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

bushfire&natural HAZARDSCRC

Amila P. Dissanayake[1], Srikanth Venkatesan[1], Sujeeva Setunge[1] , Hessam Mohseni[1]

[1] School of Engineering, RMIT University

THE FOCUS OF THIS RESEARCH IS TO ASSESS THE PERFORMANCE OF EXISTING COMPOSITE STEEL GIRDER BRIDGES TO MOST BUSHFIRE(*BF*) FIRE EVENTS. EFFECT OF A BUSHFIRE WAS FIRST EVALUATED BASED ON AVAILABLE EXPERIMENTALLY MEASURED BUSHFIRE TIME TEMPERATURE DATA. THEN THE BUSHFIRE ITSELF AND ITS EFFECT WERE CALCULATED WITH PHYSICS BASED FIRE DYNAMIC ANALYSIS. THE AIM OF THIS RESEARCH IS TO IDENTIFY A RANGE OF CRITICAL FUEL GEOMETRIES AND FIELD CHARACTERISTICS WHICH COULD RESULT IN POTENTIAL DAMAGE TO A STRUCTURE.

INTRODUCTION

Fire is one of the severe hazards a bridge could be subjected to during its lifetime. Occurrence of bridge fire is a low probability event. However its impact and consequences are potentially very high. Car crashes with burning gasoline and bushfire 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 fire than concrete structures. In this research the potential impact of a bushfire on steel composite plate girder bridges is investigated.

Bridge collapsed due to HC fire

Concrete bridge investigated after a bushfire

RESEARCH QUESTIONS

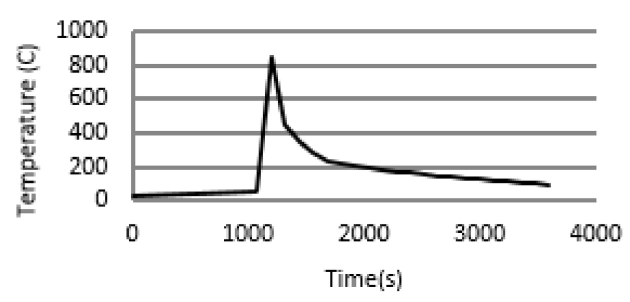
- How to model a bushfire?
- What is the effect of a probable bushfire on an existing steel bridge?
- How to identify critical fuel geometries/characteristics and field characteristics around a bridge that could make a potential impact.

FIRE MODELING

No standard bushfire time temperature curves are available in the literature. Modeling has to be relied for the various field experimental data or numerical Fire Dynamic simulation(*FDS*) data resulting from experimental fuel load characteristics and site conditions. Wildland Fire Dynamic Simulation(WFDS) software is used for the analysis. Boundary Fuel(BF) models and Fuel Element(FE) models are used for modeling the grass and trees respectively. Average height of vegetation, vegetation bulk density, vegetation surface to volume ratio, vegetation dehydration rate, char fraction, and maximum burning rate are the main fuel characteristics used in modelling. There is only limited data available on experimentally measured bush fire characteristics in the literature. Out of Butler and Putnam literature collection work on such limited data, Wallace burning site data was selected as for its longer duration and high peak temperature. 13-15kg/m2 vegetative based fuel was available at the site at burning as a form of log lashes strewn. This amount of fuel at a site is considerably higher than most of the common cases. However this was chosen to set up an upper limit for the damage as a result of a bush fire.

HEAT TRANSFER ANALYSIS RESULTS

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



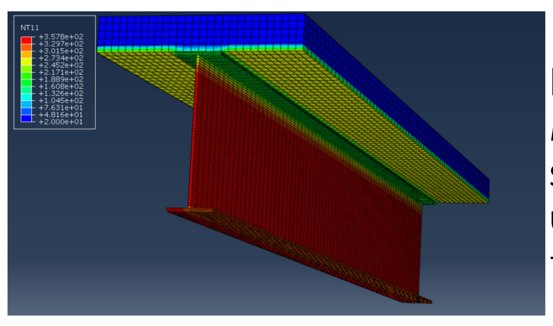
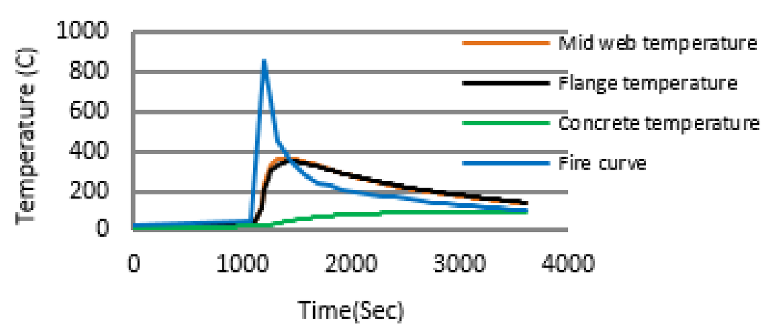


Fig. 4. 3-D Abaqus Model of the structural element used for the heat transfer analysis

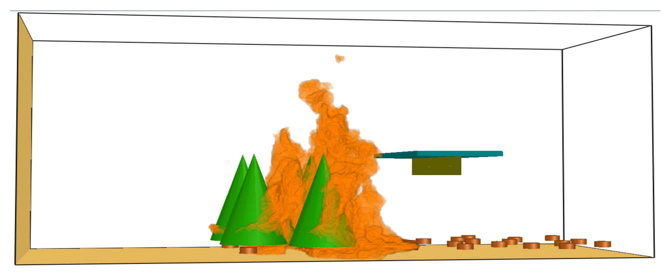
Fig.5 Exposed to burning Wallace site experimental fire



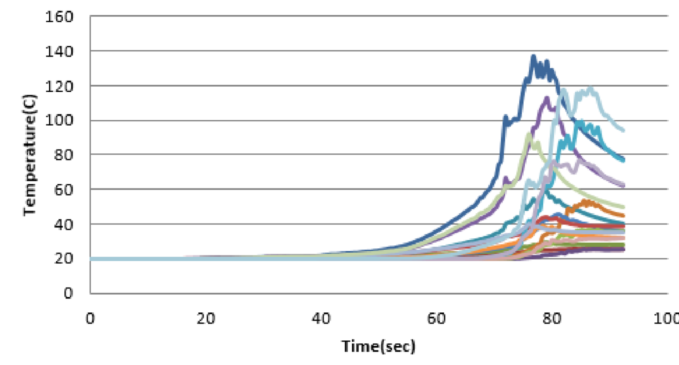
Significant residual strength reduction of concrete or the steel cannot happen in the structure. Bottom surface temperature up to 250°C could result in localized cracks and dehydration of the cementitious paste with complete loss of free moisture which could lead to spalling of concrete.

WFDS ANALYSIS RESULTS

7.5 m width 30 m long land strip with a composite bridge structure was modelled. Two models, one with FE and BF model and other only with BF models developed. Analysis domain is open boundary condition.

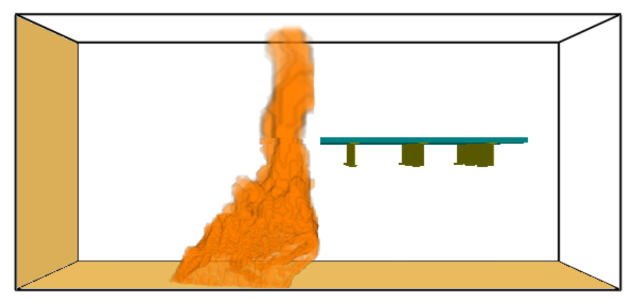


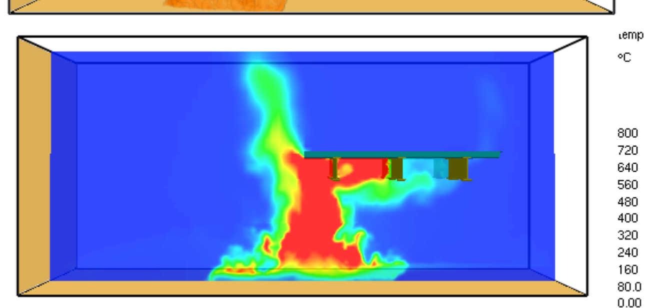
0.075mgrid size is used in the analysis

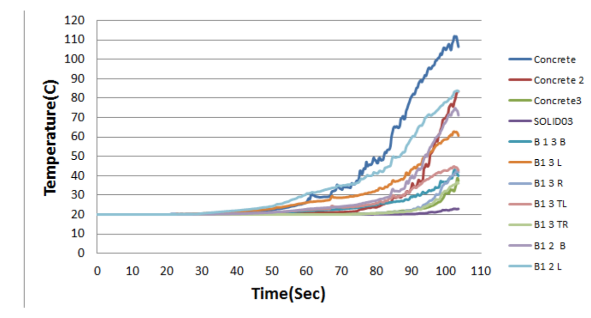


Temperature development for different points on the structure

0.5mm height grass land with 5 conical trees of 4.5m height and 2m base set 3m apart from the structure with common bulk density of 2.5kg/m resulted 140C temperature development in concrete at 2m/s wind situation. Average flame travel speed was about 0.142m/s. Air temperature around the structure goes beyond 800C







Temperature development of different point on the structure

2m height 6m length grass in the approaching side and 0.75m height grass elsewhere with 2.5kg/m3 bulk density results a peak temperature development of 112C in concrete. Wind velocity is 1.5m/s. Average flame travel speed is 0.134 m/s

FUTURE WORK

A series of parametric studies will be conducted to understand various critical fuel geometries/characteristics and field characteristics around a bridge. This information ultimately could be used for bushfire based bridge fire hazard mapping.

Australian Government Department of Industry, Innovation and Science | Business Cooperative Research Centres Programme
RMIT UNIVERSITY
vicroads