Numerical assessment of a steel bridge subjected to Wildland Urban Interface (WUI) fires

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The focus of this research is to assess the performance of a steel plate girder bridge subjected to WUI fire events. Fire scenarios were modelled with physics based Fire Dynamic Simulation(FDS). Sequentially coupled heat transfer analysis gave the temperature distribution of the bridge. 12mm Web area experienced the highest temperature development of 350C°. This leads to a 25% of decrease of steel Youngs modulus.

INTRODUCTION

There is a lack of research to understand the different fire exposure levels of bridges located in a WUI. This poster presents the results of 3 initial case studies of an ongoing work designed to assess the thermal performance of an existing composite steel girder bridge, exposed to probable fire events with different fuel and environmental conditions. Analysis domain size is of 56m length 10m wide and 25m height with a uniform 200mm mesh resolution. Vegetative fuels and fires in a wildland setting can be categorized as surface, or crown types.

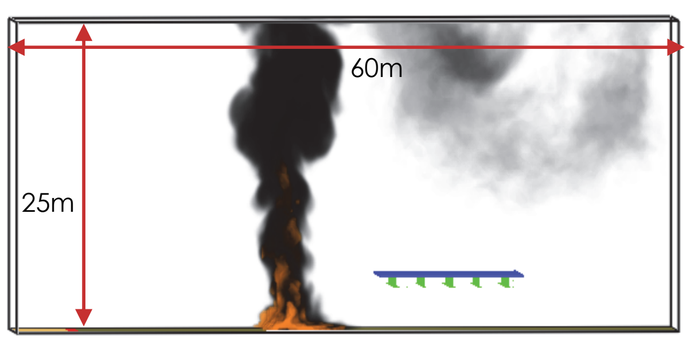
Fuel properties Surface fire model

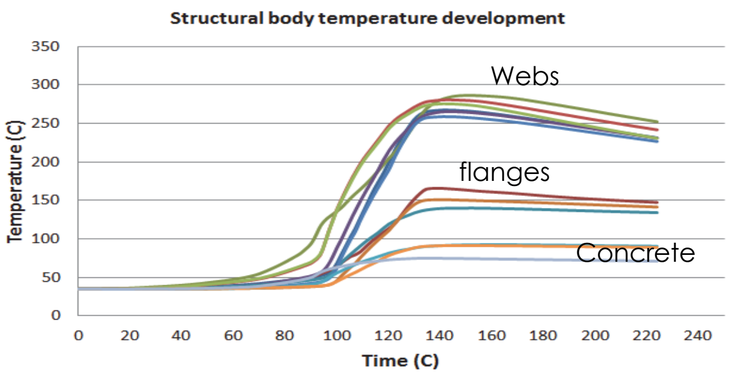
Parameter	Value
Vegetation bulk density	2.5 kg/m3
Vegetation height	1.0m
Vegetation moisture content	6.3%
Vegetation Surface to Volume Ratio (SVR)	9770m-1
Vegetation element density	440kg/m3
Maximum Mass loss rate	0.4 kg/s
Vegetation Drag Coefficient	0.125
Emissivity	0.9
Air temperature	35 °c

Fuel properties in crown fire model (douglas fir)

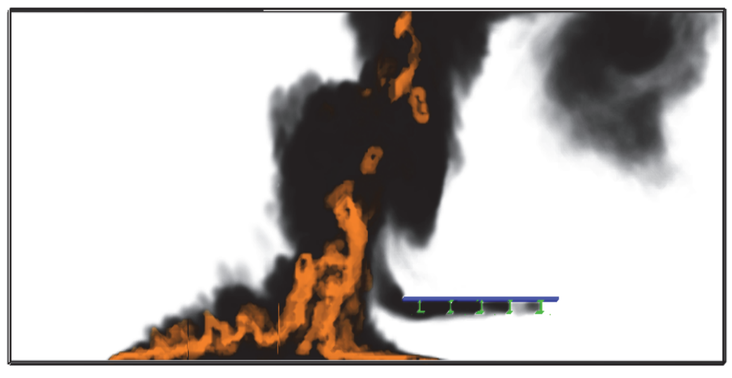
Parameter	Moisture	Vegetation	Char
Thermal con-ductivity (W/m.K)	2.0	2.0	2.0
Specific heat (kJ/kg. K)	4.148	1.2	1.2
Density (kg/m3)	1000	514	300
Reference temperature (C)	100	200	350
Reference rate	0.002	0.0005	0.0002
Heating rate (C/min)	1.6	1.6	1.6
Heat of reac-tion (kJ/kg)	2500	418	418

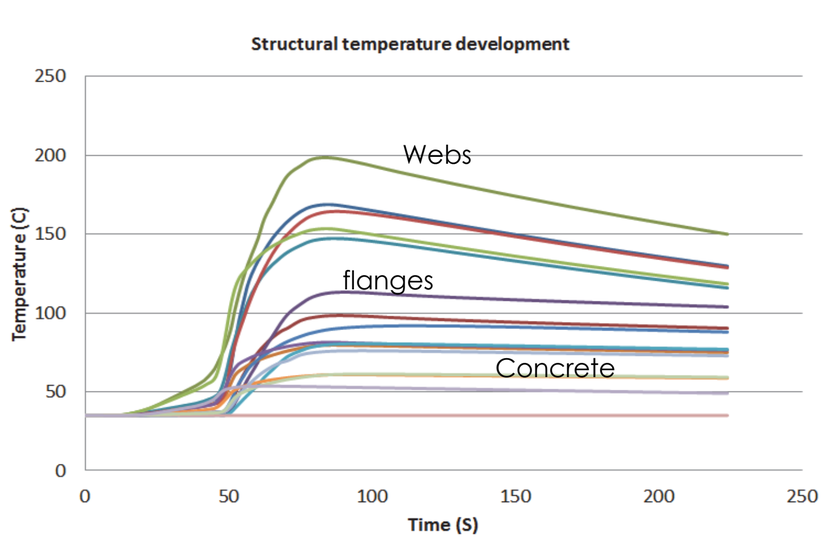
Model 1: Surface fuel model with wind velocity 2m/s at 10m above the ground



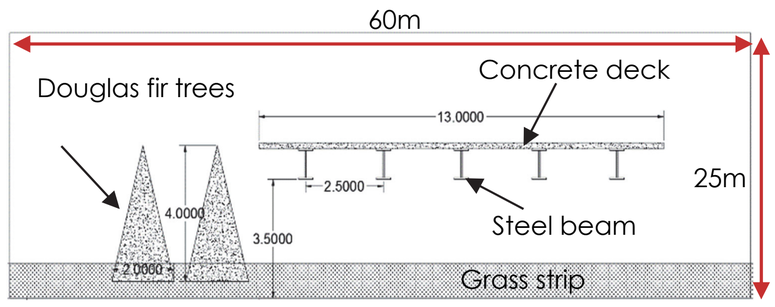


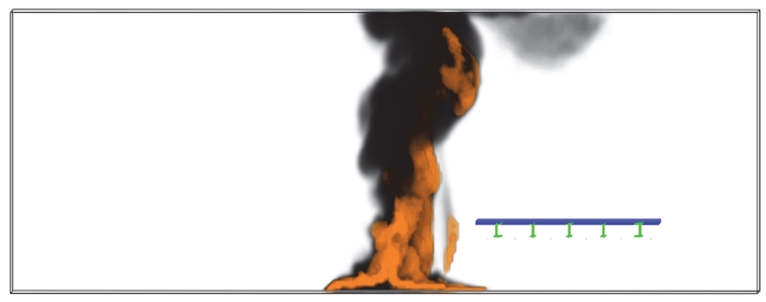
Model 2 : Surface fuel model with wind velocity 5m/s at 10m above the ground

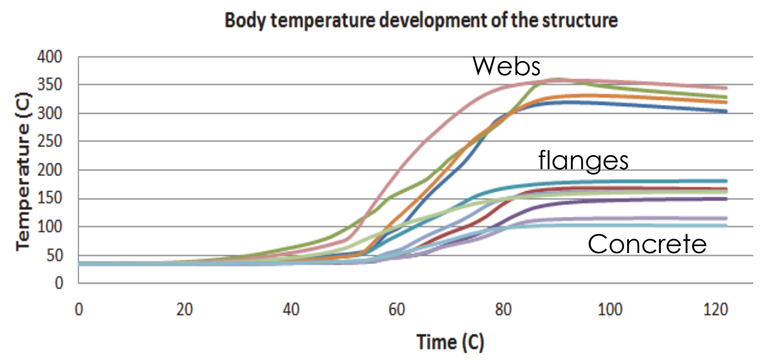




Model 3: Crown+surface fuel model, Wind velocity at 10m from ground is 2m/s







CONCLUSIONS

Initial analysis results show the temperature developments of the structural components could not lead to a residual strength degradation of steel or the cracking/spalling of the concrete. This is mainly due to the shorter flame residence time that did not allow the temperature to build within the structure. However, the presence of crown vegetation increases the risk. The steel Young's modulus value decreased by 25% while the strength degradation of steel up to 400C is limited. Further studies are needed to draw clear conclusions. Studies are necessary to identify further critical fuel geometries around a bridge. These future research results will help predict the isolated and cumulative effects on a structure when exposed to recurrent WUI fire events.

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