Effective Thermal Conductivity of Fire Proof Materials and the Measuring Method

Outline of Lecture

- The Definition of Effective Thermal Conductivity
- Def.1: the average of the thermal conductivities when the specimen temperature was 400~600℃
- Def.2: the thermal conductivity when the specimen temperature was 540℃ (1000°F)
- Experimental Investigation
- Conclusion

Application of Structural Fire Design
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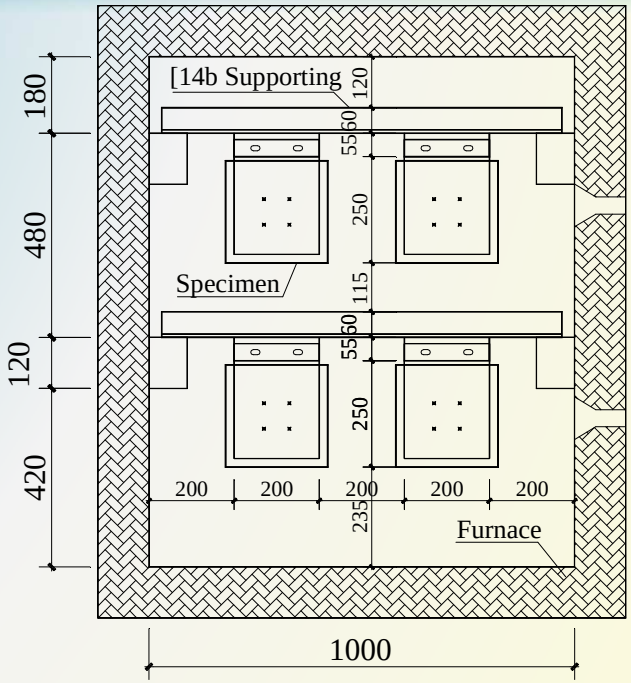
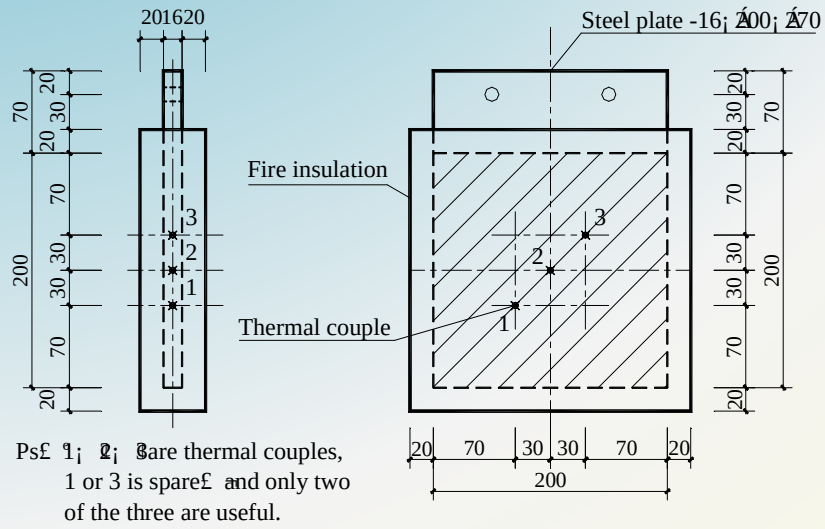
Experimental Investigation

a) The furnace



b) The cross-section and the arrangement of specimens



Ps£ 1¡ 2¡ 3are thermal couples, 1 or 3 is spare£ and only two of the three are useful.

c) Dimensions of specimens

Fig. 2 Test setup and specimens

Experimental Investigation

Test Results

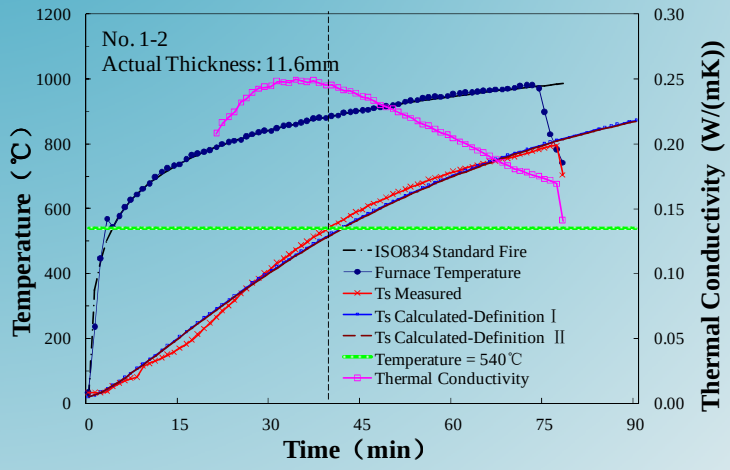
Table 1 Testing results of effective thermal conductivity

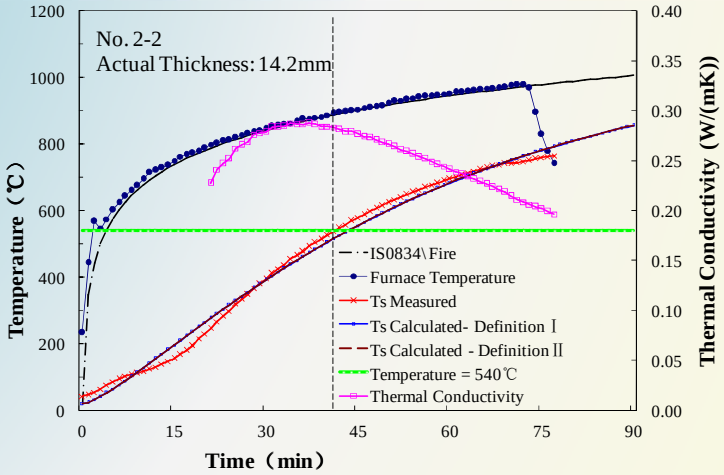
Specimen ID	Design Fire-resistance (h)	Design Thickness (mm)	Actual Thickness (mm)	Time of Ts=540℃(min)	Effective Thermal Conductivity (W/m·K)			
					By Def.1	Average of Def.1	By Def.2	Average of Def.2
1-1	0.5	10	11.2	41	0.2271		0.2277	
1-2	0.5	10	11.6	39	0.2472	0.2359	0.2448	0.2349
1-3	0.5	10	12.5	43	0.2334		0.2323	
2-2	1.0	17	14.2	41	0.2827	0.2597	0.2834	0.2604
2-3	1.0	17	14.5	47	0.2366		0.2373	
3-1	1.5	20	18.5	55	0.2476		0.2498	
3-2	1.5	20	18.0	62	0.2031	0.2339	0.2055	0.2366
3-3	1.5	20	18.0	53	0.2511		0.2545	
4-1	2.0	30	33.0	86	0.2373		0.2456	
4-2	2.0	30	31.0	91	0.2050	0.2299	0.2125	0.2374
4-3	2.0	30	31.5	81	0.2475		0.2542	
5-1	2.5	40	36.0	94	0.2300		0.2378	
5-2	2.5	40	36.0	98	0.2182	0.2272	0.2251	0.2342
5-3	2.5	40	36.0	94	0.2335		0.2396	

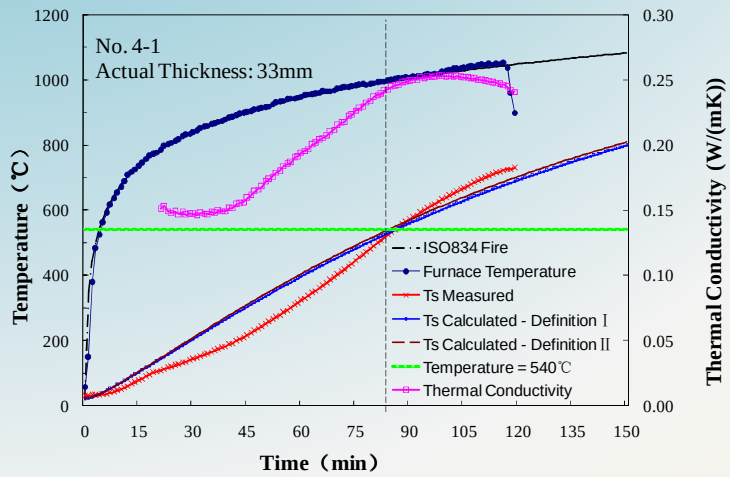
Ps：the steel plates are all sized 16 mm×200 mm×270mm；
the shape factor of the steel plates are all 145m^{-1}.
Def.1—the average of the thermal conductivity when the specimen temperature was 400~600℃
Def.2—the thermal conductivity when the specimen temperature was 540℃ (1000℉)

Experimental Investigation

Test Results







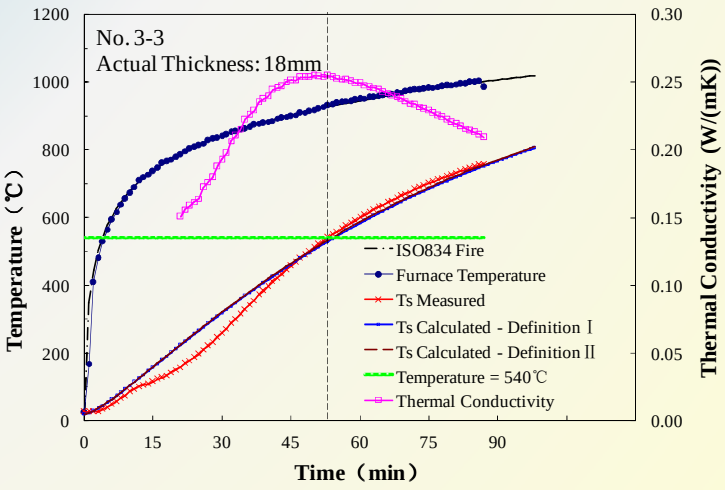


Fig. 4 Comparison between Ts calculated and Ts measured

Conclusion

1. Proposed a measuring method suitable for thermal conductivity of fire proof materials and developed the corresponding test setup.
2. Proposed two definitions of thermal conductivity.
3. Verification and comparison of the two definitions were proposed. Comparison between the calculated temperature and the measured temperature indicated that the two definitions met the engineering requirements.
4. The thickness of fire insulation has little effect on the effective thermal conductivity. 20mm was chosen as typical thickness taking actual use into consideration.