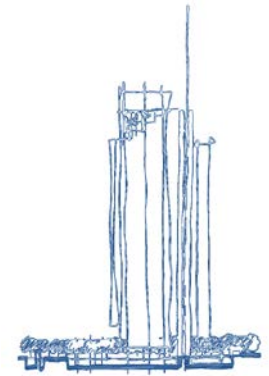
II PROGETTO COSTRUTTIVO								
Condizione di Calcolo			FSC Engineering	Condizione di Calcolo			FSC Engineering	
Fire + ΔN(8m)				Fire + ΔN(32.5m)				
Asse	Livello	Tipo di Incendio	Asse	Livello	Tipo di Incendio	Asse	Livello	
10	B2	ISO 834	10	B2	ISO 834	10	0	
	0	ISO 834		0	ISO 834		0	ISO 834
	2	ISO 834		2	ISO 834		2	ISO 834
	4	ISO 834		4	ISO 834		4	ISO 834
	5	ISO 834		5	ISO 834		5	ISO 834
	6	ISO 834		6	ISO 834		6	ISO 834
	7	ISO 834		7	ISO 834		7	ISO 834
	B2	ISO 834		B2	ISO 834		B2	ISO 834
13	0	ISO 834	13	0	ISO 834	13	0	
	2	ISO 834		2	ISO 834		2	ISO 834
	4	ISO 834		4	ISO 834		4	ISO 834
	5	ISO 834		5	ISO 834		5	ISO 834
	6	ISO 834		6	ISO 834		6	ISO 834
	7	ISO 834		7	ISO 834		7	ISO 834
	B2	ISO 834		B2	ISO 834		B2	ISO 834
	0	ISO 834		0	ISO 834		0	ISO 834
16	2	ISO 834	16	2	ISO 834	16	2	
	4	ISO 834		4	ISO 834		4	ISO 834
	5	ISO 834		5	ISO 834		5	ISO 834
	6	ISO 834		6	ISO 834		6	ISO 834
	7	ISO 834		7	ISO 834		7	ISO 834
	B2	ISO 834		B2	ISO 834		B2	ISO 834
	0	ISO 834		0	ISO 834		0	ISO 834
	2	ISO 834		2	ISO 834		2	ISO 834



LA TORRE:

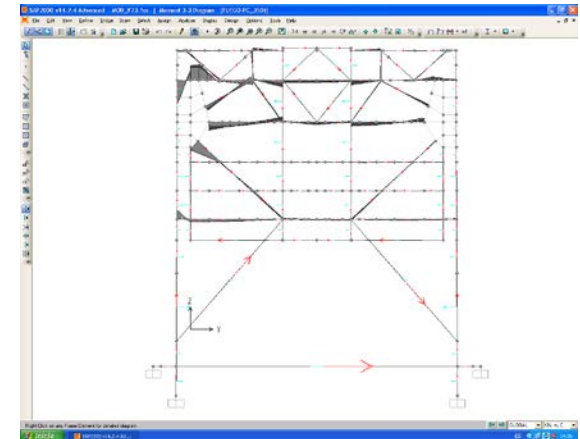
Transfer sud

Ipotesi iniziale $T_{max\ transfer} = 350^{\circ}C$ dopo 120' minuti
 curva ISO 834 al fine di evitare ripercussioni ai pinai
 superiori (deformazioni differenziali)



1° scenario incremento di temperatura pari a $500^{\circ}C$ per
 un tratto di MC lungo 8 m (corrispondente ad un incendio
 localizzato alla base o alla sommità delle MC;

2° scenario incremento di temperatura media pari a $500^{\circ}C$
 per l'intero sviluppo della MC compreso tra L0 e L7 (l=
 32,5 m)

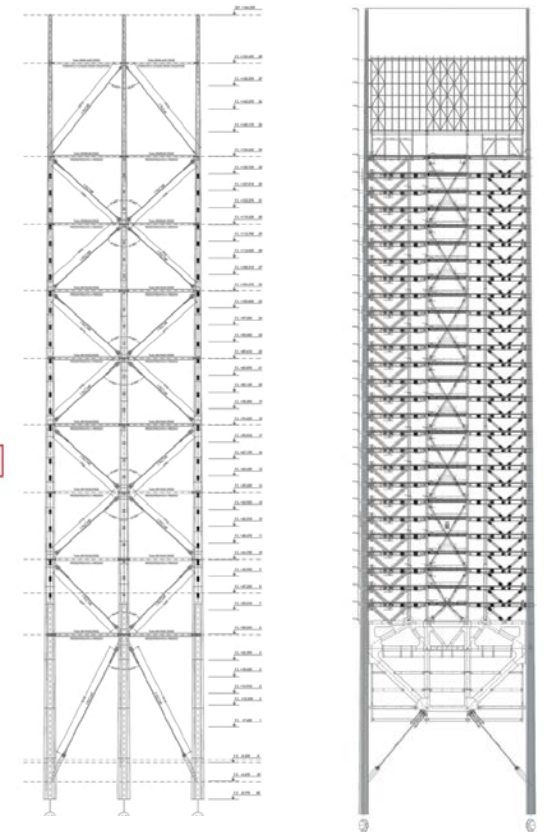
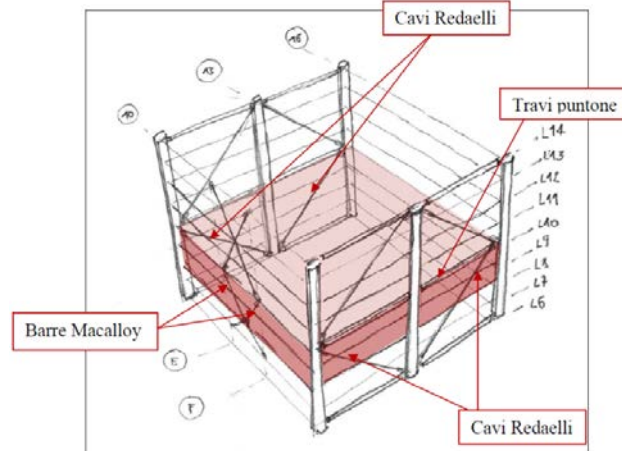
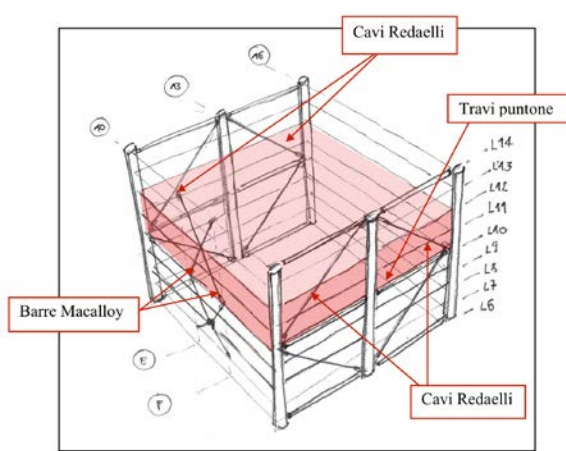
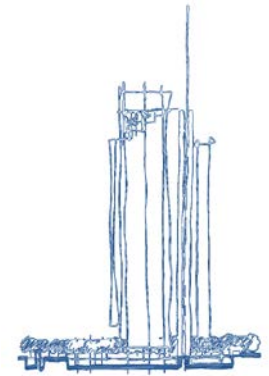


Condizione di Calcolo		FSC Engineering	coefficiente di sicurezza
1° Scenario - Verifiche delle strutture transfer			
Asse	codice elemento	T_{cr} [°C]	
10	SS - 10 - 01 A	350	2.16
	SS - 10 - 01 B	350	2.58
	SS - 10 - 02	350	1.46
	SS - 10 - 06	350	1.51

IMPOSSIBILTA' DI PROTEGGERE AL FUOCO DEI CONTROVENTI SASSE B-J E 10 E LE TRAVI PUNTONE

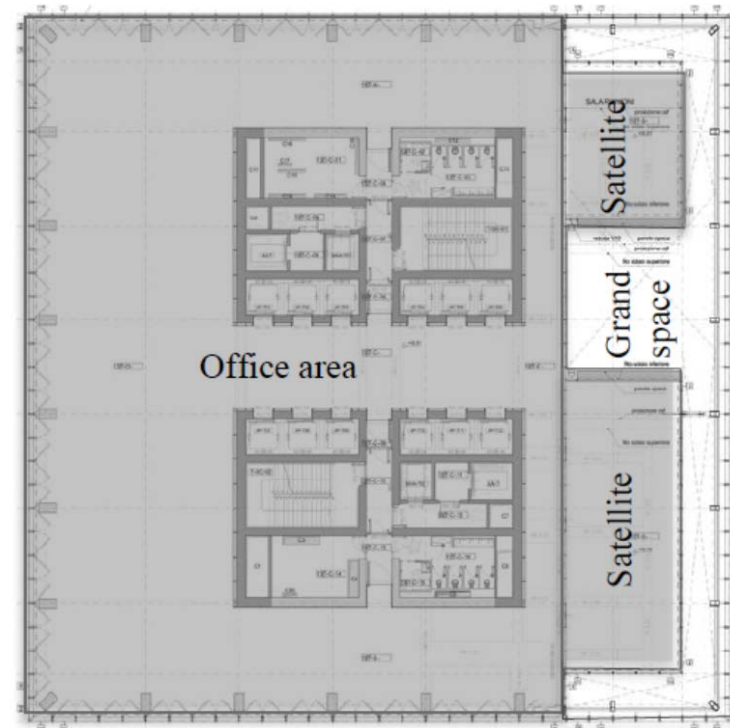
SCENARIO DI FUCO : INCENDIO GENERALIZZATO SU 2 PIANI CONSECUTIVI

Verifica del comportamento globale della torre senza i controventi e le travi puntone interessate dal fuoco e soggette a curva di incendio da esterni secondo 9 marzo 2007



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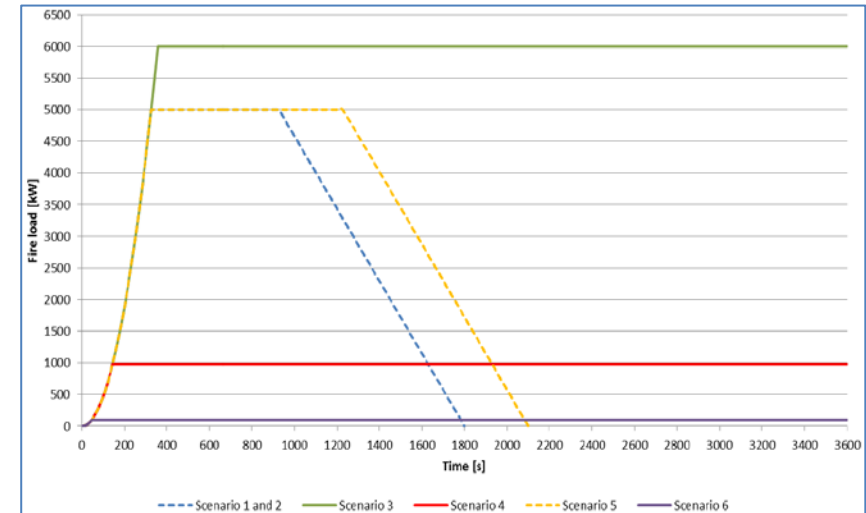
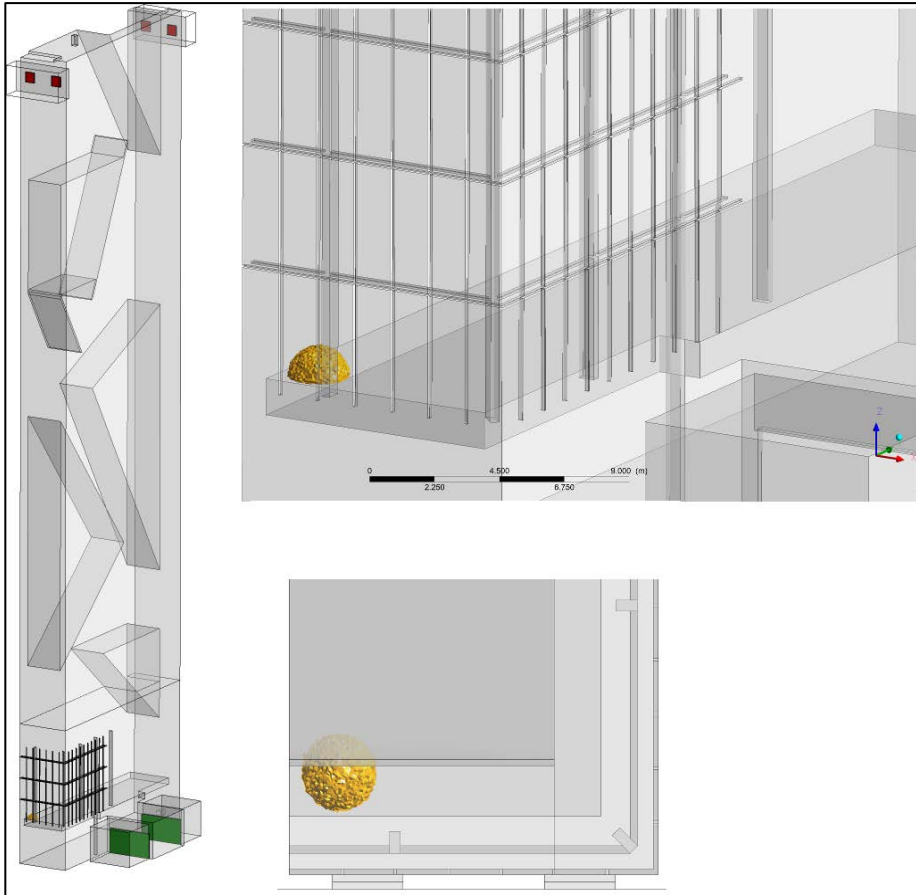
Torre Regione Piemonte



- Resistenza al fuoco delle strutture del grande vuoto
- Resistenza al fuoco delle facciate di confine con il GV
- Problemi di manutenzione
- Problemi di eccessivo riscaldamento vetri EI

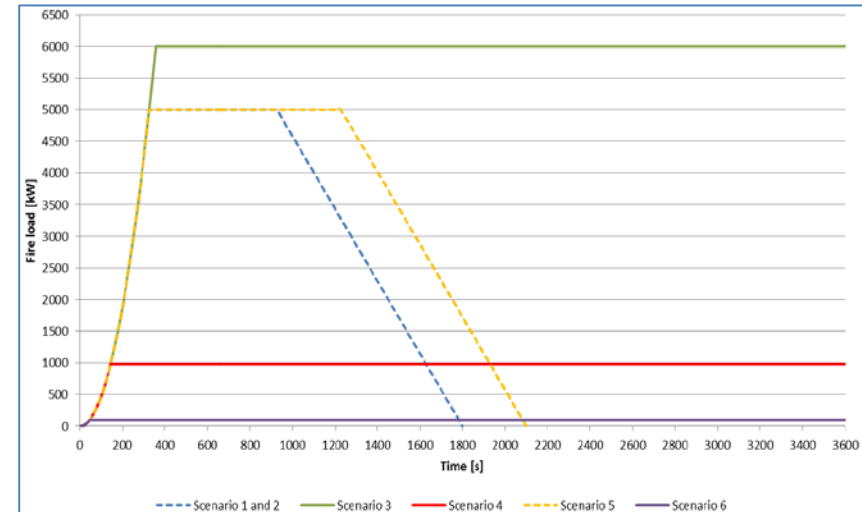
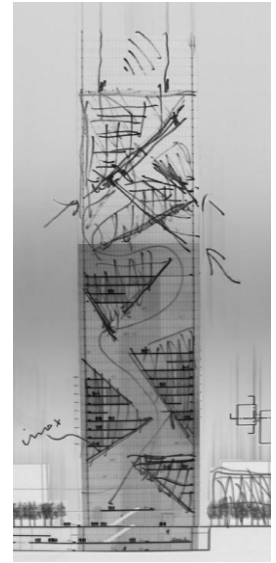
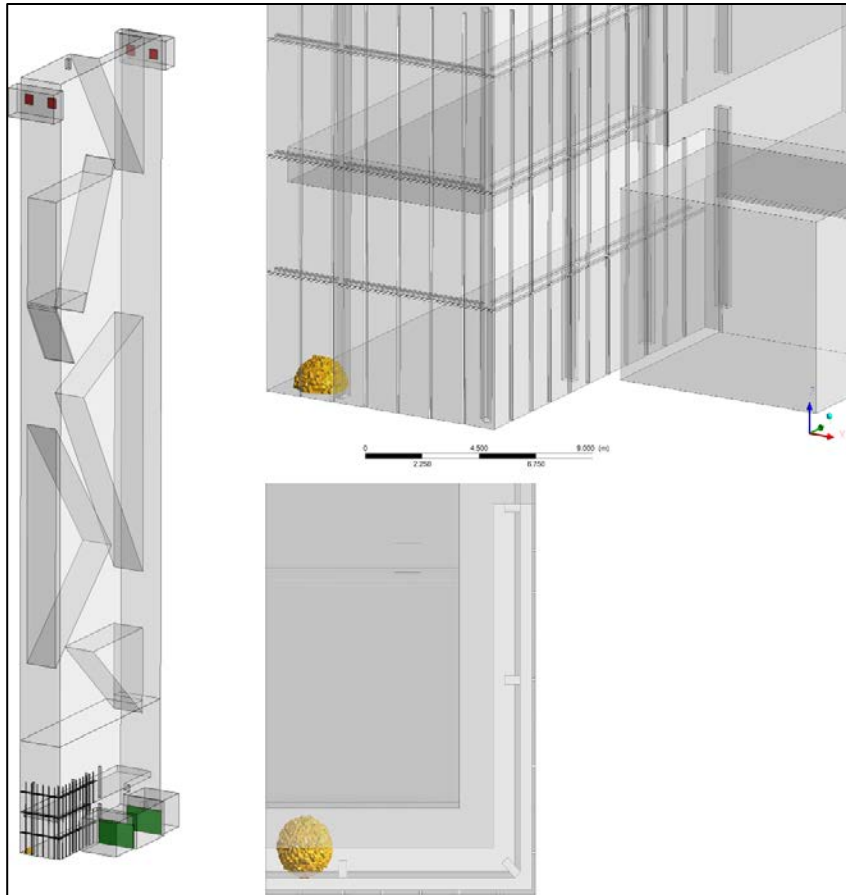
ESEMPI PRATICI

Torre Regione Piemonte – Scenario fuoco all'interno del grande vuoto livello 0



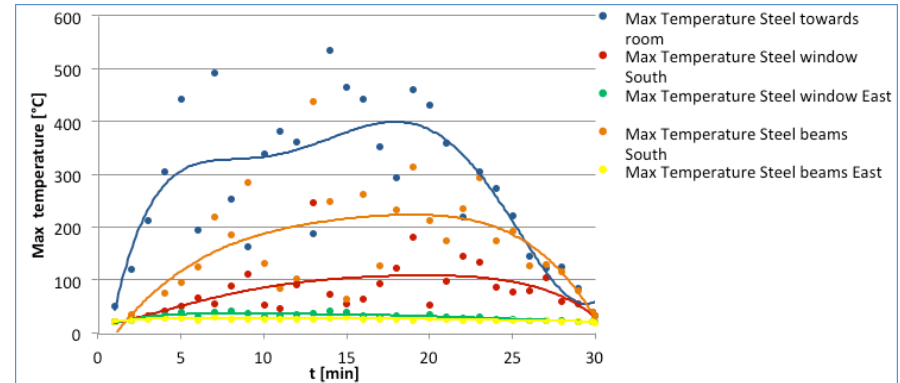
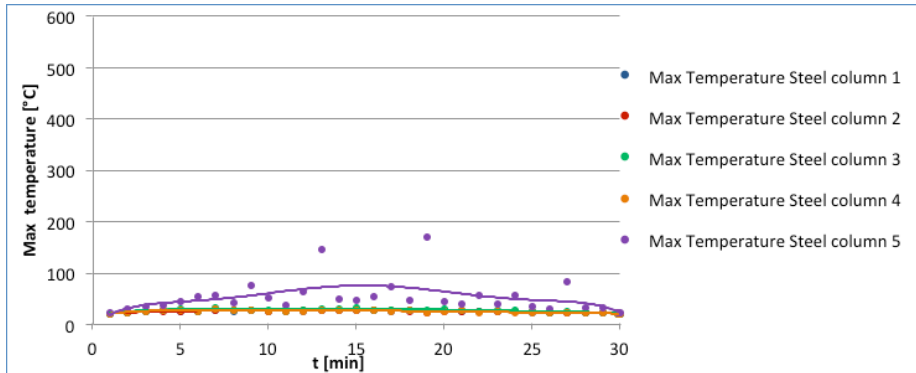
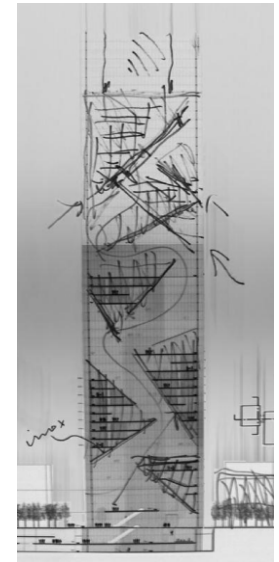
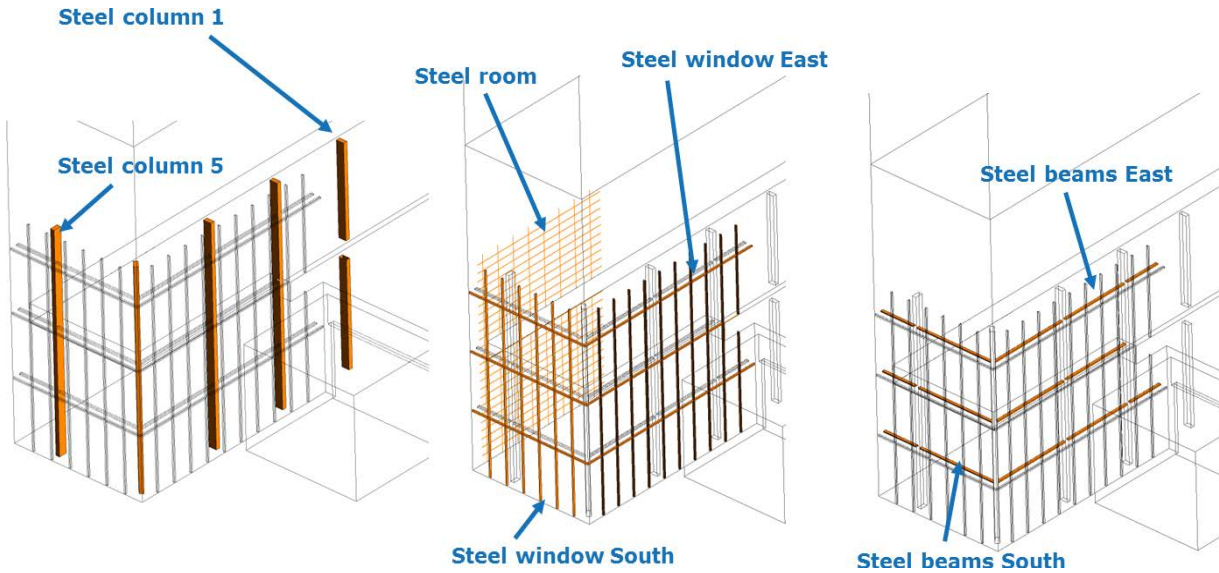
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Torre Regione Piemonte – Scenario fuoco all'interno del grande vuoto livello -2



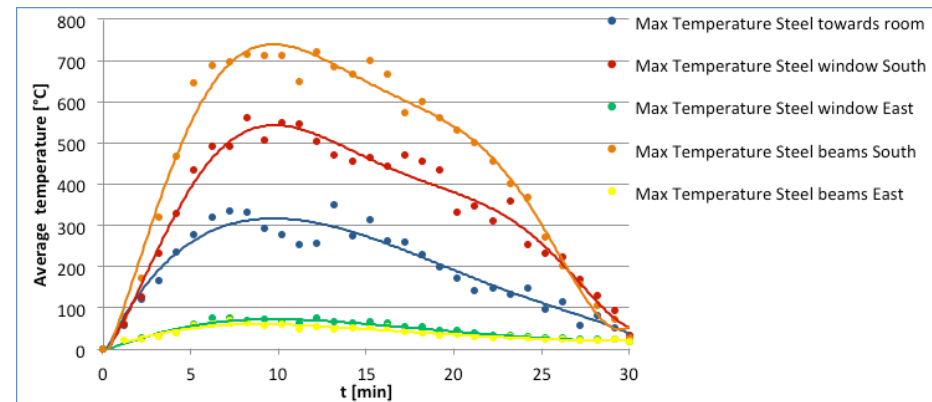
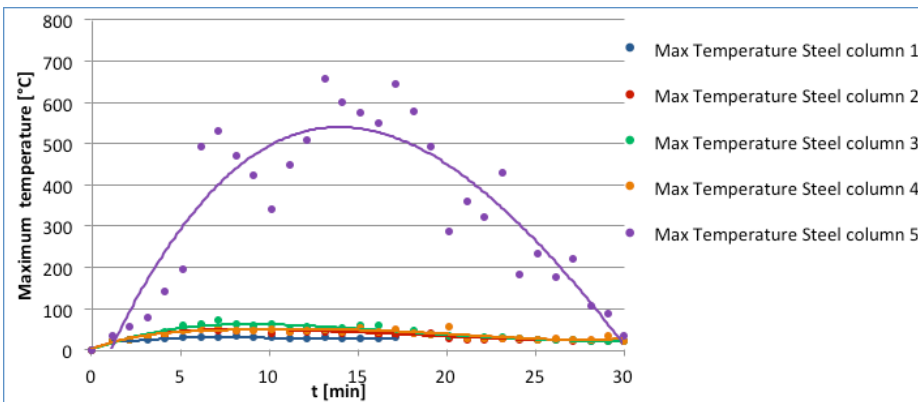
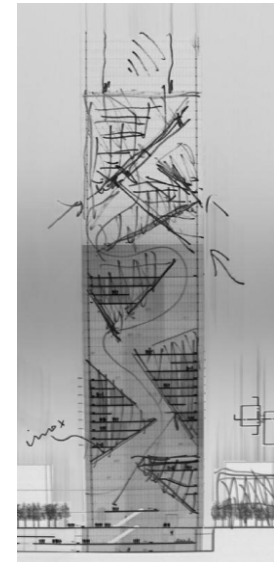
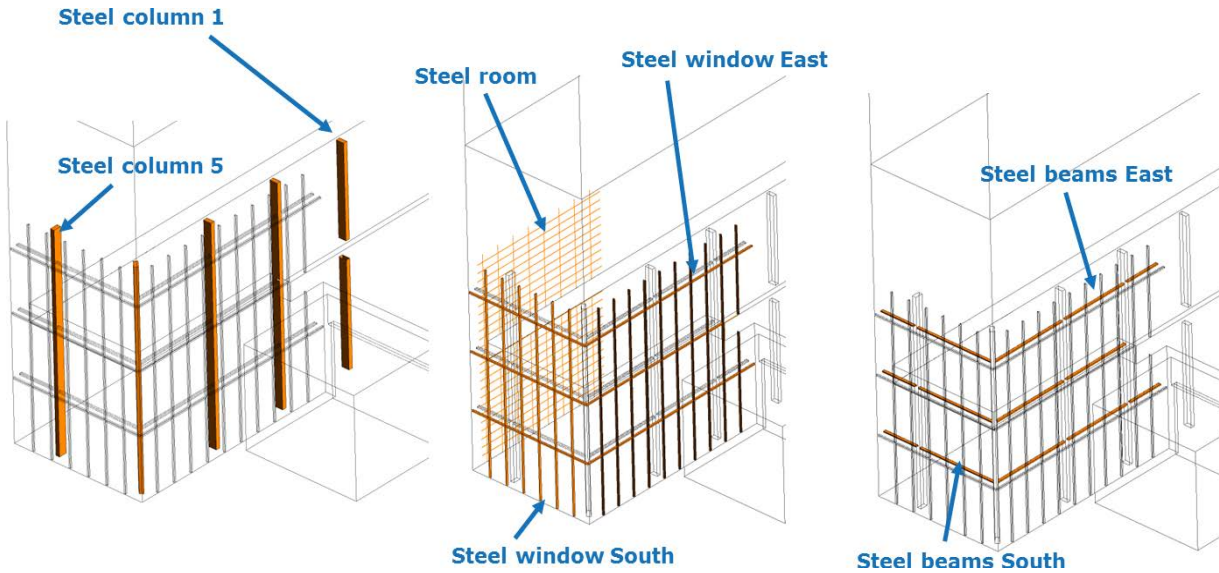
ESEMPI PRATICI

Torre Regione Piemonte – Scenario fuoco all'interno del grande vuoto livello 0



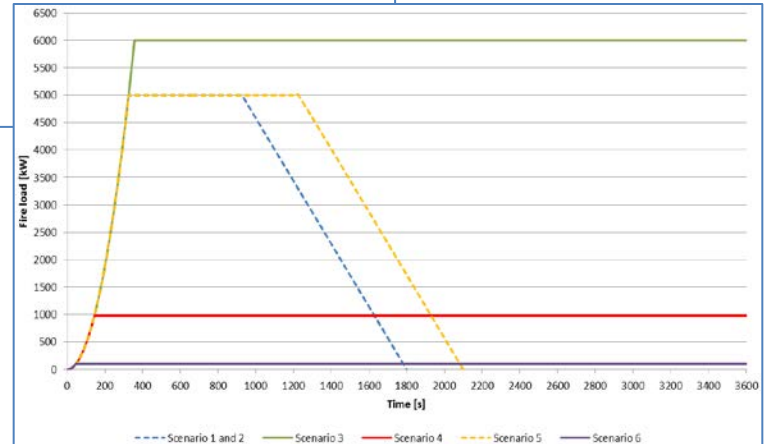
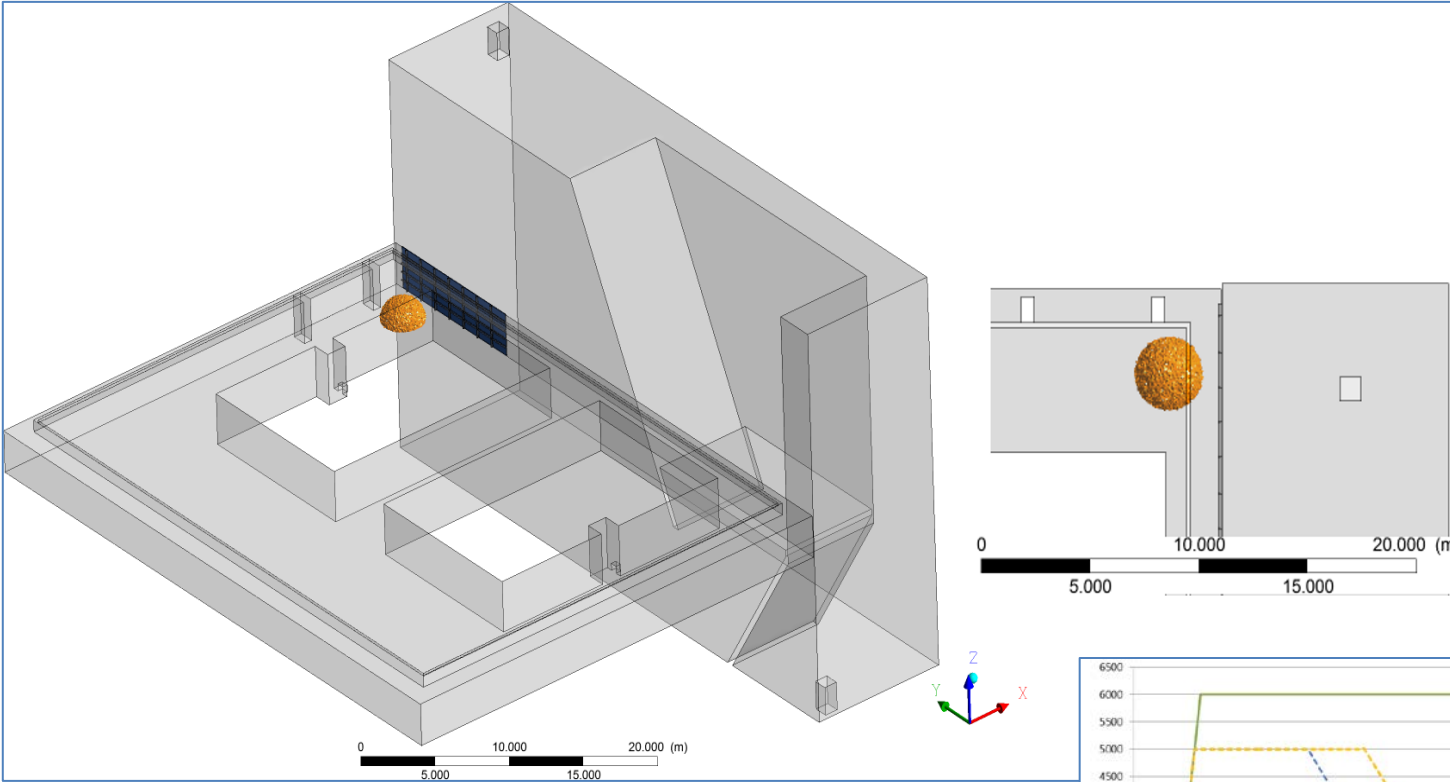
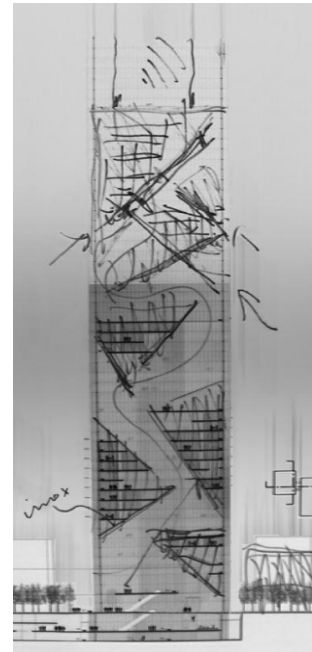
ESEMPI PRATICI

Torre Regione Piemonte – Scenario fuoco all'interno del grande vuoto livello -2



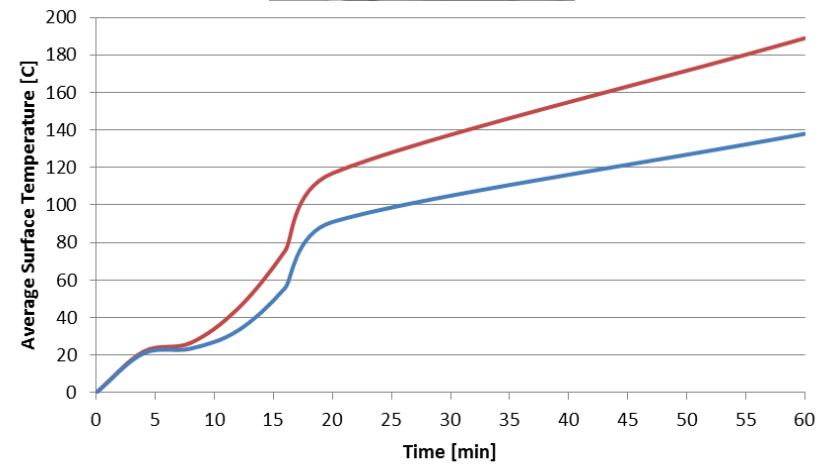
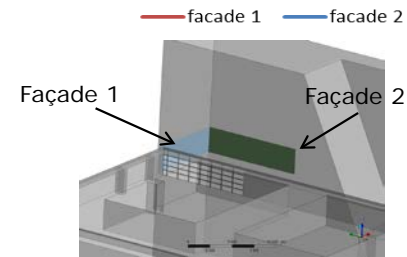
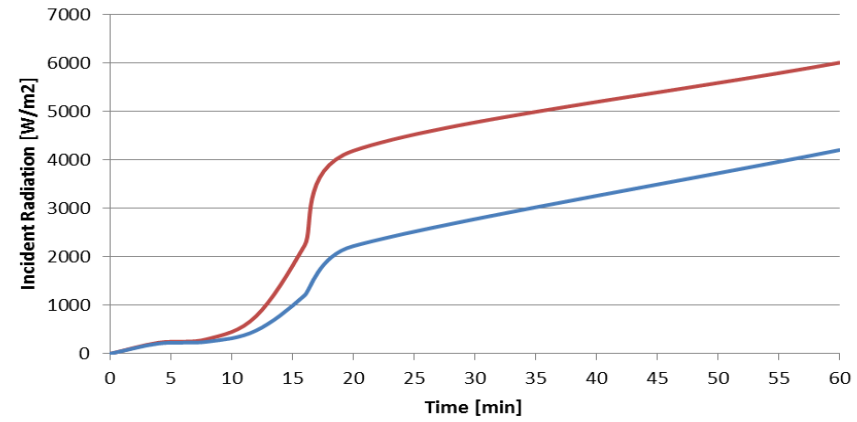
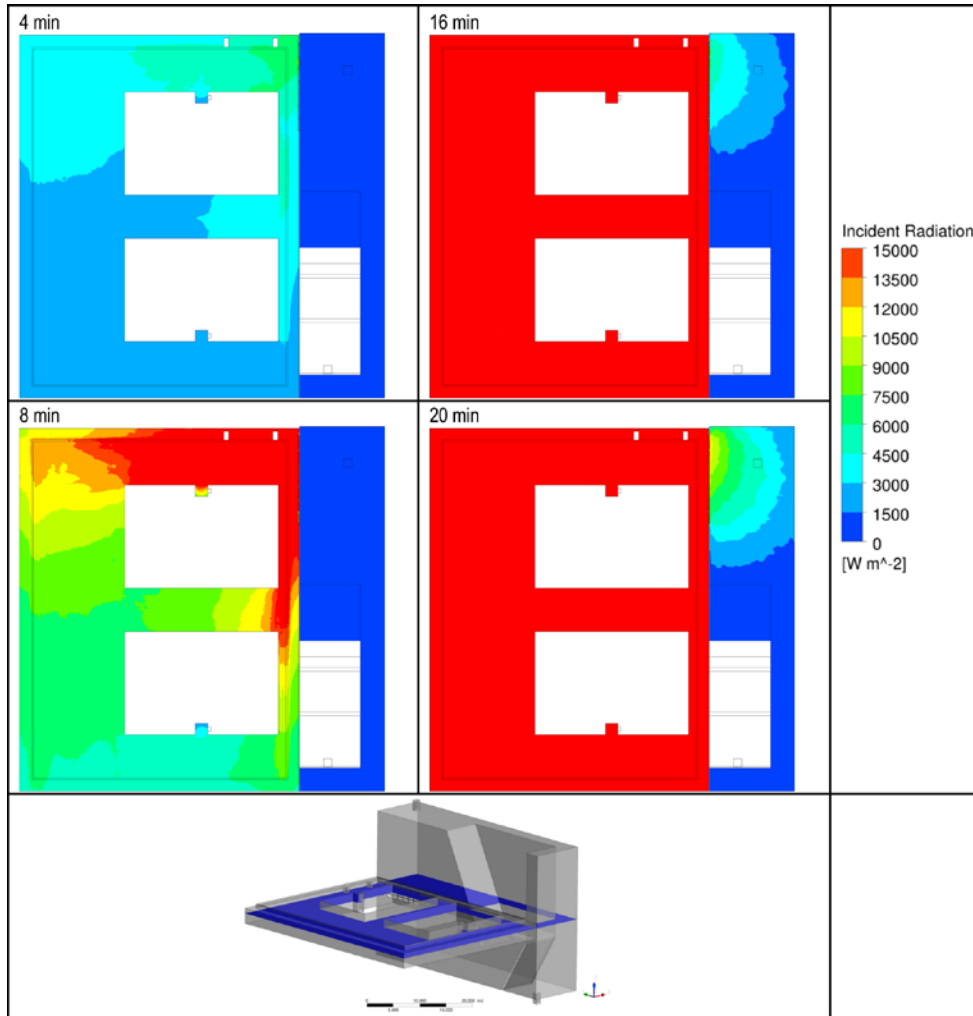
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Torre Regione Piemonte – Scenario fuoco al piano tipo



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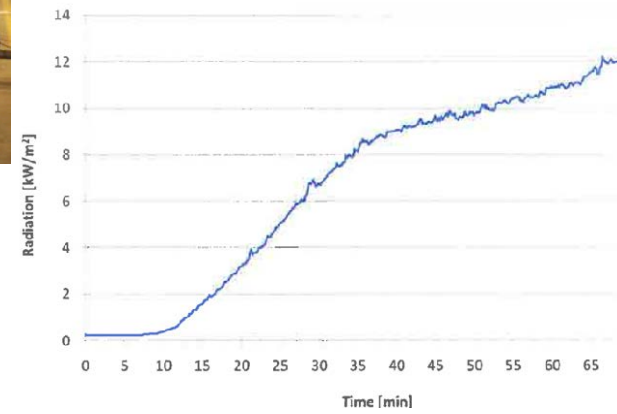
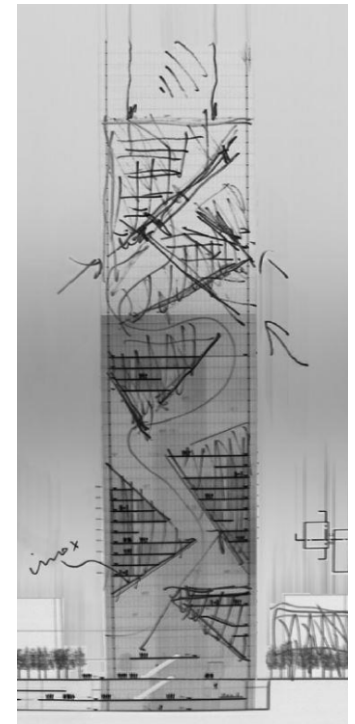
Torre Regione Piemonte – Scenario fuoco al piano tipo



— facade 1 — facade 2

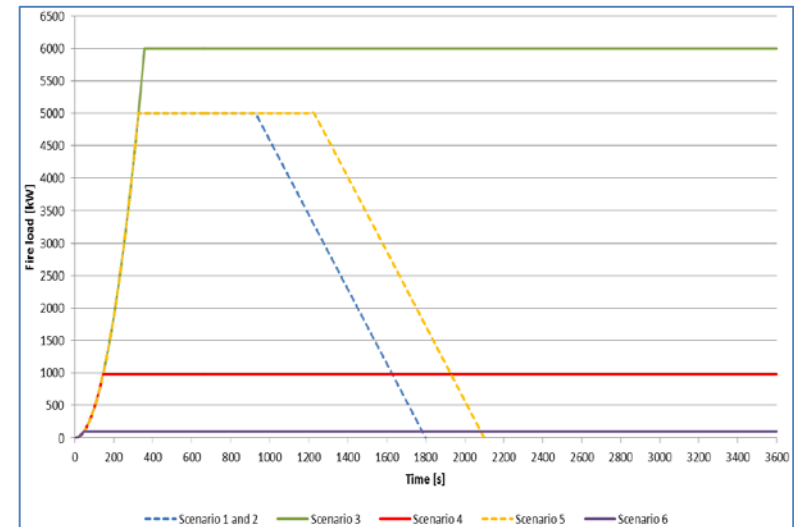
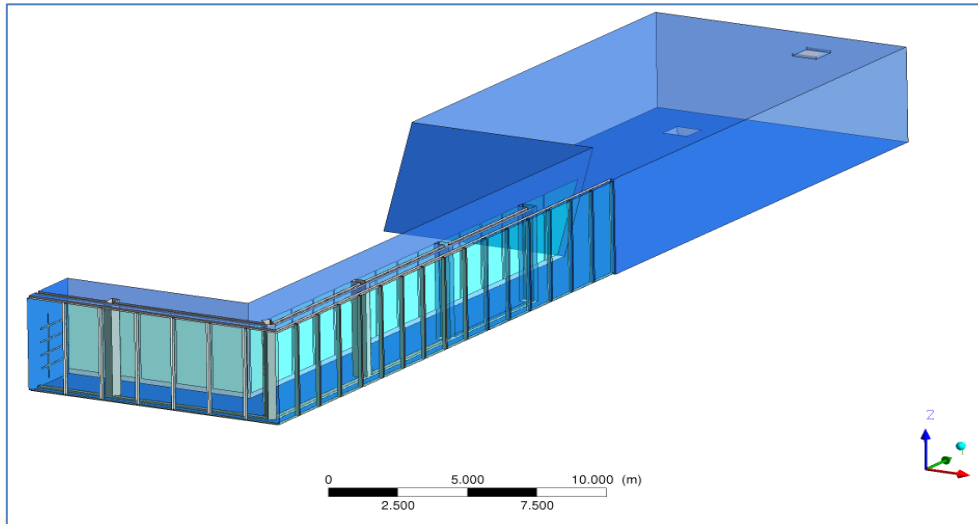
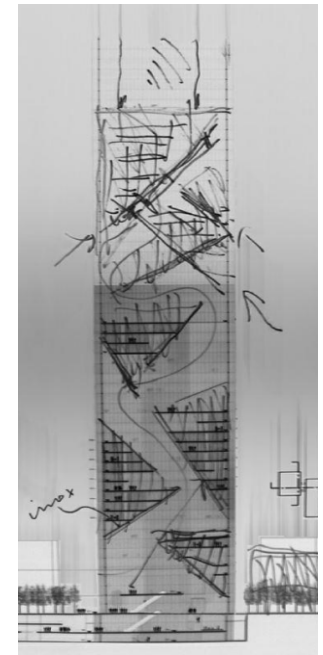
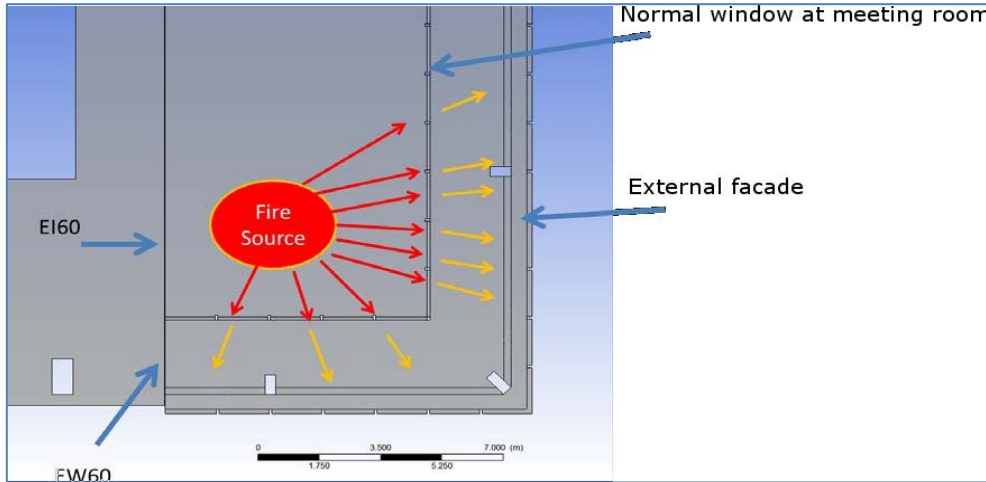
ESEMPI PRATICI

Torre Regione Piemonte



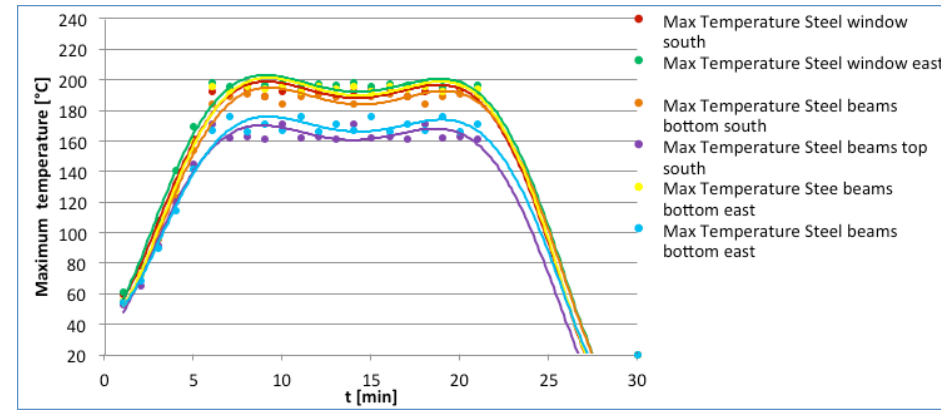
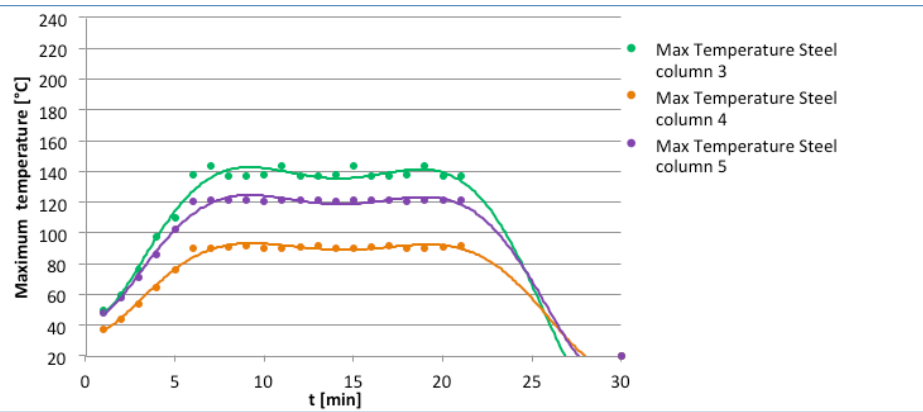
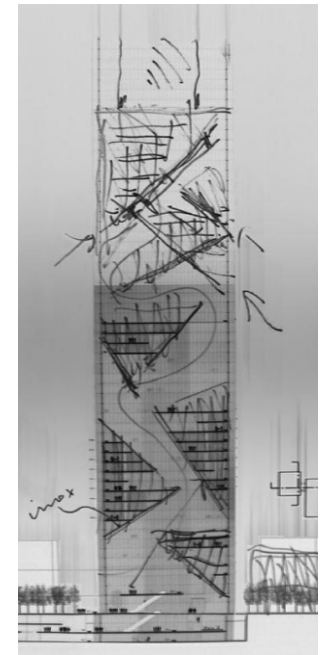
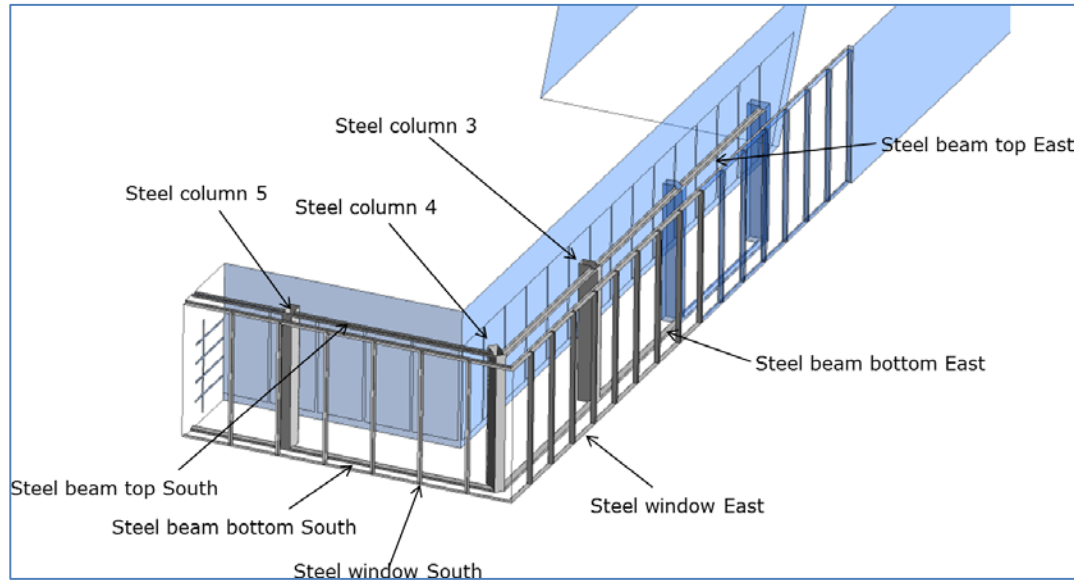
ESEMPI PRATICI

Torre Regione Piemonte – Scenario fuoco all'interno di un satellite



ESEMPI PRATICI

Torre Regione Piemonte – Scenario fuoco al piano tipo



GRAZIE PER L'ATTENZIONE