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Temperature-induced structural static responses of a long-span steel box girder suspension bridge



Key words:

Long-span suspension bridge; Temperature effect; Static response; Vehicle load; Field monitoring

Temperature field calculation

Precise calculation is full of challenge

- Many meteorological parameters are involved in the temperature calculation;
- The meteorological parameters have great randomness and strong uncertainty;
- The meteorological parameters are time-varying.

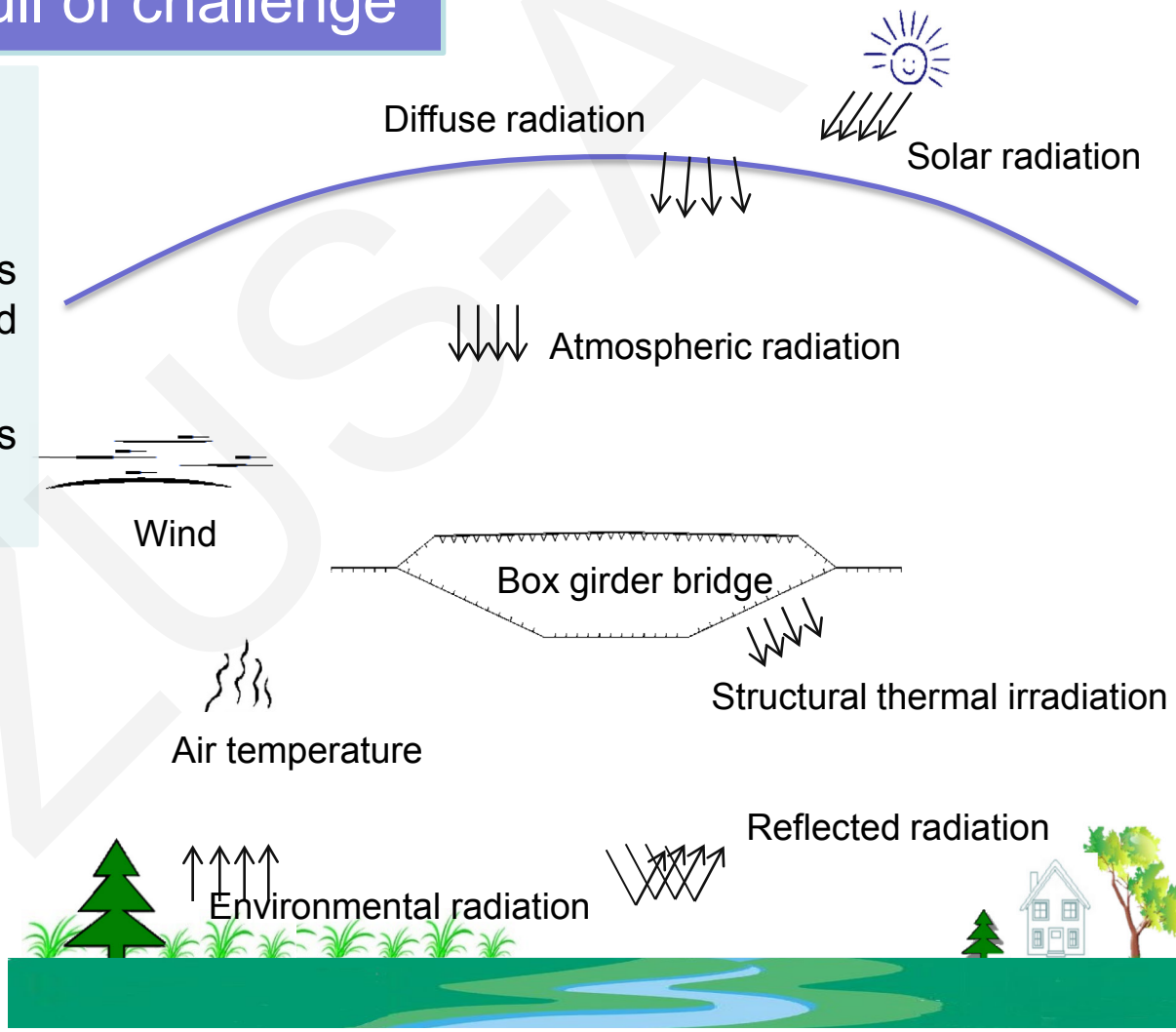
The meteorological parameters

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Bridge structural information

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Thermal boundary conditions

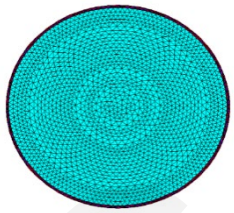


Finite Element Thermal Analysis

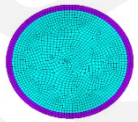
2-D FE thermal analysis

- Using the ANSYS software package;
- 2-D thermal analysis method;
- Modeling the typical sections of the suspension bridge;
- Using PLANE55 elements;
- Ensure a complete thermal equilibrium system of each model.

- Full size and time-varying temperature filed of the entire bridge .

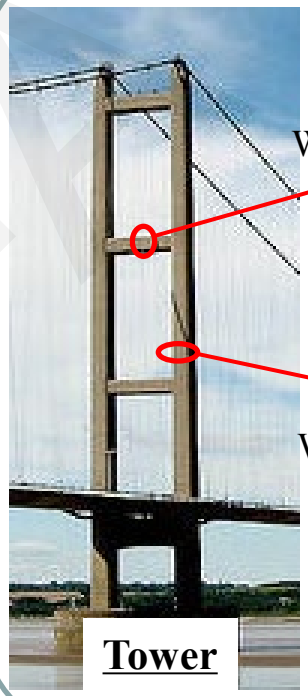


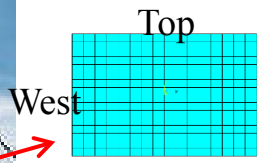
Main cable



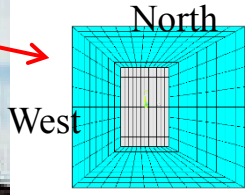
Hanger

Cables

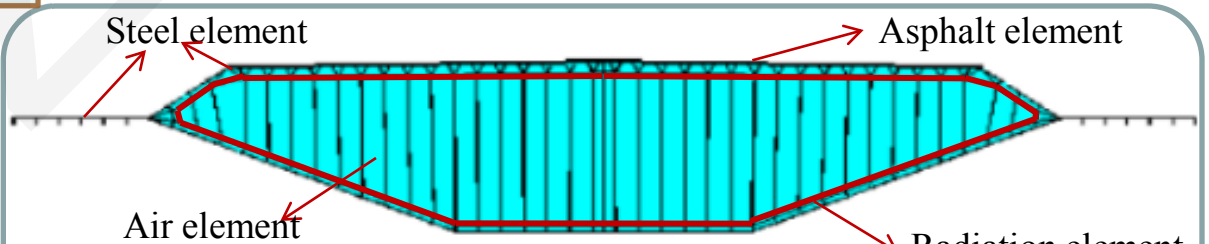




Cross beam



Tower column



Box girder

Finite Element Structural Analysis

3-D FE structural analysis

Daily varying temperature load

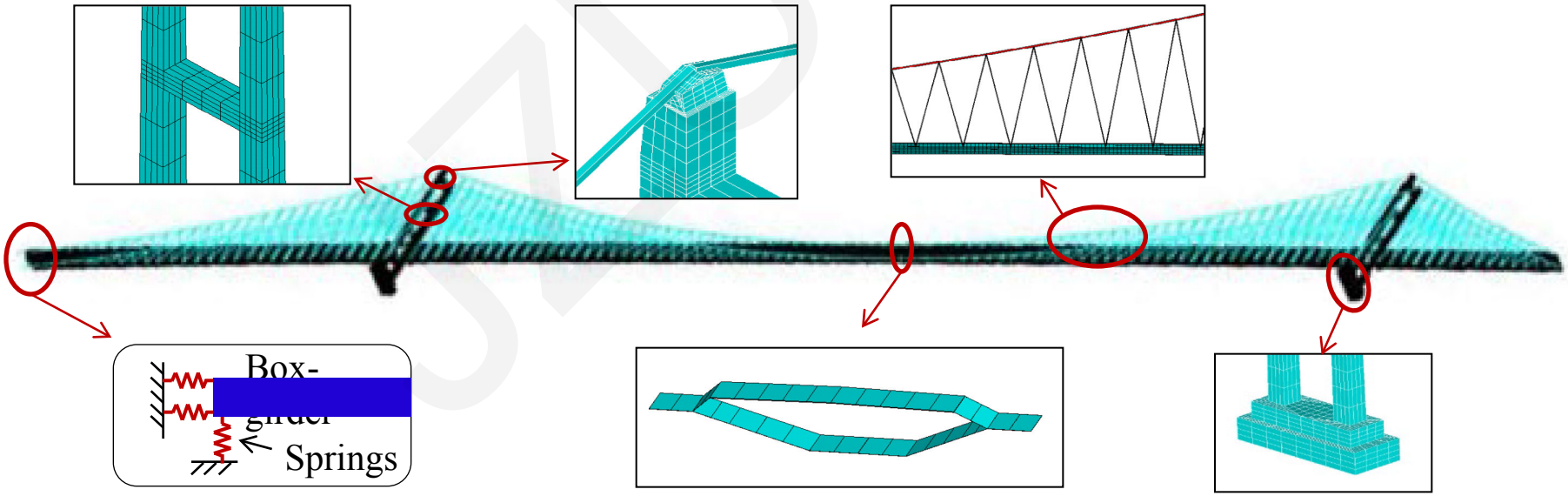
The design vehicle load

3-D bridge FE mode

Temperature-induced responses

Comparison

Vehicle load-induced responses



Conclusions

- The daily change in temperature-induced structural responses of a long-span suspension bridge are considerable. For some components, the temperature-induced static responses were greater than those caused by the design vehicle load.
- Bridge deck inclination is mainly generated by transverse temperature difference and the wind, but temperature accounts for the major portion of the daily changes.
- The temperature effects could be the major load action for bridge's secondary structures;
- Temperature-induced strain in the tower column is caused not only by exposure to ambient heat but also the temperature effects impacting on the main cables.

It is worth noting that the structural temperatures used in this study are from a single day. Since the weather varies greatly within weeks, months and even over years, temperature effects are likely to be more extreme than the effect measured in this study.