Integral Bridge Design

in Midas Civil

Midas UK
Contents

- Types of Integral Bridges
- Why Integral Construction?
- Do we need Construction Stage Analysis for Integral Bridges?
- Soil-Structure Interaction at abutments
- Earth Pressure
- Soil Springs
- Moving Load Analysis to Eurocode
- Live Demonstration
- Q&A
Types of Integral Bridges

- Frame Abutments (i.e. Bank Pad abutments);
- Flexible Support Abutments (i.e. Sleeved Piles);
- Semi Integral Abutments;
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Why Integral Construction?

- Including **joints** in the deck often leads to leaks which **corrode the structure** by bringing **chloride** from **road salts** to the abutments, piers and soffit of the deck;

- **Jointed deck** structures require **regular maintenance** including regular inspections and replacement of bearings and other parts of the structure;

- The main **advantages** of **integral construction** are **increased durability** and **reduced maintenance costs**;

- **Highway agencies recommend integral construction** to be the first choice for decks shorter than 60m and skew less than 30°
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Construction Stage Analysis for Integral Bridges

- Consider before and after composite properties of the deck;
- Changes in boundary conditions (i.e. simply supported to integral condition);
- Allows us to consider deck pouring sequence for better optimisation of sections;
- Interlocked stresses in members
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Due to temperature variations the bridge deck expands and contracts.

As there are no movement joints integral bridges introduce horizontal forces in the soil at the abutments;

Depending on the supporting structure and the soil conditions the forces generated in the structure and the soil can vary significantly;

Detailed analysis can be carried out using specialised geotechnical software;

In many cases a simplified procedure is needed for the purposes of everyday integral bridge design
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Earth Pressure

- The earth pressure on the abutments can be considered using appropriate pressure coefficient $K$.
- **Eurocode** does not provide detailed information on how to consider earth pressure in the case of integral bridges.
- Earth pressure for integral structures can be calculated as specified in **PD 6694-1**;
- However, the calculation of the pressure coefficients can be quite **tedious** and **time consuming**. Additionally, **different scenarios** need to be considered.
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Soil Springs

- An alternative to applying the earth pressure loads is to assign appropriate spring supports to the abutment and/or piles to represent the soil properties.
- A number of studies have looked into ways to calculate equivalent spring stiffness based on soil parameters.
- The procedure considers the nonlinear behaviour of soils and accounts for long term ratcheting effects.
- In midas Civil this method has been adopted for automated definition of soil springs for abutments and piles.
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Moving Load Analysis to Eurocode

- **Loading**
  - Load Model 1 (UK NA).
  - Load Model 3 – SV196 Vehicle
  - Pedestrian Loading

- **Additional Considerations**
  - 1.5m Pedestrian path on either side of the bridge
  - 2x Notional Lanes
  - Remaining Area
  - Straddling

### Table 4.2 - Load model 1: characteristic values

<table>
<thead>
<tr>
<th>Location</th>
<th>Tandem system $TS$</th>
<th>UDL system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$Q_6$ (kN)</td>
<td>$q_6$ (kN/m²)</td>
</tr>
<tr>
<td>Lane Number 1</td>
<td>300</td>
<td>9</td>
</tr>
<tr>
<td>Lane Number 2</td>
<td>200</td>
<td>2.5</td>
</tr>
<tr>
<td>Lane Number 3</td>
<td>100</td>
<td>2.5</td>
</tr>
<tr>
<td>Other lanes</td>
<td>0</td>
<td>2.5</td>
</tr>
<tr>
<td>Remaining area ($q_k$)</td>
<td>0</td>
<td>2.5</td>
</tr>
</tbody>
</table>

### Table NA.1 - Adjustment factors $\alpha_q$ and $\alpha_x$ for Load Model 1

<table>
<thead>
<tr>
<th>Location</th>
<th>$\alpha_q$ for tandem axle loads</th>
<th>$\alpha_q$ for UDL loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane 1</td>
<td>$\alpha_{q1} = 1.0$</td>
<td>$\alpha_{qU} = 0.61$ (see note)</td>
</tr>
<tr>
<td>Lane 2</td>
<td>$\alpha_{q2} = 1.0$</td>
<td>$\alpha_{qU} = 2.2$</td>
</tr>
<tr>
<td>Lane 3</td>
<td>$\alpha_{q3} = 1.0$</td>
<td>$\alpha_{qU} = 2.2$</td>
</tr>
<tr>
<td>Other lanes</td>
<td>$\alpha_q = 2.2$</td>
<td>$\alpha_q = 2.2$</td>
</tr>
<tr>
<td>Remaining area</td>
<td>$\alpha_q = 2.2$</td>
<td>$\alpha_q = 2.2$</td>
</tr>
</tbody>
</table>

*NOTE: $\alpha_q$ should be taken as 1.0 for h.4.1(g) of BS EN 1991-2.*
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Q&A

Thank you!

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For any questions send an e-mail at:

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