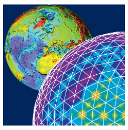
Rail Track Analysis



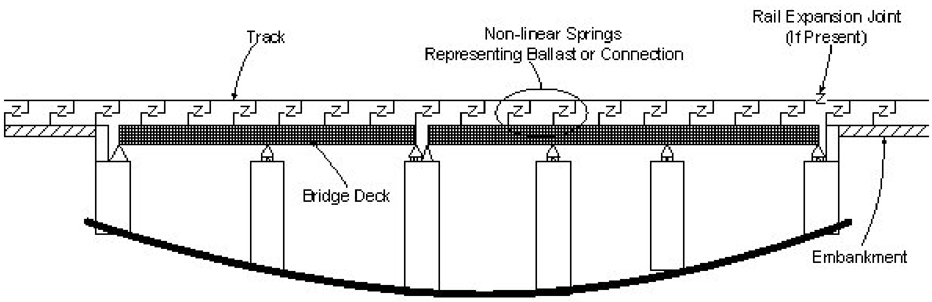
With the growth in both High Speed and Light Rail infrastructure projects worldwide there is a general requirement for accurate modelling of the interaction of the track with respect to any supporting bridge structures, and in particular, to ensure that any interaction between the track and the bridge as a result of temperature and train loading is within specified design limits. When used in conjunction with the Nonlinear option, the LUSAS Rail Track Analysis option permits track/structure interaction analysis to the International Union of Railways Code UIC 774-3 and to the relevant sections in Eurocode 1. It automatically builds models from data defined in Excel spreadsheets and quickly produces results in spreadsheet or LUSAS results file formats.

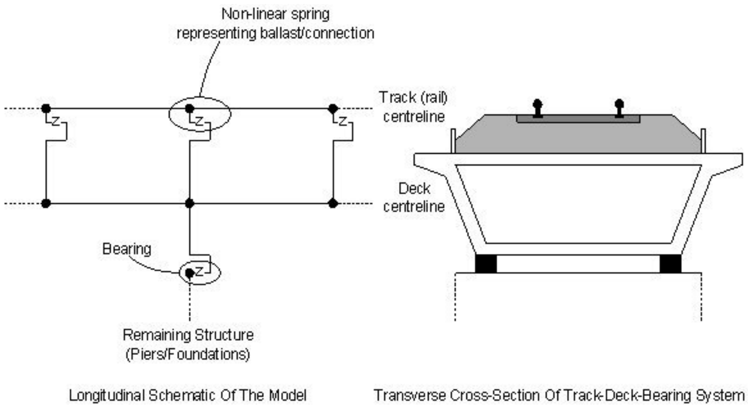
Model building

To accurately assess track-structure interaction effects nonlinear analyses are required to investigate thermal loading on the bridge deck, thermal loading on the rail if any rail expansion devices are fitted, and vertical and longitudinal braking and/or acceleration loads associated with the trainsets. This can be done for both ballasted or ballast-free tracks.

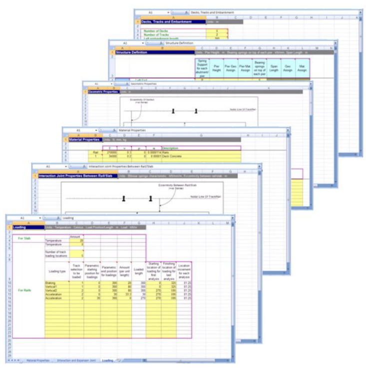
Track and bridge interaction models are built automatically in LUSAS in 3D from geometric, material property, and loading data defined within a MS Excel spreadsheet. Both thermal loading to the track and train loading due to acceleration and braking forces can defined. In accordance with the UIC774-3 code of practice, a user-specified element length is used to define the longitudinal embankment and bridge features. Rail clips, ballast movement, bearings and pier stiffnesses can all be included in the analysis model. The model building dialogs allow for either one train crossing one or more structures, or for multiple trains crossing the same structure.

NOTE: A key feature of the LUSAS Rail Track Analysis option is that it automatically updates the material properties associated with the track/structure interface based upon the position of the train or trains crossing the bridge.

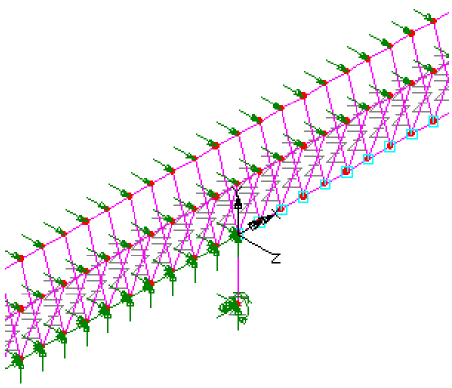




Modelling to the International Union of Railways Code UIC 774-3



Spreadsheet data is used to generate a suitable LUSAS model for rail track analysis



Example LUSAS model (top) and exploded view showing embankment support and beginning of first span

... continued

Running an Analysis

When running an analysis, deck temperature loading can be considered in isolation for subsequent analysis of multiple rail configurations, or a full analysis can be carried out considering the combined temperature in the deck and rail loading. Because the response of the ballast and/or track restraining clips is nonlinear a nonlinear analysis always needs to be carried out. For a complete rail track assessment, dynamic effects caused by the passage of trains that affect the structure itself should also be considered.

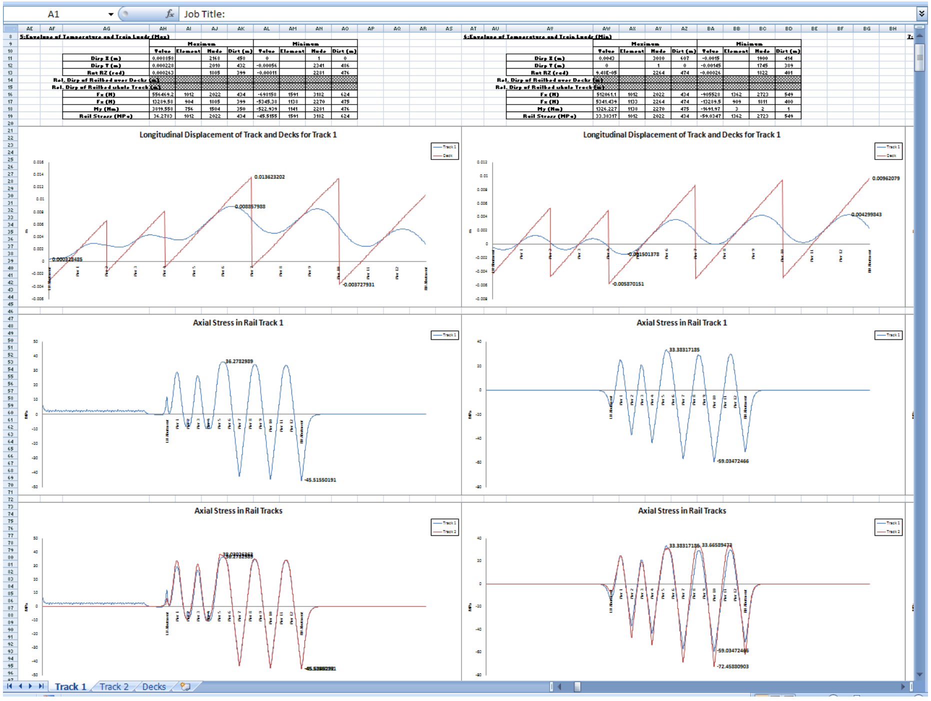
Results available

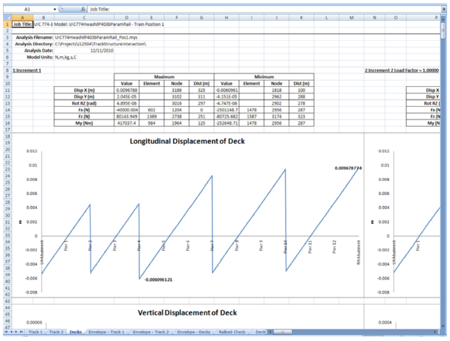
Results can be produced in either Excel spreadsheet or standard LUSAS results file format. Enveloping of results is carried out by either choosing to do so automatically inside Excel or by specifying user-defined load combinations inside LUSAS. Separate worksheets within the results spreadsheet contain results for specific areas of interest. These worksheets include:

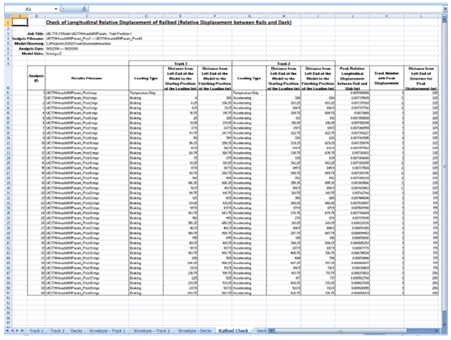
- Raw results data in summary, graph and tabular form for each track and deck component
- Envelopes of raw track and deck data in summary, graph and tabular form for combinations of temperature and trainset rail loading
- Tables of railbed displacements
- Tables of longitudinal reactions
- Tables of rail stress values.

The three latter tables provide key results in summary form and allow the quick determination of which analysis is causing the worst effects for each of the checks that need to be carried out to the UIC774-3 code.

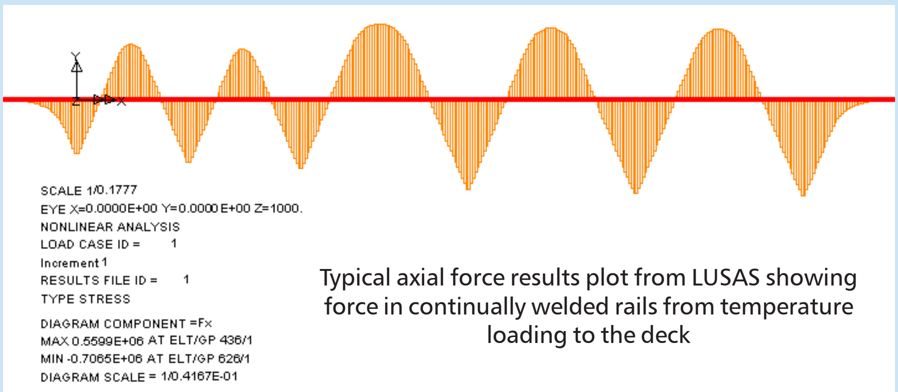
Eurocode EN 1991-2:2003 Eurocode 1: Actions on structures - Part 2: Traffic loads on bridges encompasses significant elements of the UIC 774-3 modelling approach when evaluating the combined response of the structure and track to variable actions. Limiting design criteria are the same as those specified in the UIC 774-3 code meaning that Rail Track Analysis software can be directly employed to meet Eurocode requirements.







Typical enveloped, graphed and tabular results generated automatically in Excel



Typical axial force results plot from LUSAS showing force in continually welded rails from temperature loading to the deck

For multi-span and multi-deck structures the interaction between the embankments / abutments and other decks means that the behaviour can be complex. As in the example above, when considering only thermal loading on a structure having continually welded track it is common to see a reversal of the axial force / stress in the rails. Whilst not apparent from the size of the model shown, the structure is 325m long and consists of two decks, each with two 25 m spans followed by three decks, each with three 25 m spans. One pier / bearing support for each deck is represented by a restraining spring which takes account of the deflection characteristics of the pier / bearing system in accordance with UIC774-3. All of the remaining piers / bearing supports are roller supports allowing longitudinal movement of the decks. Under the effect of temperature on the structure the axial force / stress in either of the tracks / rails can be seen to vary, primarily due to the interaction between the movable and fixed structural components.

LUSAS
Forge House,
66 High Street,
Kingston upon Thames,
Surrey, KT1 1HN, UK.

Tel: +44 (0)20 8541 1999
Fax: +44 (0)20 8549 9399
Email: info@lusas.com
http://www.lusas.com