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Discussion: Use of adiabatic calorimetry for performance assessment of concretes

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The authors have produced some useful experimental data on the heat evolution of concrete mixes containing different mineral admixtures (Ramu *et al.*, 2016). These data may be further analysed for deeper study.

For the ordinary Portland cement (OPC) concrete, it is observed that the heat evolution was not directly proportional to the cement content, as listed in Table 6, where it can be seen that the total heat varied from 245 kJ/kg at a water to cement (*w/c*) ratio of 0·38 to 256 kJ/kg at a *w/c* ratio of 0·45. Such variation may be attributed to the incomplete degree of hydration, which is dependent on the *w/c* ratio, as has been found in previous studies by the discussers (Ng *et al.*, 2008, 2009).

For the fly ash concrete, it is evident from the results listed in Table 7 that the total heat was generally lower at a higher fly ash replacement ratio and/or a lower water to binder (*w/b*) ratio. Again, the lower total heat at lower *w/b* ratio and higher total heat at higher *w/b* ratio may be attributed to the difference in degree of chemical reactions at different *w/b* ratios, as has been reported previously by the discussers (Kwan *et al.*, 2011a). The placing temperature might have also affected the total heat, but the placing temperature results have not been given in the paper.

For the silica fume concrete, for which the results are summarised in Table 8, it is particularly interesting to note that the addition of 5% silica fume has reduced the total heat by 8·0%, whereas the addition of 10% silica fume has reduced the total heat by 10·3%. Hence, the percentage reduction in heat evolution was larger than the percentage reduction in cement content. A similar phenomenon was observed by the discussers in a previous study (Kwan *et al.*, 2011b). Further research is recommended to explain this phenomenon.

Mix	Water content: kg/m^3	Cement content: kg/m^3	*w/c* ratio	Total heat: kJ/kg
C2-M30-1	171	380	0·45	256
C2-M30-6	153	360	0·43	250
C2-M50-3	180	470	0·38	245

Table 6. Total heat evolution of OPC concrete

Mix	Fly ash replacement ratio	Binder content: kg/m^3	*w/b* ratio	Total heat: kJ/kg
C2-M30-2	0·25	400	0·45	274
C2-M30-3	0·21	380	0·43	277
C2-M30-4	0·38	450	0·39	219
C2-M30-5	0·25	480	0·47	207
C2-M30-7	0·17	360	0·50	377
C2-M30-8	0·29	450	0·42	190
C2-M30-9	0·27	460	0·49	226

Table 7. Total heat evolution of fly ash concrete

Mix	Silica fume replacement ratio	Binder content: kg/m^3	*w/b* ratio	Total heat: kJ/kg
C1-M80-P	0	430	0·35	261
C1-M80-MA1	0·05	430	0·35	240
C1-M80-MA2	0·10	430	0·35	234

Table 8. Total heat evolution of silica fume concrete

Authors' reply

The authors thank Dr Kwan and Dr Ng for their insightful discussion of this paper. Indeed, the extent of the chemical reactions at different *w*/*b* ratios is expected to have an effect on the heat evolved. However, the authors wish to clarify that this was not a parametric study; rather, they analysed only heat evolution from concretes with mixture designs that are used commercially. Further, as rightly pointed out, additional work is necessary to understand the reduction in heat evolution with silica fume concrete, particularly also considering the influence of the particle size of the material.

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