Composite column under ISO fire

Different variants based on DIN EN 1991-1-2/NA:2012-03

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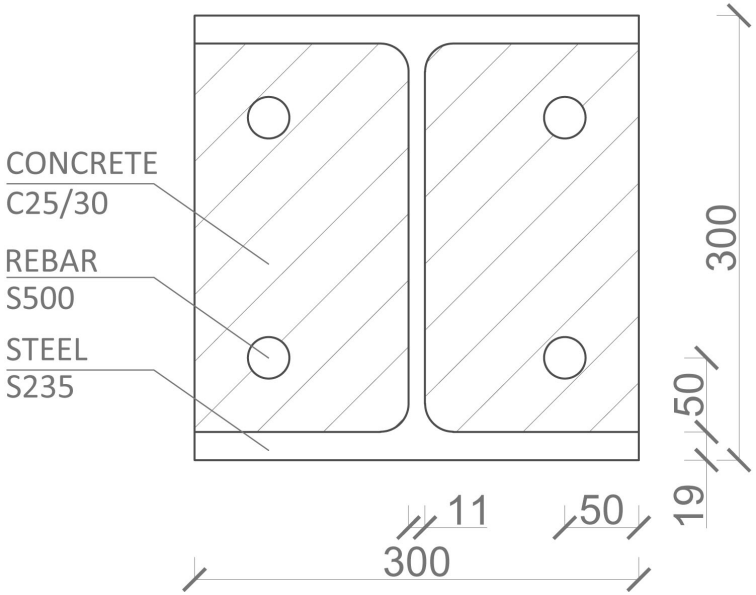
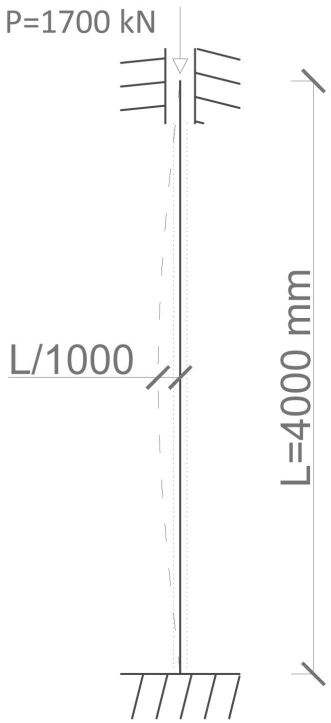
March 12, 2014

COLUMN SECTION AND MATERIALS



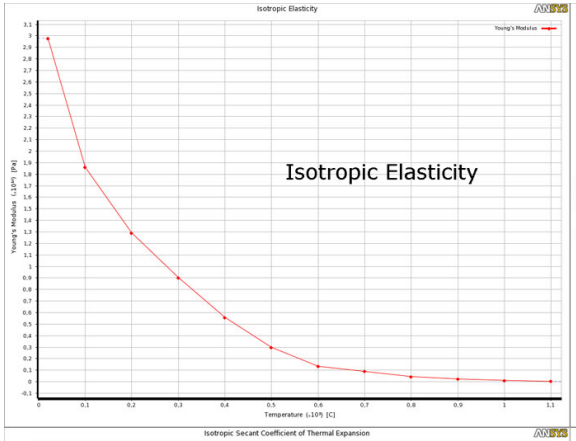


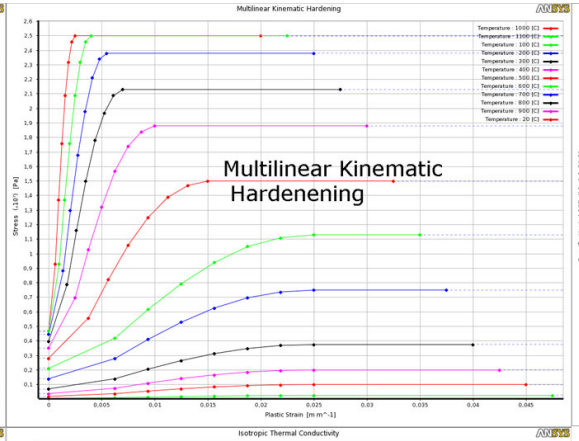
INPUT DATA

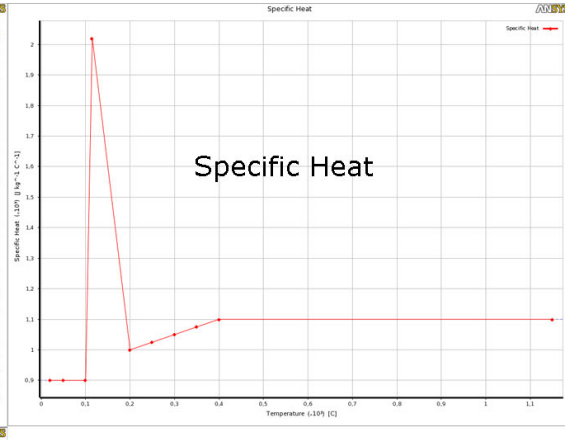
Stress - strain curve	DIN EN 1994-1-2
Temperature Load	DIN EN 1991-1-2
Heat tramsfer coefficient	25 W/(m² x K)
Emissivity	0.7
Thermal and physical material properties	DIN EN 1994-1-2

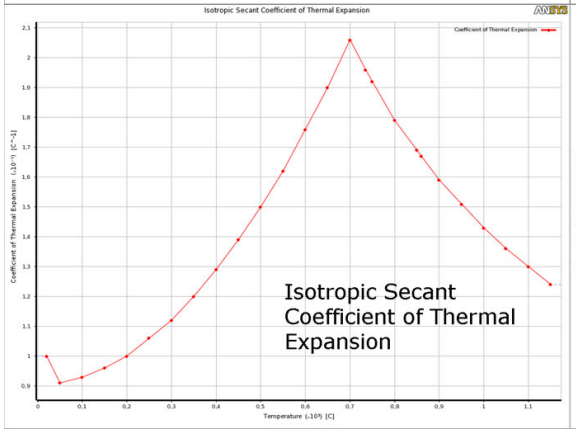
FLAME
INITIAL IMPERFECTION (PARABOLIC)

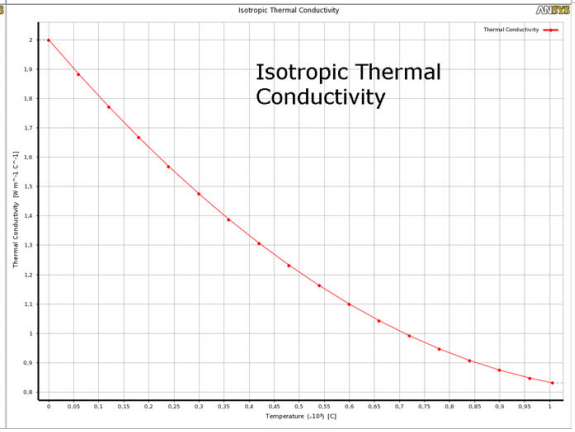
Material - Concrete



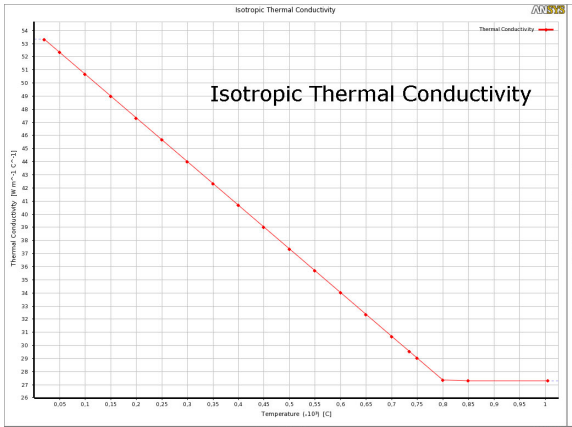


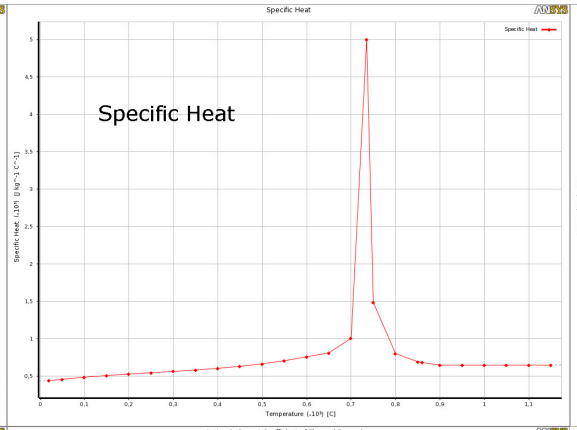


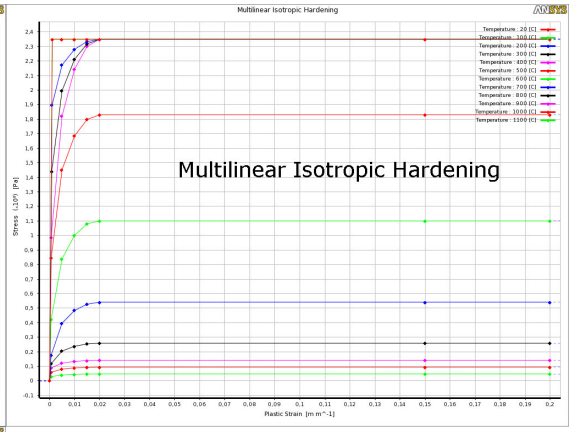


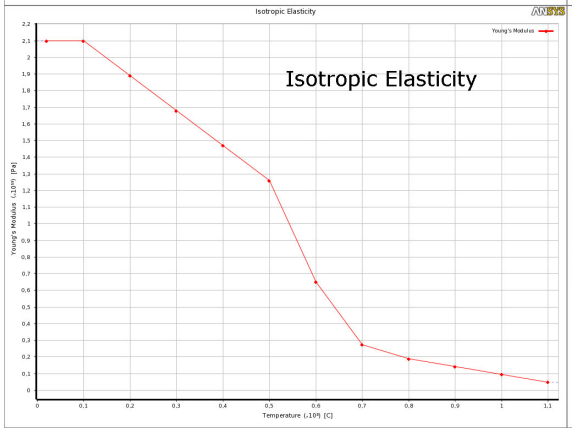


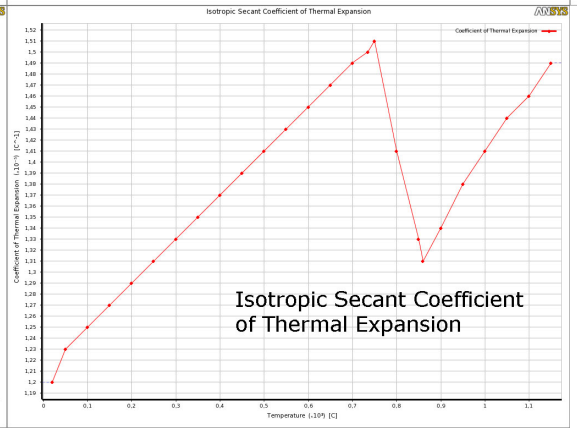
Material - Steel

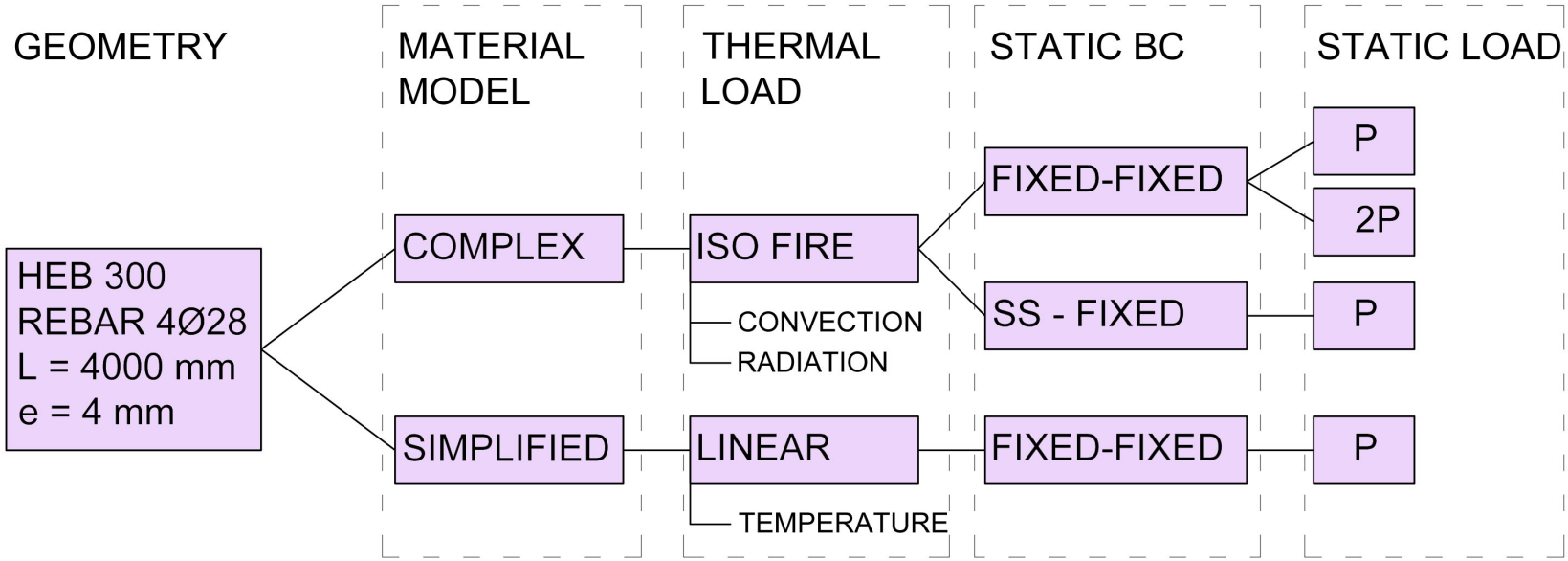




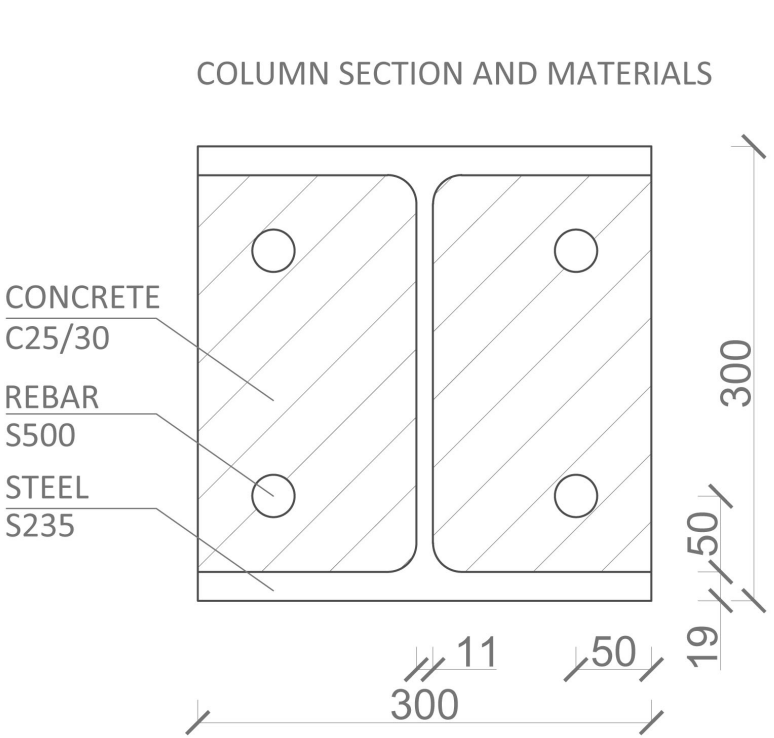


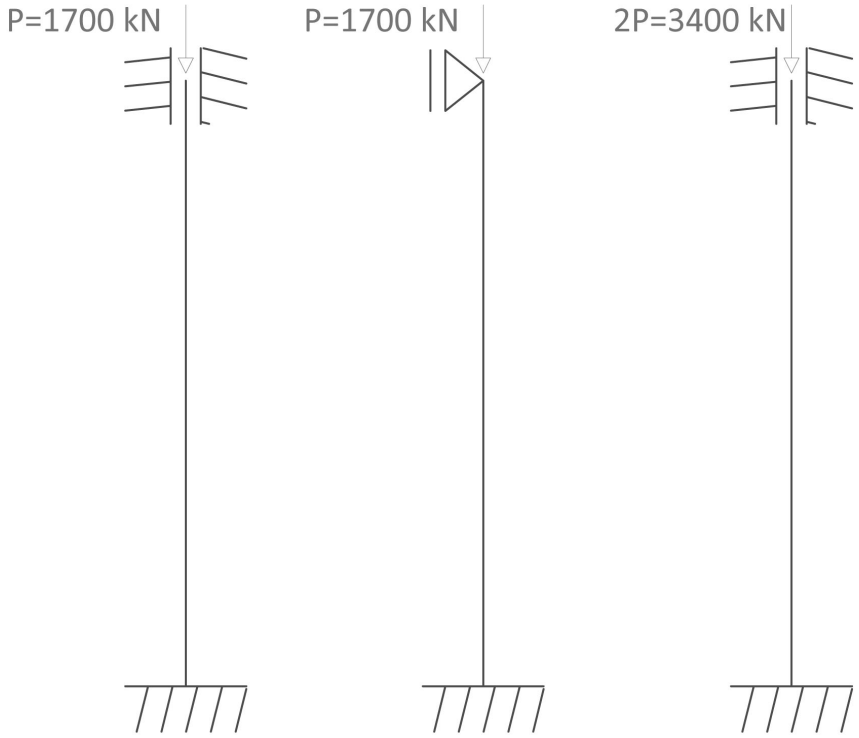


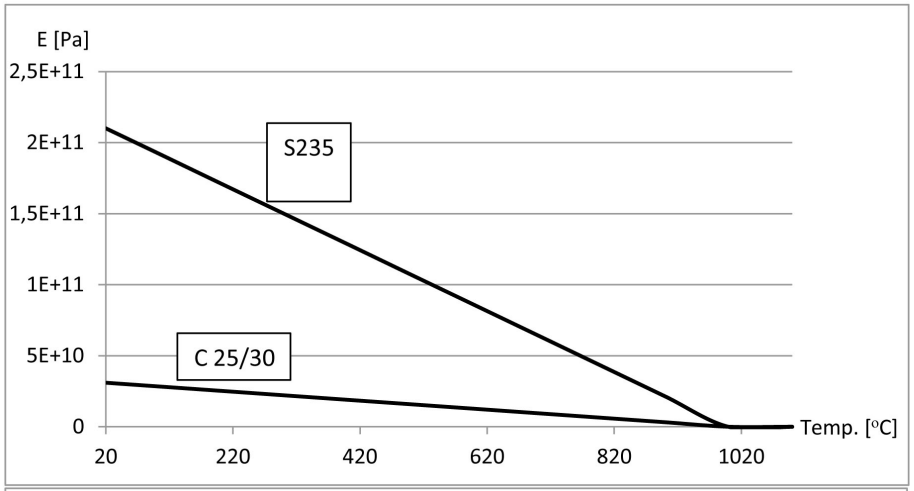


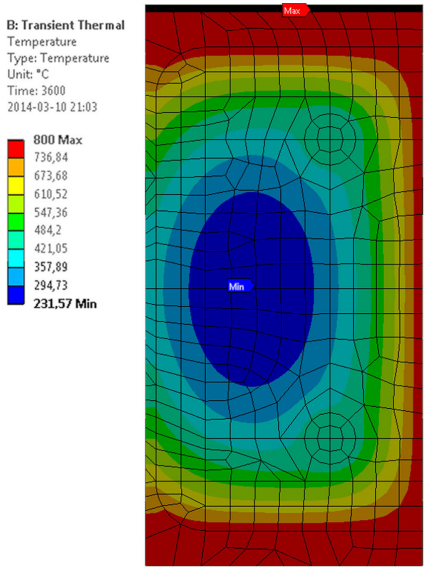

GEOMETRY
MATERIAL MODEL
THERMAL LOAD
STATIC BC
STATIC LOAD
HEB 300
REBAR 4Ø28
L = 4000 mm
e = 4 mm
COMPLEX
SIMPLIFIED
ISO FIRE
CONVECTION
RADIATION
LINEAR
TEMPERATURE
FIXED-FIXED
SS - FIXED
FIXED-FIXED
P
2P
P
P

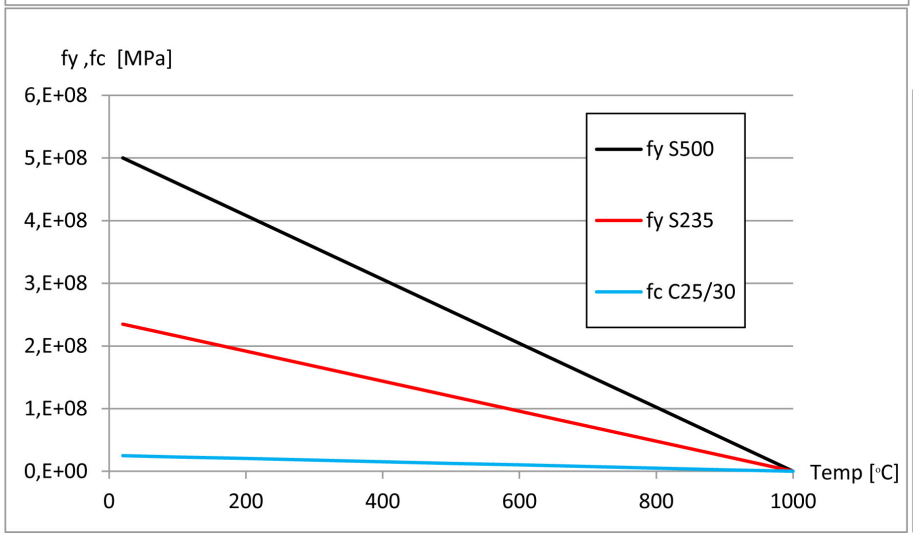
Model Variants

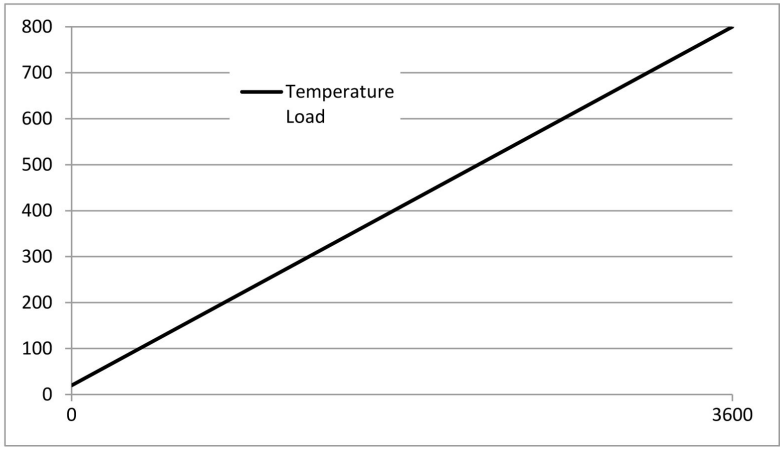




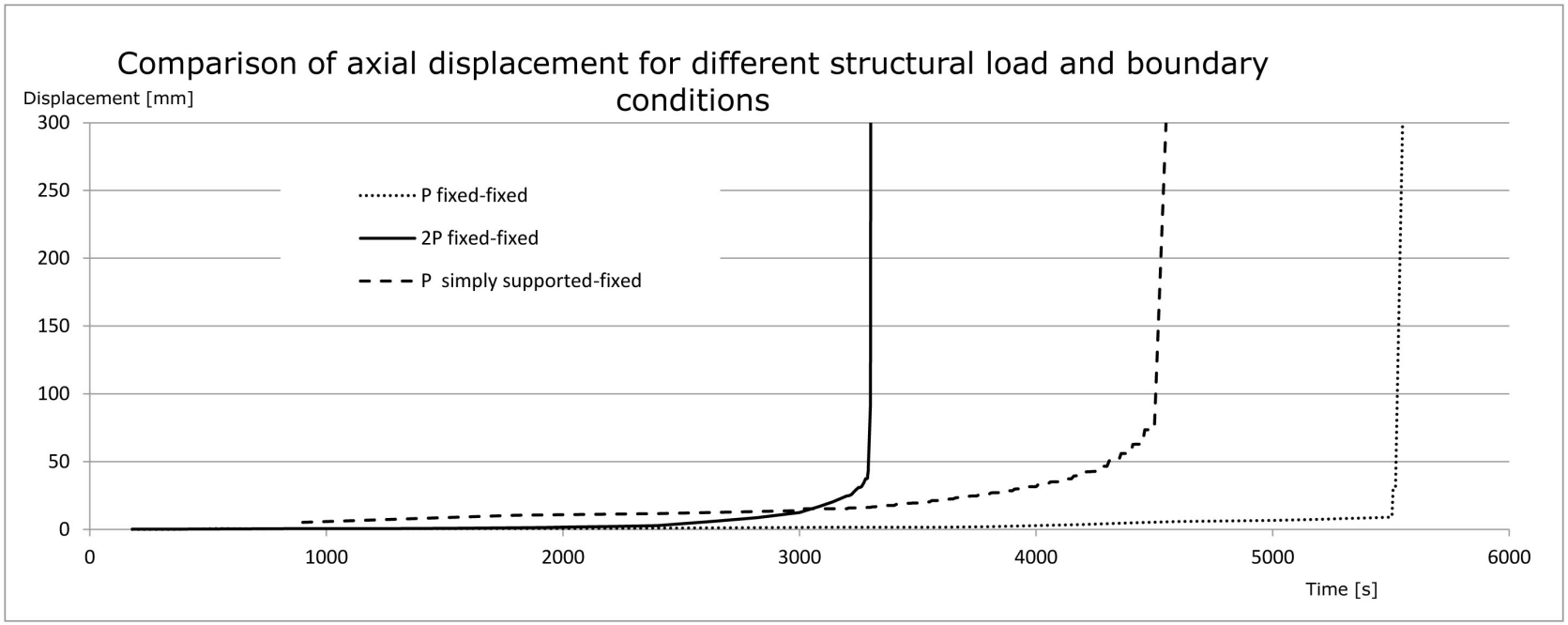

E [Pa]
2,5E+11
2E+11
1,5E+11
1E+11
5E+10
0
S235
C 25/30
20
220
420
620
820
1020
Temp. [°C]


B: Transient Thermal
Temperature
Type: Temperature
Unit: °C
Time: 3600
2014-03-10 21:03
800 Max
736,84
673,68
610,52
547,36
484,2
421,05
357,89
294,73
231,57 Min
Max
Min


fy ,fc [MPa]
6,E+08
5,E+08
4,E+08
3,E+08
2,E+08
1,E+08
0,E+00
fy S500
fy S235
fc C25/30
0
200
400
600
800
1000
Temp [°C]

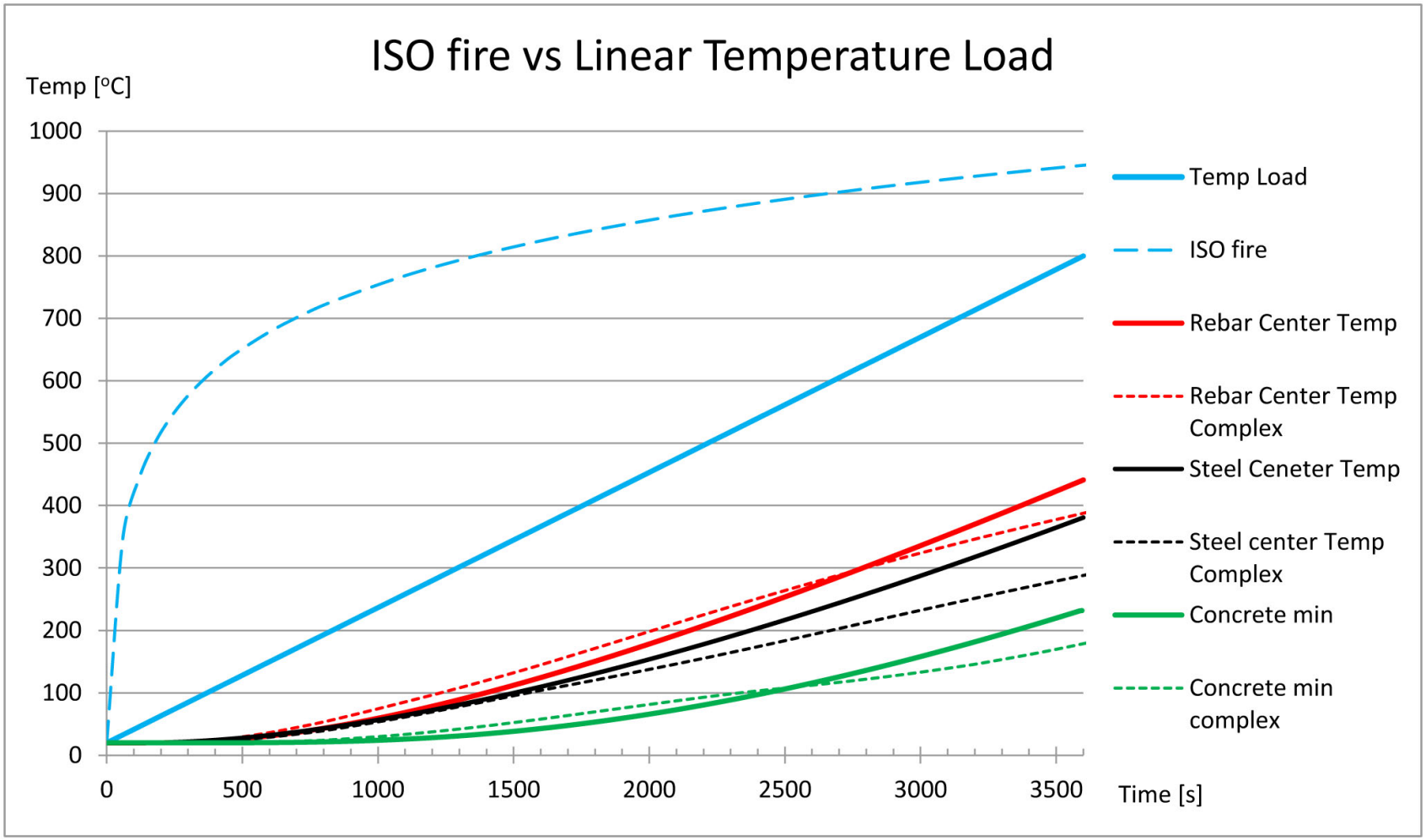

800
700
600
500
400
300
200
100
0
Temperature
Load
0
3600

Displacement for Complex Material Variants



Static Load	Boundary Conditions	Displacement [mm]						
		30 minutes	45 minutes	55 minutes	60 minutes	75 minutes	90 minutes	92 minutes
P	fix-fix	0,5	1,25	1,5	1,68	5,32	8,49	30,47
P	ss-fix	1,23	6,98	16,35	21,38	73,63	-	-
2P	fix-fix	10,49	12,84	92	-	-	-	-

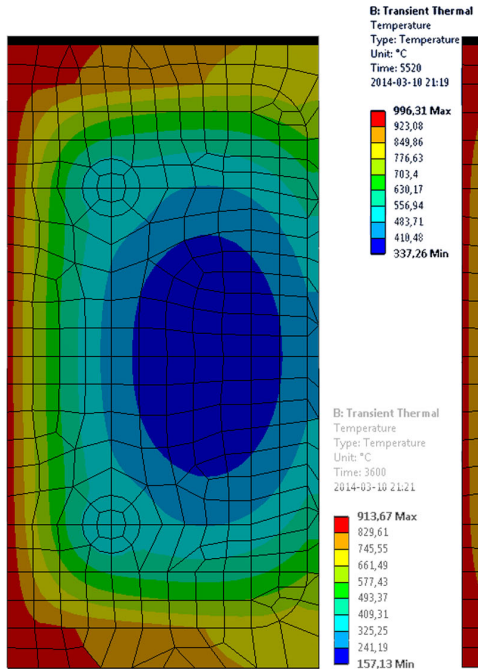
Temperature Results for Different Temp. Load



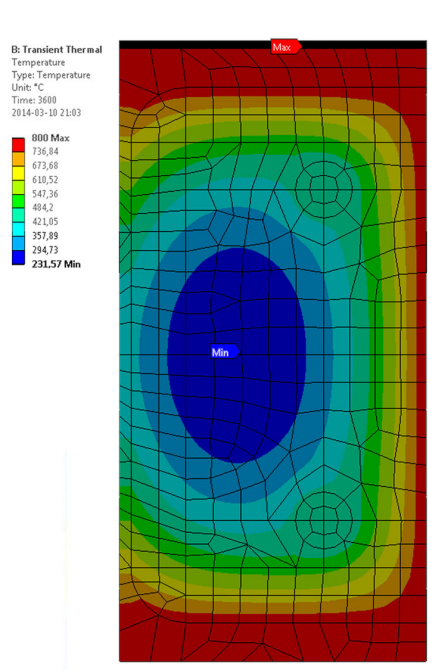
Complex and Simplified Material Results Comparison

MATERIAL	POINT	0 min	10 min	20 min	30 min	40 min	50 min	60 min
Simplified	HEB 300	20	32,47	72,62	131,04	203,52	287,47	380,78
	Rebar	20	31,22	78,64	150,65	238,04	335,74	440,95
Complex	HEB 300	20	29,08	69,76	120,46	173,95	232,22	287,91
	Rebar	20	36,47	387,49	171,35	251,10	323,90	287,91
Deviation [%]	HEB 300	0,00%	11,65%	4,10%	8,78%	17,00%	23,79%	32,26%
	Rebar	0,00%	-14,40%	-79,71%	-12,08%	-5,20%	3,66%	53,16%

COMPLEX MODEL, RADIATION AND CONVECTION

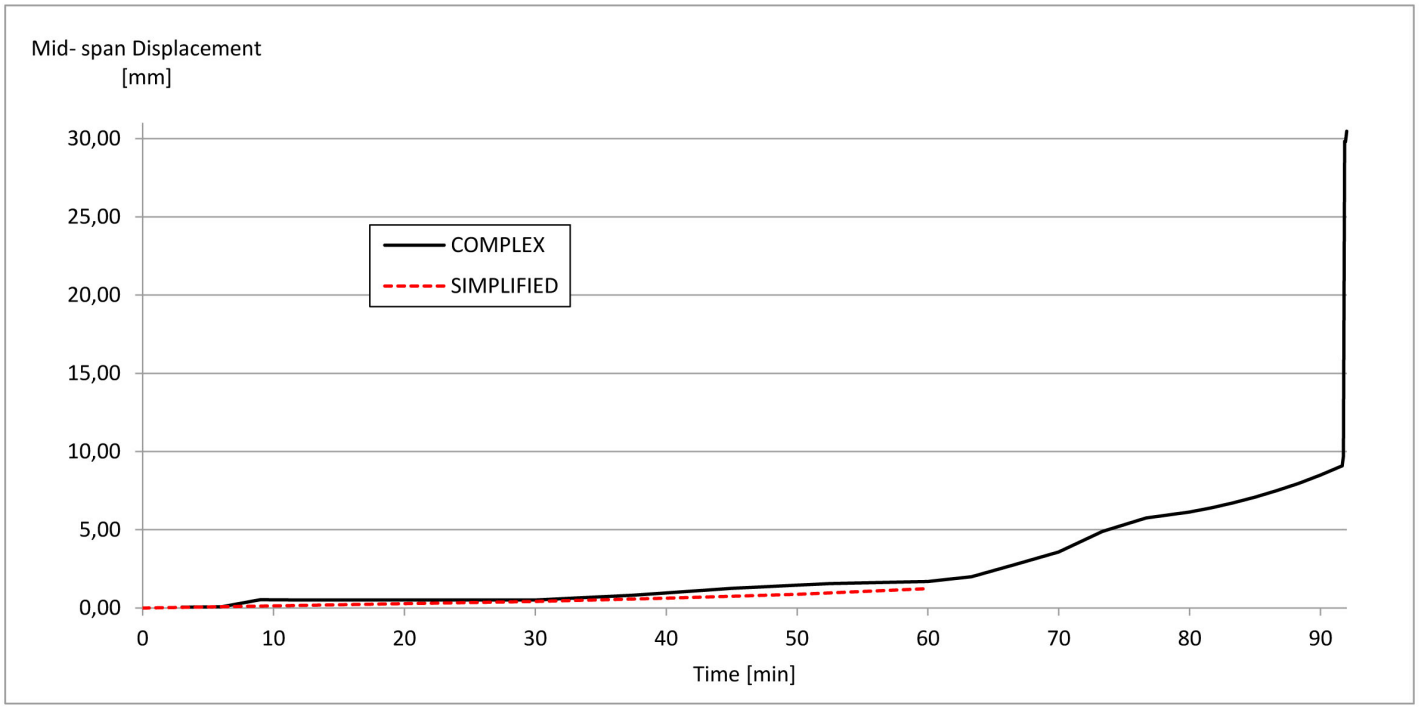


SIMPLIFIED MODEL, TEMPERATURE



Complex and Simplified Material Results Comparison

		Mid-span horizontal displacement [mm]						
TIME [min]		0	30	40	50	60	90	92
MODEL	SIMPLIFIED	0,00	0,41	0,62	0,87	1,23		
	COMPLEX	0,00	0,50	0,96	1,45	1,68	8,49	30,47



Complex and Simplified Material Results Comparison

DIFFERENT SOFTWARE VALIDATION RESULTS BASED ON DIN

Temperature [C] after 90 minutes of ISO fire		Abaqus	Safir	DIN	LSDYNA	Ansys
Probe point	HEB300	452	459	447	453	438
	Rebar	512	518	535	539	542
Deviation from DIN		-1,12%	-2,68%	0,00%	-1,34%	2,00%
		4,30%	3,18%	0,00%	-0,75%	-1,39%

						Ansys	
Displacement [mm]		Abaqus	Safir	DIN	LSDYNA	COMPLEX	SIMPL
Time [min]	30	4,36	4,44	4,4	-	4,50	4,41
	60	5,05	5,04	5,5	-	5,68	5,23
Deviation from DIN		0,91%	-0,91%	0,00%	-	-2,38%	-0,30%
		8,18%	8,36%	0,00%	-	-3,34%	4,91%

CONCLUSIONS

1. Simplified model does not give representative temperature field both in quality and quantity.
2. Despite lower thermal loading simplified model gives relatively high values of displacement.
3. Less rigid boundary conditions/more susceptible joints or certain over-load may lead to significant change in time of fire resistance.
4. Further studies for different range of boundary conditions on complex model ...