TECHNICAL CASE STUDY

A crossing over a live road

Delivering a steel pedestrian overpass and covered walkway



Concept illustration. The scaled engineering figures appear on page 3.

Abstract

This article examines how a pedestrian overpass and a covered approach can be delivered over a live road. A reproducible numerical model links site clearance, structural actions, pedestrian comfort, drainage and erection constraints to construction inspection and handover. The model exposes the limits of a preliminary gravity check and the information needed to complete design verification.

Acknowledgement

I would like to express my sincere appreciation to a friend, a Design Engineer and Professional Engineer with Practising Certificate (PEPC), for sharing the case and the engineering perspective that informed this article.

Confidentiality and disclaimer

This article draws on an actual case shared by the contributor. The case has been anonymised to safeguard the project, the people involved and the organisations associated with it. Names, location and identifying details are withheld. The dimensions, loads, figures, calculations and construction scenarios are representative assumptions developed for this article. They do not disclose the original design or establish what occurred on site. This educational study is unsuitable for procurement, construction, lifting or statutory approval. The contributor's input does not constitute endorsement or certification.

Compiled by Nik Zafri and Che Abdul Roni

Design basis and assumptions

Question and method

The study asks how early design assumptions influence survey, fabrication, erection and commissioning decisions at the road and footpath interfaces. It uses an anonymised practitioner account as context and a deterministic worked example for analysis. No original design package, test records, site survey or measured performance data were used. A span sensitivity check tests the influence of one input while holding the others constant.

Representative structural arrangement

Adopt a 24.0 m simply supported bridge with two parallel, nominally identical steel plate girders at 2.70 m centres. Use a 3.00 m clear pedestrian width and a 150 mm concrete deck. For the worked model, assume that the structural deck width also equals 3.00 m and that handrail posts are edge-mounted. Each girder carries half the deck load for symmetric loading. Assume zero composite stiffness and ideal simple supports. The bridge span is open above. The separate ground-level covered walkway has an assumed 3.00 m roof width and 30.0 m drainage length.

Inputs used in the calculations

Geometry. Girder overall depth 1,000 mm. Two 350 × 25 mm flanges and one 950 × 14 mm web per girder. Nominal road datum +0.000 m. Unloaded idealised bridge soffit +5.850 m and walking surface +7.000 m.

Materials. Steel elastic modulus E = 210,000 N/mm^2 and unit weight 78.5 kN/m^3. Concrete unit weight = 25 kN/m^3. An illustrative nominal steel yield strength of 355 N/mm^2 is used for comparison only. Verify actual product grade and thickness-dependent strength from the selected standard and material certificates.

Actions. Finishes allowance = 0.65 kN/m^2. Additional allowance for bracing, secondary steel and edge fixtures = 1.00 kN/m per girder. Pedestrian imposed load q = 5.00 kN/m^2 assumed for this example. Gravity trial factors 1.35G and 1.50Q. These inputs define one reproducible load case. Final actions, factors and combinations must be selected from the applicable standards, National Annexes and authority conditions.

Survey and validation

Confirm road crown, crossfall, future surfacing, utilities, support levels, footpath tie-ins, accessibility and outfall. Investigate ground conditions and crane access. Validate a final three-dimensional model for eccentric loading, cross-frame behaviour, restraint conditions and erection stages. Revisit the quantities and temporary load cases after fabricator and lifting contractor input.

Compiled by Nik Zafri and Che Abdul Roni

Elevation and cross-section

Dimensions govern. Print on A4 at 100% actual size to retain the stated scales. Check the scale bars if printed or reproduced at a different size.

FIGURE 1 / LONGITUDINAL ELEVATION / SCALE 1:200

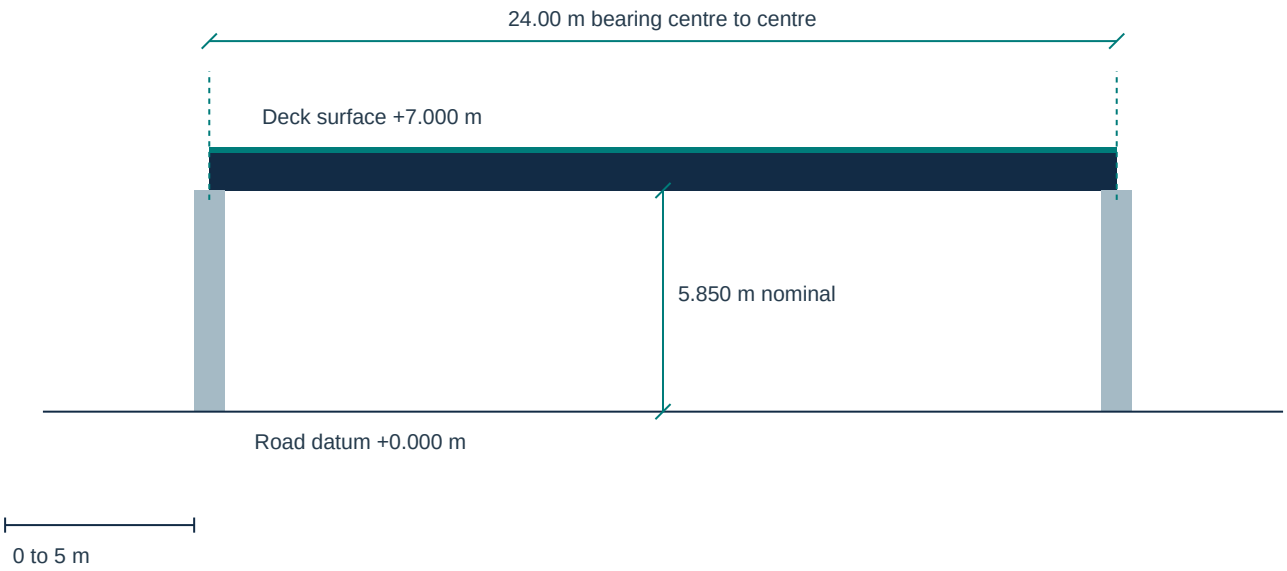


FIGURE 2 / BRIDGE CROSS-SECTION / SCALE 1:50

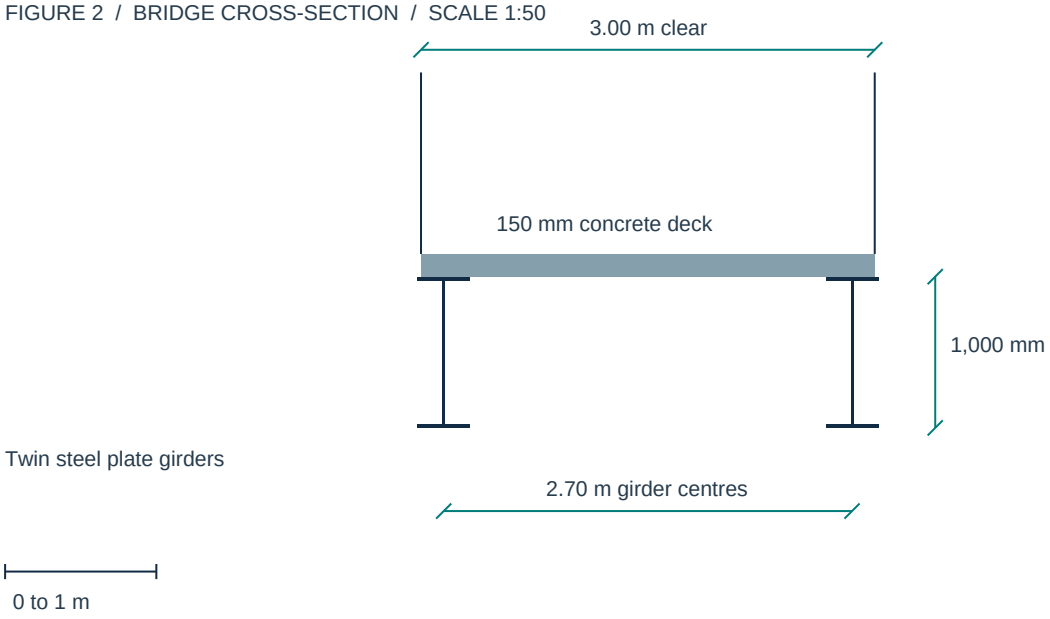


Figure 1 omits approach structures for clarity. Figure 2 shows the nominal assembly and schematic rails. Exact flange/web dimensions and deck assumptions are on page 2.

Compiled by Nik Zafri and Che Abdul Roni

Main span gravity checks

1. Section properties per girder

Area A = 2(350 × 25) + 950 × 14 = **30,800 mm^2**. The symmetry axis lies at mid-depth. Flange centroid distance = 500 – 12.5 = 487.5 mm.

Second moment I = 2[350 × 25^3/12 + (350 × 25)(487.5^2)] + 14 × 950^3/12 = **5.160 × 10^9 mm^4**. Elastic section modulus W = I/500 = **10.320 × 10^6 mm^3**.

2. Actions and support reactions

Girder self-weight = (30,800 × 10^{-6})(78.5) = 2.418 kN/m. Deck and finishes = (0.150 × 25 + 0.65)(3.00/2) = 6.60 kN/m. With 1.00 kN/m for secondary items, G = **10.018 kN/m** per girder. Q = 5.00 × 1.50 = **7.50 kN/m** per girder.

Trial ULS line load = 1.35(10.018) + 1.50(7.50) = **24.774 kN/m**. Under uniform loading, each girder bearing reaction V = wL/2 = 24.774 × 24/2 = **297.3 kN**. Sum at each support line = **594.6 kN**, excluding support self-weight and separate approach loads.

3. Bending and shear stress screens

Peak moment M = wL^2/8 = 24.774 × 24^2/8 = **1,783.7 kN·m** per girder. Extreme-fibre elastic stress M/W = 1,783.7 × 10^6/(10.320 × 10^6) = **172.8 N/mm^2**. Mean web shear V/(950 × 14) = **22.4 N/mm^2**. These are demand indicators. Check section classification, local plate and shear buckling, bending–shear interaction, lateral torsional stability, load introduction, connections and restraint in final design.

4. Static serviceability

For a uniform load, δ = 5wL^4/(384EI), using w in N/mm and L = 24,000 mm. The unfactored G+Q response is **69.8 mm** and the Q-only response is **29.9 mm**. These values exclude shear flexibility, support settlement and any camber. Compare the appropriate response with the limit and load combination specified for the project.

If span increases to 26 m with the same section and line loads, moment increases by (26/24)^2 – 1 = **17.4%** and deflection by (26/24)^4 – 1 = **37.7%**. The G+Q estimate rises to **96.2 mm**.

Compiled by Nik Zafri and Che Abdul Roni

Interfaces and erection checks

5. Pedestrian vibration

Using a uniform simply supported beam and permanent mass only, m = 10.018 × 1,000/9.81 = 1,021 kg/m per girder. With I = 0.005160 m^4, $f_1 = \pi/(2L^2) \times \sqrt{(EI/m)}$ = **2.81 Hz**. This estimate warrants a pedestrian comfort assessment using modal properties, damping, pedestrian loading and acceleration criteria agreed for the project. Include lateral and torsional modes where relevant.

6. Road clearance and access

Unloaded nominal soffit = 7.000 – 0.150 – 1.000 = 5.850 m. Illustrative clearance allowance uses 0.070 m deflection, 0.050 m future road surfacing and 0.030 m for combined adverse levels and tolerances. Residual = **5.700 m**. Relative to a scenario requirement of 5.500 m, the margin is **0.200 m**. Replace the benchmark and allowances with agreed values. Check across all affected lanes and for the lowest attachment.

An illustrative straight access ramp at 1:15 for a 7.00 m rise requires **105 m** of sloping horizontal run before landings. A 1:15 slope is a geometric input. Select compliant gradients, landings, handrails and access provisions against MS 1184 and local authority requirements. This estimate explains why the approach footprint must be resolved early.

7. Canopy runoff

Assume rainfall intensity i = 180 mm/h, roof plan area A = 30 × 3 = 90 m^2 and runoff coefficient C = 1.00. Q = CiA/3,600 = **4.50 L/s**. Two outlets with equal catchments each receive **2.25 L/s**. Confirm local rainfall data, gutter falls, hydraulic capacity, overflow path, blockage provision and approved outfall. Keep discharge off the walking surface.

8. Erection weight and thermal movement

The two bare girders weigh 2 × 2.418 × 24 = 116.1 kN. Assuming 48.0 kN for attached steel/fixtures and 10.0 kN of below-hook rigging, suspended load = **174.1 kN** or **17.75 t**. This scenario assumes the concrete deck is installed after erection. Reconcile actual weights, pick points, centre of gravity and hook-block/chart deductions before lift-plan approval. The lifting planner checks crane radius, ground support, wind and temporary stability using the actual configuration.

Free thermal movement for a fixed/movable support arrangement with $\alpha = 12 \times 10^{-6}$/°C and assumed ΔT = ±25°C is $\alpha L \Delta T$ = **±7.2 mm**. Add applicable effects such as setting tolerance, movements from the selected deck system and bearing rotation when sizing joints and bearings.

From fabrication to opening

Design, procurement and fabrication

Resolve utility clashes, road clearances and approach tie-ins before shop drawing release. Confirm material traceability, welding qualifications, weld inspection and specified NDT. Check geometry and trial-fit critical connections where required. Release steel for coating after fabrication acceptance. Inspect the specified protective finish before dispatch. Maintain tags and identify connection faces, pick points and temporary restraint provisions.

Substructure, traffic and erection

Establish surveyed controls, permits and pedestrian diversions. Inspect founding or pile records, reinforcement, formwork, embedded items and anchors as applicable. Verify the concrete release strength, surveyed bearing positions and available erection clearances. At the pre-lift hold point, confirm the approved road closure, lifting arrangement, exclusion zone, equipment, communications and contingency conditions. Secure the span to the approved initial-connection state before releasing lifting gear. Verify erection-stage stability again before removing temporary restraints or reopening the road.

Approach, commissioning and records

Install walkway framing, roof, gutters, stairs or accessible approaches and specified lighting. Inspect final connections, walking surfaces, guarding, lighting, drainage and clearances. Follow the entire route during the joint walk-through to catch trip points and runoff at interfaces. Conduct specified electrical checks and any load test required by the contract or authority under an approved test plan. Release the road and pedestrian facility separately. Retain surveys, material certificates, weld and coating records, concrete and bolt records, commissioning results, as-builts and maintenance information.

Detailed design checks still required

Apply the full design combinations for asymmetric crowds, local deck and parapet loading, any maintenance vehicle, wind, thermal effects, accidental vehicle impact and relevant seismic actions. Complete girder and cross-frame stability, fatigue, connections, bearings, deck and approach structural design. For supports and foundations, use site investigation and load combinations to check sliding, overturning, bearing resistance, settlement and structural capacity. Include temporary load paths, wet concrete placement and crane support reactions. Finalise the canopy for wind uplift and cladding fixings. Quantities and resistances for these checks require project inputs.

Conclusion

The example shows that a small increase in span has a greater proportional effect on deflection than bending moment. Vibration, clearance allowances and access footprint can therefore influence the scheme before fabrication begins. A linked design review, erection release and end-to-end commissioning inspection provide a traceable route from assumptions to evidence.

Compiled by Nik Zafri and Che Abdul Roni

Standards and codes of practice

Confirm the adopted editions, amendments and Malaysian National Annexes with the contract administrator and relevant authority. The calculations use explicitly stated scenario inputs and do not certify compliance with these references.

Structural design and materials

Basis and actions. EN 1990 with applicable bridge provisions and National Annex, MS EN 1991-2:2022 and its Malaysia National Annex for bridge traffic actions, and the applicable parts of EN 1991 for wind, thermal, execution and accidental actions.

Design by material. Applicable editions of EN 1993-2 for steel bridges, EN 1993-1-5 for plated elements, EN 1993-1-8 for joints and EN 1993-1-9 for fatigue. Use EN 1992 bridge or concrete provisions as applicable, EN 1994-2 if composite action is adopted, EN 1997 and relevant National Annexes for foundations, and EN 1337 series for bearings where specified.

Execution and protective treatment. EN 1090-2 for steelwork execution where specified, EN 13670 for concrete execution, ISO 1461 for hot-dip galvanized coatings when selected and ISO 12944 series for protective paint systems when specified. The execution specification should define inspection, testing and acceptance requirements.

Malaysian accessibility, safety and traffic

Accessibility. Standards Malaysia, MS 1184:2014, *Universal design and accessibility in the built environment — Code of practice*, and AMD. 1:2017, subject to confirmation of the applicable edition.

Construction safety. Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024, P.U. (A) 147. See also DOSH guidance on planning and supervising lifting work.

Traffic management. Apply road authority conditions and the adopted JKR ATJ 2C/85 provisions for temporary signs and work-zone control. See JKR Standard Specification for Road Works, Section 19.

Technical background

European Commission Joint Research Centre, *Bridge Design to Eurocodes: Worked Examples*. Use the report as a methodology reference alongside the contract-adopted standards.

Compiled by Nik Zafri and Che Abdul Roni

Load path and canopy section

Print at 100% on A4. The load diagram uses a scaled horizontal axis and schematic force arrows. The canopy section uses representative geometry.

FIGURE 3 / SINGLE GIRDER GRAVITY MODEL / HORIZONTAL SCALE 1:200

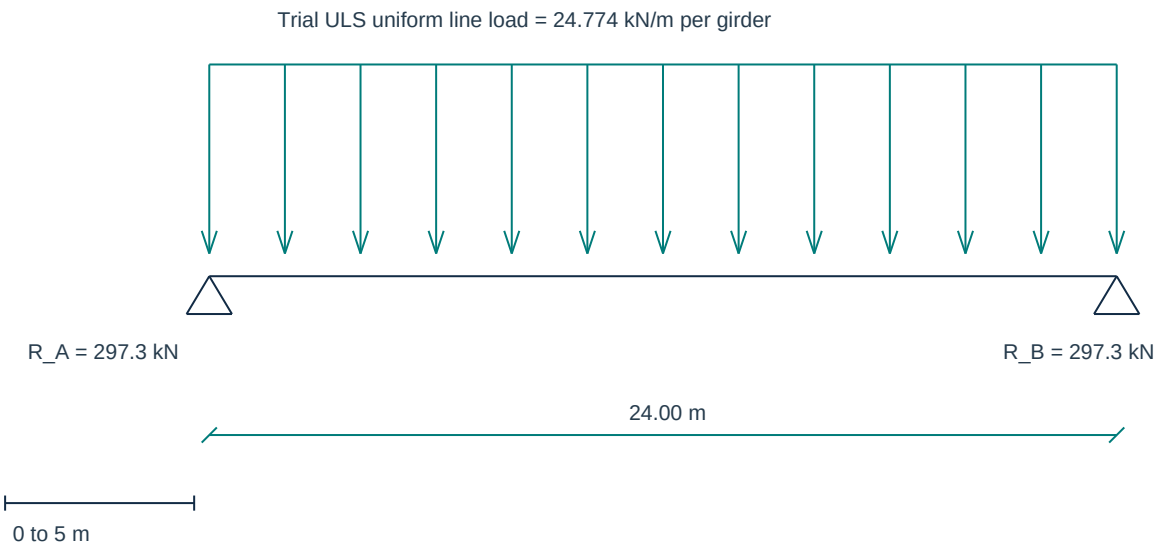
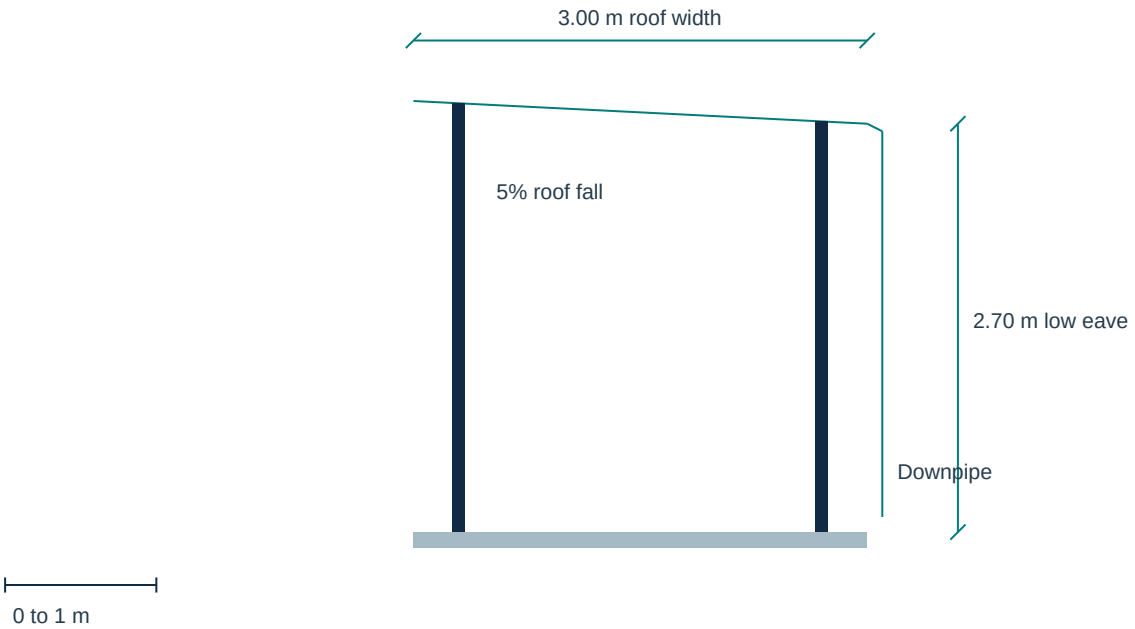


FIGURE 4 / COVERED WALKWAY CROSS-SECTION / SCALE 1:50



Roof fall = 0.05 × 3.00 = 0.150 m. The canopy geometry illustrates runoff direction. Roof clearance, framing, gutter dimensions and downpipe sizing require detailed design.

Compiled by Nik Zafri and Che Abdul Roni