PERFORMANCE ANALYSIS OF COMPOSITE STEEL GIRDER BRIDGE STRUCTURAL ELEMENTS SUBJECTED TO HYDROCARBON AND BUSHFIRES

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FOCUS OF THIS RESEARCH IS TO ASSESS THE PERFORMANCE OF EXISTING COMPOSITE STEEL GIRDER BRIDGES TO MOST RATIONAL BUSHFIRE(*BF*) AND HYDROCARBON(*HC*) FIRE EVENTS. A PROPER MODELING OF A *BF* AND *HC* FIRE EVENT AND A VALIDATED MODELING FRAMEWORK FOR THERMO-MECHANICAL ANALYSIS OF THE SYSTEM IS DEVELOPED. FURTHER, GUIDELINES FOR DESIGN AND USE OF INSULATION TO IMPROVE THE PERFORMANCE WILL BE RECOMMENDED. FINALLY, BRIDGE FIRE VULNERABILITY MODELS WILL BE DEVELOPED.

INTRODUCTION

Fire is one of the sever hazards a bridge would be subjected to during its lifetime out of many other hazards. Occurrence of bridge fire is a low probability event. However its impact and consequences are very high. Crashing of vehicles and burning gasoline, bushfire or wild fires are the most probable causes of bridge fires. Compared to *HC* based fires on bridges the impact of bushfire on bridge components is less investigated. Steel structures are more vulnerable to the fire than concrete structures. In this research the genre of steel plate girder bridges were investigated.

Fig.1a Bridge collapsed due to *HC* fire

Fig.1b Concrete bridge investigated after a bushfire

RESEARCH QUESTIONS

- How to model a bushfire?
- What is the effect of a probable bushfire or a HC fire on an existing steel bridge?
- How to come up with a vulnerability model for a particular bridge subjected to *BF or HC fire*?
- How to increase the fire resilience of a bridge?

ANALYSIS FRAMEWORK

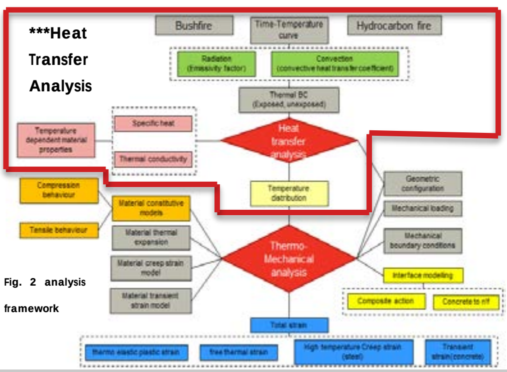


Fig. 2 analysis framework

Case studies will be performed based on the analysis framework with different site conditions and different bridge configurations. Results of this studies will be used to produce fire resilience curves under different failure criteria that ultimately lead to vulnerability curves. Only the preliminary results of heat transfer analysis are discussed in the following sections.

FIRE MODELING

No standard bushfire time temperature curves are available in literature. Modeling has to be relied on the various field experimental data or numerical Fire Dynamic simulation(*FDS*) data resulting from actual fuel load available on a site and its condition. *FDS* is currently considered as a part of this research. No standard *HC* fire curve is available in literature for bridge applications. Standard fire curves available for building applications are used for bridge fire rating calculations.

Fig 3. Burning Wallace site fire curve obtained from real experiment

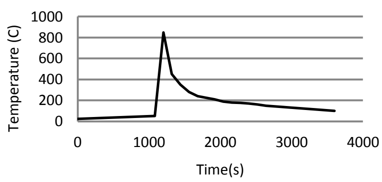
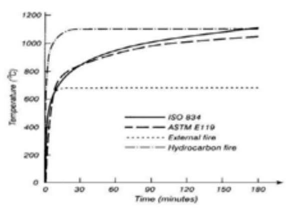


Fig. 4 Standard fire curves recommended in codes



HEAT TRANSFER ANALYSIS RESULTS

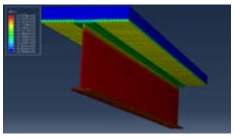


Fig. 5. 3-D Abaqus Model of the structural element

General purpose FE software, Abaqus, is used to solve the problem numerically.

Fig.6 Exposed to burning Wallace site experimental fire

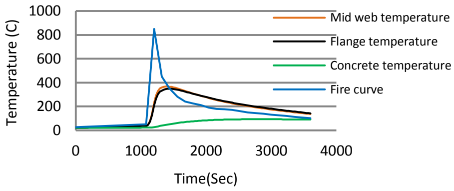
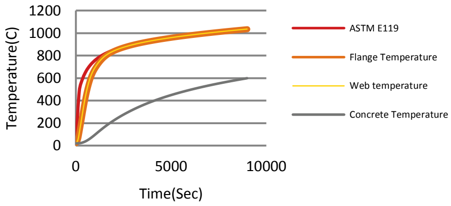


Fig. 7 Exposed to ASTM E119 standard fire



DISCUSSION

Reference to Fig. 6, in a typical bushfire event temperature range from 200C-365C exist for up to 24 mins in steel. This is small when compared to a standard fire exposure(fig.7), but its total effect may be governed by the load presence at the time of the fire event.

FUTURE WORK

- FDS analysis will be developed to represent a realistic site conditions and to account for a realistic bush fire effect.
- Comprehensive thermo mechanical analysis will be performed to understand the behavior and Model will be validated.
- Protective measures will be incorporated in to the analysis.
- Propose design recommendations
- Cary out case study analysis and produce vulnerability models.

END USER SUPPORT STATEMENT

The major outcome of the project will be vulnerability models for steel bridges under bushfire exposure. According to VicRoads this also is important in determining the evacuation routes in the road network under a bushfire condition.

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