An assessment of a coupled method between continuous and discontinuous Galerkin methods

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ABSTRACT

Glass Fibre Reinforced Polymer (GFRP) has several advantages over conventional materials like strength, self-weight, insulation properties and durability. Although, the mechanical and physical properties of GFRP pultruded profiles are well studied, their response to fire is not properly established. Several numerical models based on finite elements has been developed to study the thermo-mechanical behavior of the GFRPs [1].

The present work focuses on developing numerical techniques for tubular GFRP sections to predict their behaviour under fire. The principle physics involved in the problem are heat conduction in GFRP, fluid dynamics induced by natural buoyancy of air inside the cavity of the section and internal radiation along the cavity. Hence, the multiphysics problem can be solved by coupling conduction equation and radiosity equation in the solid (GFRP) along with Navier–Stokes and convection–diffusion equations in fluid (air).

The problem is solved using continuous Galerkin (CG) methods to discretize all the relevant equations using monolithic coupling scheme and implicit time stepping method (CG-CG model). It is noticed that natural buoyancy of the air inside the cavity at higher temperatures tends to be unstable. The recently developed Hydridizable discontinuous Galerkin (HDG) [2] methods have superior convergence and stability properties when compared to CG. Numerical assessment of HDG using benchmark problems reveals that the computational efficiency of the HDG method is similar, and sometimes superior, to CG for a given level of accuracy and, in addition, HDG has better stability properties in the presence of sharp fronts.

The present work consists of discretizing the Navier–Stokes and convection–diffusion equations of fluid part (air) using HDG and conduction and radiosity equations in solid part (GFRP) using CG (HDG-CG model). The results of HDG-CG model will be compared with CG-CG model in terms of accuracy and computational efficiency. The results of both models will be compared to that of experimental data. The models will be run for different configurations of GFRP like tubular section with protection, I-section, *etc.*

REFERENCES

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