Fire performance assessment of historic buildings

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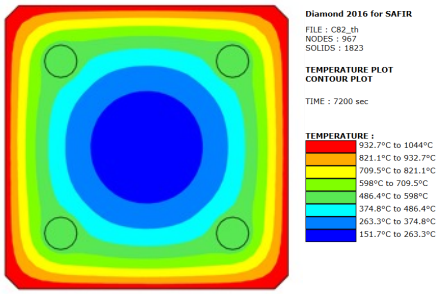
Fire Safety Engineering

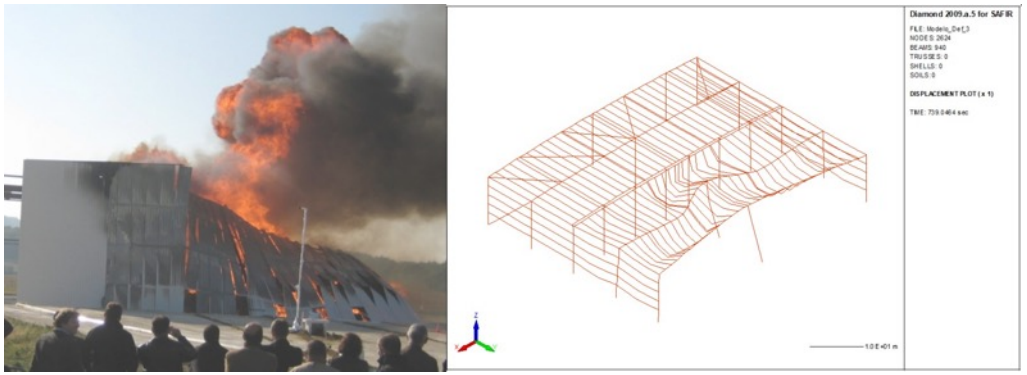
How is the fire performance determined?

Standard fire testing

Large scale fire testing non-standard

Numerical methods





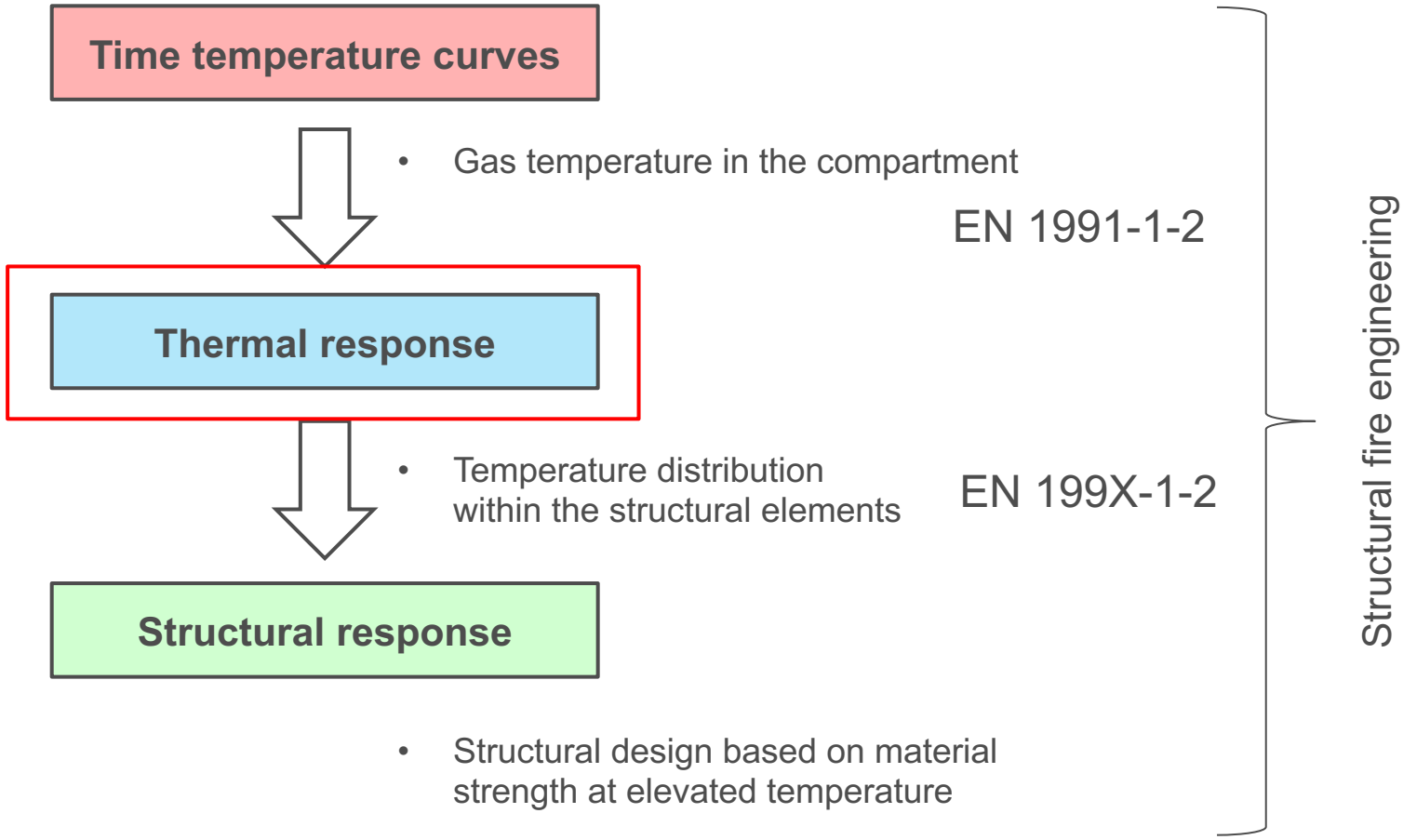
Fire resistance performance

Loadbearing capacity (R) – is the ability of a structural element to withstand fire exposure under specified mechanical actions, on one or more faces, for a period of time, without any loss of structural stability.

Fire resistance 80 minutes - **R 60**

Fire resistance 44 minutes- **REI 30**

Eurocode design guides for structural fire design



Eurocode design guides for structural fire design - concrete

Thermal response

- Existing test data – tabulated data and isotherms
- Simple heat transfer models
- Advanced heat transfer models

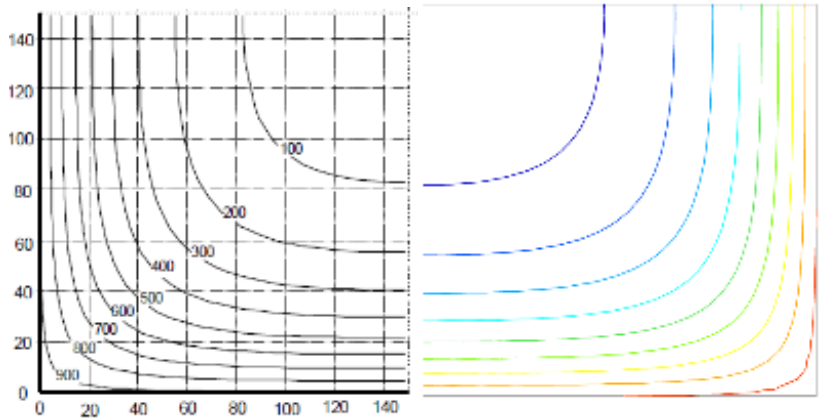
Tabulated data

Standard fire resistance	Mechanical reinforcement ratio ω	Minimum dimensions (mm). Column width b_{min}/axis distance a			
		n = 0,15	n = 0,3	n = 0,5	n = 0,7
1	2	3	4	5	6
R 30	0,100	150/25*	150/25*	200/30:250/25*	300/30:350/25*
	0,500	150/25*	150/25*	150/25*	200/30:250/25*
	1,000	150/25*	150/25*	150/25*	200/30:300/25*
R 60	0,100	150/30:200/25*	200/40:300/25*	300/40:500/25*	500/25*
	0,500	150/25*	150/35:200/25*	250/35:350/25*	350/40:550/25*
	1,000	150/25*	150/30:200/25*	200/40:400/25*	300/50:600/30
R 90	0,100	200/40:250/25*	300/40:400/25*	500/50:550/25*	550/40:600/25*
	0,500	150/35:200/25*	200/45:300/25*	300/45:550/25*	500/50:600/40
	1,000	200/25*	200/40:300/25*	250/40:550/25	500/50:600/45
R 120	0,100	250/50:350/25*	400/50:550/25*	550/25*	550/60:600/45
	0,500	200/45:300/25*	300/45:550/25*	450/50:600/25*	500/60:600/50
	1,000	200/40:250/25*	250/50:400/25*	450/45:600/30	600/60
R 180	0,100	400/50:500/25*	500/60:550/25*	550/60:600/30	(1)
	0,500	300/45:450/25*	450/50:600/25*	500/60:600/50	600/75
	1,000	300/35:400/25*	450/50:550/25*	500/60:600/45	(1)
R 240	0,100	500/60:550/25*	550/40:600/25*	600/75	(1)
	0,500	450/45:500/25*	550/55:600/25*	600/70	(1)
	1,000	400/45:500/25*	500/40:600/30	600/60	(1)

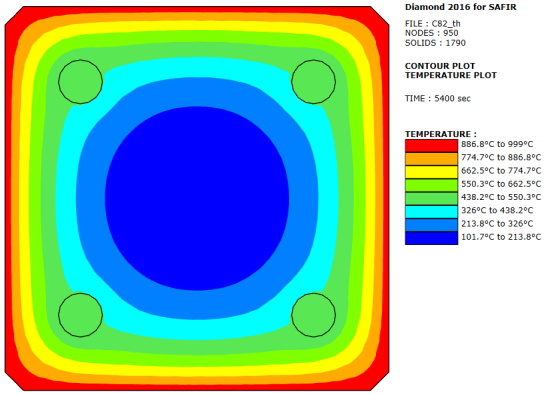
* Normally the cover required by EN 1992-1-1 will control.

(1) Requires width greater than 600 mm. Particular assessment for buckling is required.

Isotherms 90 minutes



Advanced heat transfer FEA



Fire resistance assessment of existing forms of construction

Review of building information

- Building occupancy, height, structural components
- Fire resistance requirements
- Intrusive and structural investigation, if available

Site investigation

- Type and condition of the structural components
- Dimensions and cover measurements
- Non Destructive Testing (NDT), if required

Historic fire test data

- Fire resistance test evidence
- Relevant codes and standards

Finite Element Analysis (FEA)

- Analysis in the strength domain
- Analysis in the temperature domain
- Analysis in the time domain

Anticipated fire resistance

Is the fire resistance adequate?

- Remedial solutions proposed by the design team

Applications of structural fire engineering

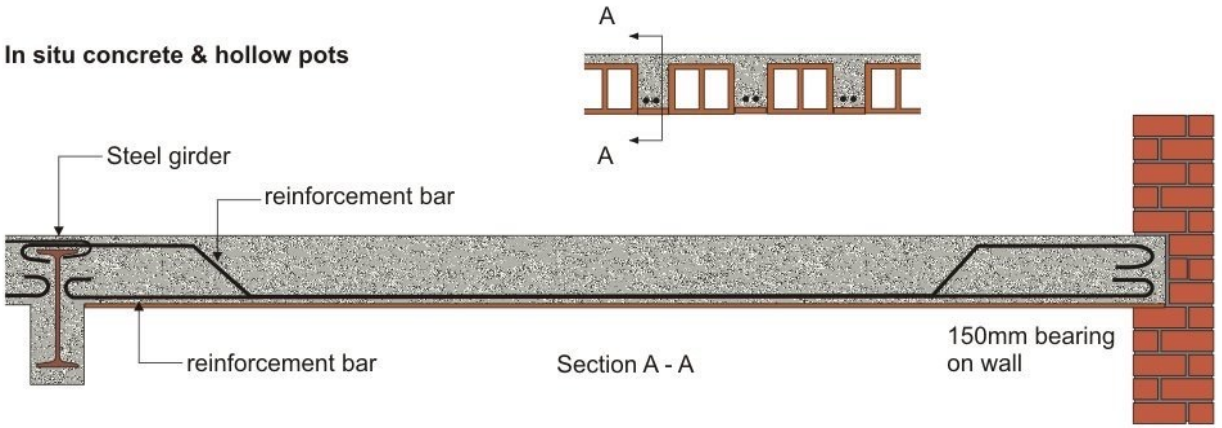
Fire resistance assessments of historic buildings

Site investigation

Applications of structural fire engineering

Fire resistance assessments of historic buildings

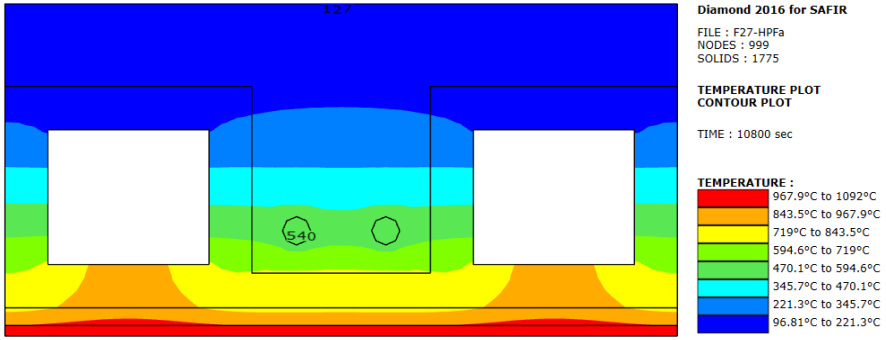
Historical test evidence

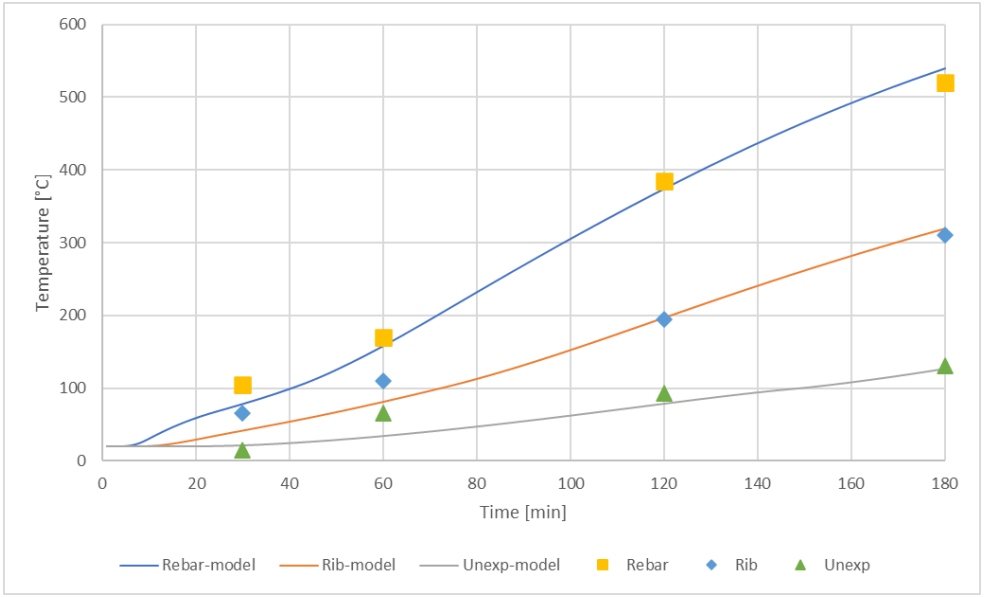


Test ref.	Test duration (h: min)	Mode of failure
F26	2:46	No failure
F27	3:23	Collapse
F13	2:14	No failure
F14	3:28	Collapse
F15	2:26	Collapse
F32	2:23	Insulation
F59	2:00	No failure
F66	2:00	No failure
F64	4:00	No failure

Fire resistance assessments of historic buildings

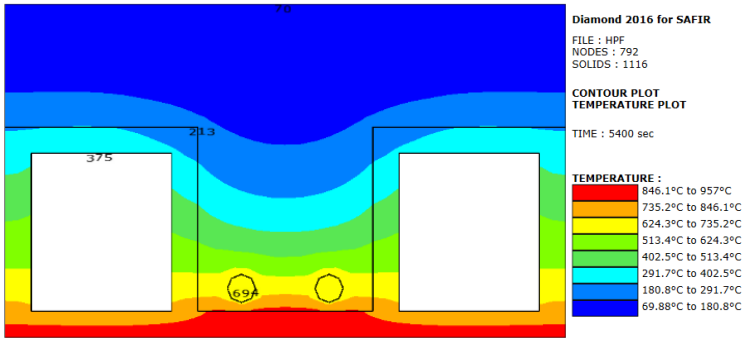
SAFIR numerical validation study

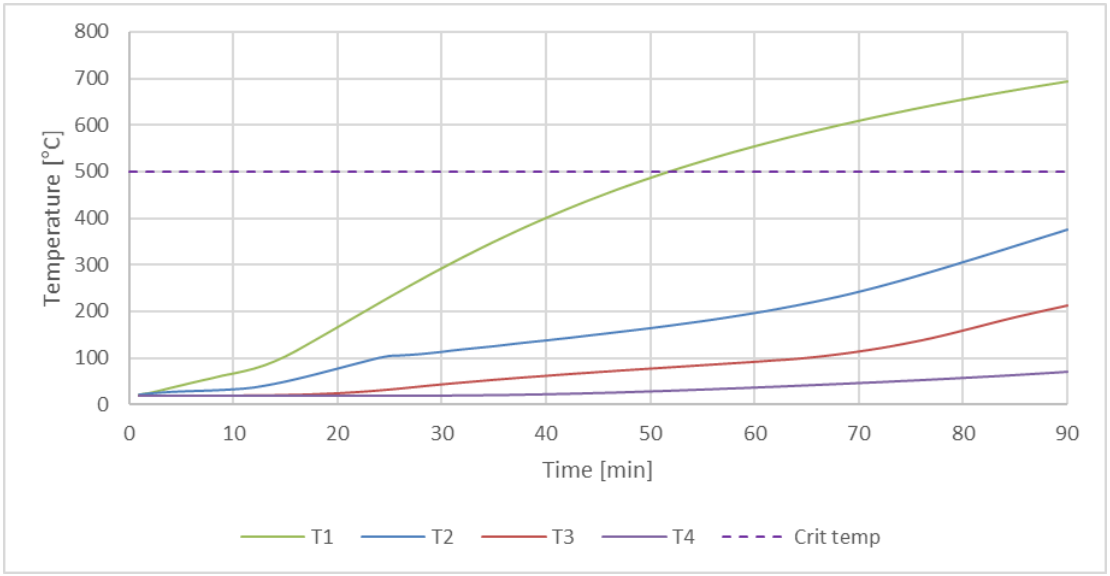




Fire resistance assessments of historic buildings

Fire resistance based on θ_{cr}





Fire resistance assessments of historic buildings

Site investigation

Fire resistance assessments of historic buildings

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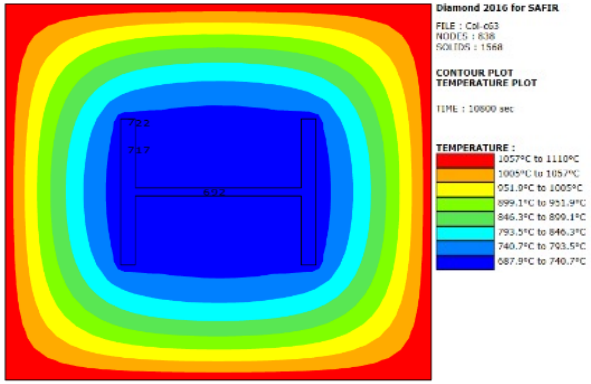
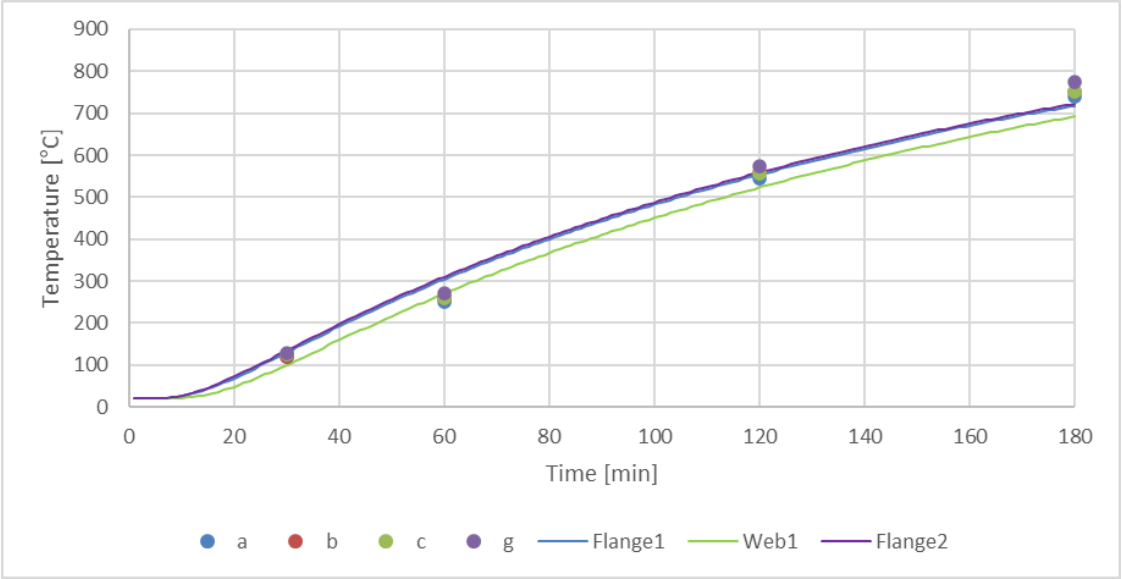
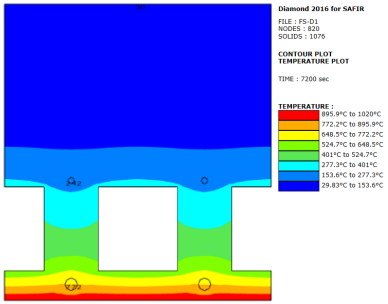
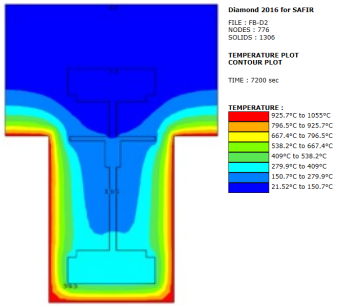


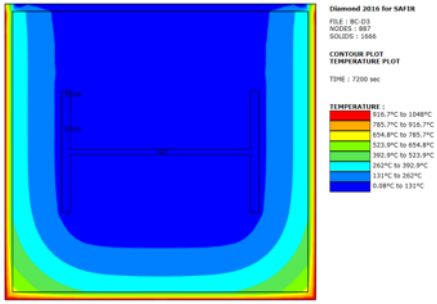


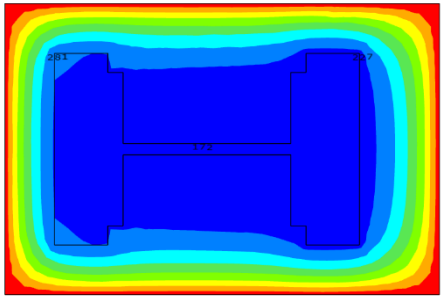
Fire resistance assessments of historic buildings

SAFIR numerical analysis

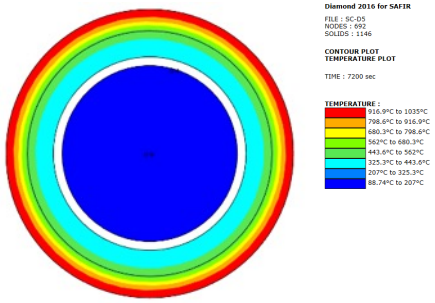








Fire resistance based on θ_{cr}



Details	Element type	Anticipated Fire resistance period (REI) (min)
Detail 1 (FS-D1)	Floor system	30
Detail 2 (FB-D2)	Concrete encased beam (primary/ secondary)	>120
Detail 3 (BC-D3)	Brick encased column	>120
Detail 4 (CC-D4)	Concrete encased column	>120
Detail 5 (SC-D5)	Circular steel column encased in precast concrete blocks	>120

The End

Questions?