Comparing Flashover Heat Release Rate Within Different Materials

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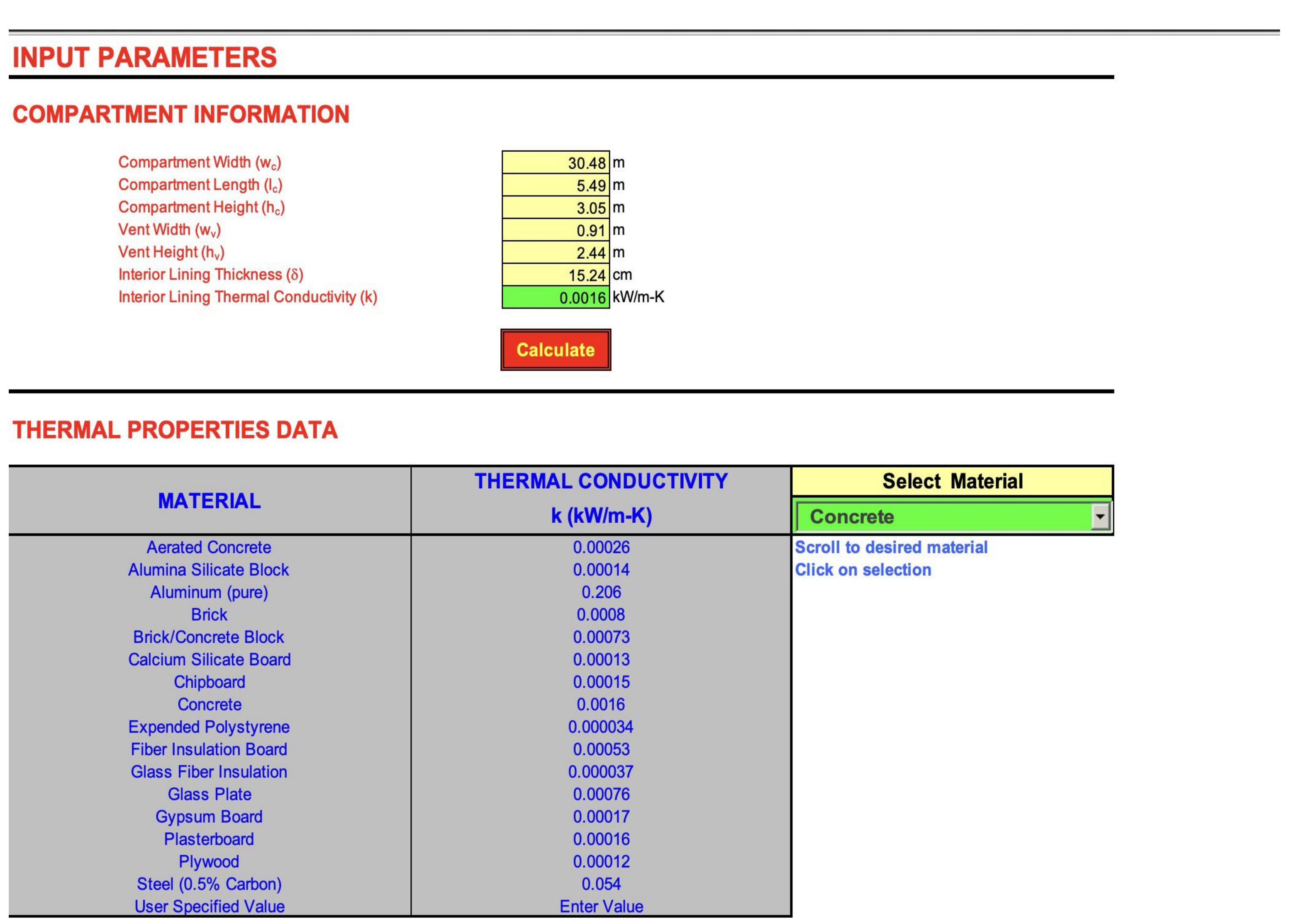
Introduction

- Fire modeling systems help figure out what happened during a fire, how a fire could have been prevented, or how a hypothetical fire would behave.
- Spreadsheet models are an important modeling system in the reconstruction of fires and prevention of fires.
- Flashover is the most dangerous phase of a fire, where surfaces exposed to thermal radiation reach ignition temperature (Icove, 2017). The smaller the heat release rate (HRR) the faster flashover will occur.
- Compartment and vent size, along with the material the compartment is made of contribute to the rate of flashover.
- Research question: Will a brick compartment experience flashover faster than a concrete compartment at various sizes?
- Hypothesis: Flashover will occur faster in a small compartment made of brick than a small compartment made of concrete due to the lower thermal conductivity.

Methods


INPUT PARAMETERS

COMPARTMENT INFORMATION

Compartment Width (w_c)	30.48	m
Compartment Length (l_c)	5.49	m
Compartment Height (h_c)	3.05	m
Vent Width (w_v)	0.91	m
Vent Height (h_v)	2.44	m
Interior Lining Thickness (δ)	15.24	cm
Interior Lining Thermal Conductivity (k)	0.0016	kW/m-K

Calculate

THERMAL PROPERTIES DATA

MATERIAL	THERMAL CONDUCTIVITY k (kW/m-K)	Select Material: Concrete
Aerated Concrete	0.00026	Scroll to desired material
Alumina Silicate Block	0.00014	Click on selection
Aluminum (pure)	0.206	
Brick	0.0008	
Brick/Concrete Block	0.00073	
Calcium Silicate Board	0.00013	
Chipboard	0.00015	
Concrete	0.0016	
Expended Polystyrene	0.000034	
Fiber Insulation Board	0.00053	
Glass Fiber Insulation	0.000037	
Glass Plate	0.00076	
Gypsum Board	0.00017	
Plasterboard	0.00016	
Plywood	0.00012	
Steel (0.5% Carbon)	0.054	
User Specified Value	Enter Value	

Fig 1. Inputted 10 values, ranging from 0.79m to 40.89m, for the compartment width, once while the material was concrete and then again when the material was brick.

Results

Fig 3. Material being concrete, results for MQH, Babrauskas, and Thomas

Fig 4. Material being brick, results for MQH, Babrauskas, and Thomas

Fig 5. Different between brick and concrete with MQH method

Methods

CALCULATION METHOD	FLASHOVER HRR (kW)
METHOD OF McCAFFREY, QUINTIERE, AND HARKLEROAD (MQH)	2740
METHOD OF BABRAUSKAS	2613
METHOD OF THOMAS	5620

Fig 2. 3 different calculation methods produces three different answers for each set of inputs

Results

- Changing the size of a compartment that was made of concrete does not affect the flashover HRR very much (Fig 3).
- Changing the width of a compartment that was made of brick does not extremely affect the flashover HRR (Fig 4).
- Babrauskas method does not change the flashover HRR when changing the width of the compartment. (Only when changing vent size)
- See the biggest change in flashover HRR with MQH method (5)

Conclusion

- Concrete has a higher flashover HRR than brick.
- Results show there is no difference when use Babrauskas or Thomas calculation methods. The only difference is in MQH method
- Did not support my hypothesis, concrete will experience flashover before brick
- Comparison of materials that are not as similar could make results better
- Will changing the vent size instead of compartment size have the same results?

References

Stroup, D, et al. "Nureg-1805, Supplement 1, Volumes 1 & 2 - NRC Web." *U.S.NRC*, 2013, https://www.nrc.gov/reading-rm/doc collections/nuregs/staff/sr1805/s1/index.html.
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