PROBLEM STATEMENT

A wooden pedestrian bridge (see Figure) in a recreational area has been in service for **12 years**. Recently, maintenance staff observed cracks at the bottom of one of the longitudinal beams near mid-span. Because **crowd load on weekends has increased**, before weekend, right on Monday the local authority requests an engineering assessment to check whether the beam is still structurally safe under bending. The task requires evaluating the actual bending stress using the flexural formula, comparing it with the allowable stress, and redesigning the beam using any suitable structural material.

Existing Beam Information:

Beam Type: Simply Supported
Span Length (L): 4.2 m
Cross-Section (Timber):
Width = 150 mm × Depth = 250 mm
Allowable bending stress = 12 MPa
Modulus of Elasticity = not required
Loading Conditions: Self-weight of the timber beam
Pedestrian load (uniformly distributed): w = 3.5 kN/m

OUR PROJECT PLAN

To further strengthen the practical relevance of this project, it is important to highlight that the structural problem presented in the assignment closely matches a real-world situation at **Lake View Park, Islamabad,** where similar wooden pedestrian beams are currently in service. Visible downward bending, bottom fiber cracking, and long-term deflection have been observed in those beams as well. By applying the same analytical methods from our coursework to an actual structure, our group aims to provide realistic engineering interpretation and solutions.

Latest Field Visit Images:

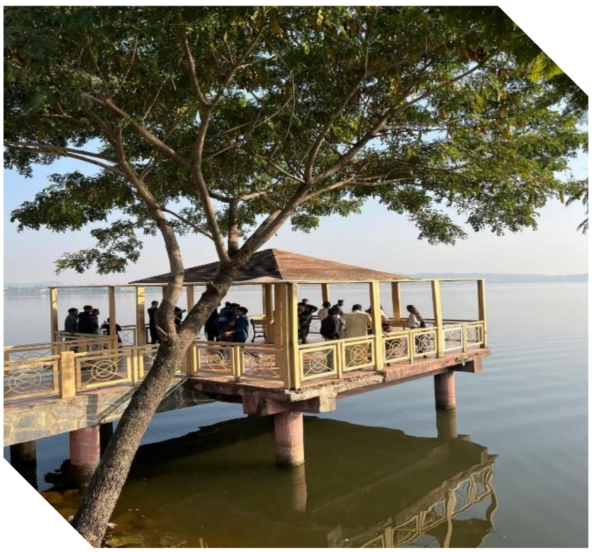

Figure 2: Site visit photographs taken at Lake View Park, Islamabad, showing the lakeside sitting deck

Figure 3: The main pedestrian promenade area where visitor movement and space utilization were observed

Figure 4: A lakeside wooden pavilion constructed on stilts, providing visitors with a scenic resting spot over the water at Lake View Park,

Figure 5: A wooden gazebo structure situated near the lakeside, designed as a shaded sitting area for park visitors.

Figure 6: An open wooden pergola installed along the pedestrian walkway, offering partial shade and enhancing the aesthetic appeal of the park.

Figure 7: A paved pedestrian pathway in Lake View Park, bordered with railing and surrounded by greenery, frequently used by visitors for walking and leisure.

SECTION A: EXISTING BEAM

Beam Data:

- Material: Solid Sawn Timber (Douglas Fir-Larch / Deodar)
- Grade: Structural Timber (Ref: BS 5268-2 / ASTM D245)
- Specific Weight: 5.3kN/m^3
- Beam Type: Simply Supported
- Span Length (L): 4.2 m
- Rectangular Section: Width = 150 mm × Depth = 250 mm
- Allowable bending stress = 12 MPa
- Loading Conditions: Self-weight of the timber beam + Pedestrian load (uniformly distributed): w = 3.5 kN/m

Requirements:

- Draw the loading diagram and the Bending Moment Diagram (BMD).
- Compute the maximum bending moment for the given UDL.
- Compute the section modulus (S) of the rectangular timber beam.
- Apply the Flexural Formula to determine the actual bending stress in the beam.
- Compare the calculated stress with the timber's allowable bending stress.

Figure 8: Picture showing Timber: Deodar or Douglas Fir with Yield Allowable bending stress of 12 MPa

CALCULATIONS

RESULTS & CONCLUSION

Is the beam safe, unsafe, or borderline under bending?

Based on mechanics understanding, explain why cracks likely appeared at the bottom fiber?

SECTION B: REDESIGN BEAM

Beam Data:

- Material: Glued Laminated Timber (Glulam)
- Stress ratio exceeds 0.80 with Applied Live Load (Weekend Crowd): 7.8 kN/m (Assumption)
- Grade: 24F-V4 (Ref: ANSI A190.1 / AITC 117)
- Specific Weight: 6kN/m^3
- Beam Type: Simply Supported
- Span Length (L): 4.2 m
- Rectangular Section: Width = 150 mm × Depth = 400 mm
- Allowable bending stress = 16.5 x 0.60 = 9.90MPa
- Loading Conditions: Self-weight of the beam + Pedestrian load (uniformly distributed): w = 7.8 kN/m

Requirements:

- Sketch of the new cross-section
- Material justification
- Flexural stress check (using flexural formula only)
- Final safety remarks

Figure 9: Picture showing Timber: Glued Laminated Timber (Glulam) with Yield Allowable bending stress of 16.5 x 0.60 = 9.90MPa

CALCULATIONS

RESULTS AND CONCLUSION

MATERIAL JUSTIFICATION	
Structural Timber	**Glued Laminated Wood (Glulam)**
Contains natural defects (knots, splits) that create weak points.	Defects are dispersed or removed during manufacturing.
Allowable stress limited to approx. 12 MPa due to defects.	High-grade Glulam achieves 16.5+ MPa allowable stress.
Limited by the diameter of the log. Hard to find large sections (e.g., >300mm deep).	Made by stacking layers; can be manufactured to any depth (e.g., 400mm).
Custom sizes are expensive/rare.	Easy to fabricate large sections for heavy loads.
Solid logs twist and cup as they dry over time.	Kiln-dried laminations are glued with opposing grains to resist warping.
Preservatives may not penetrate deep into the heartwood.	Individual laminations can be treated before gluing for deep protection.

Conceptual Reflection of the new Beam?

EXPLAINATION

How does section modulus influences bending capacity?

Why are deeper beams more efficient than wider ones?

Why are bottom fibers in maximum tension?

REFERENCES & STANDARDS

- ***BS 5268-2:2002:*** Structural use of timber. Code of practice for permissible stress design, materials and workmanship. (British Standards Institution).
- ***ANSI A190.1:*** Standard for Wood Products - Structural Glued Laminated Timber. (American National Standards Institute).
- ***AITC 117:*** Standard Specifications for Structural Glued Laminated Timber of Softwood Species. (American Institute of Timber Construction).
- ***Hibbeler, R.C.:*** Mechanics of Materials. (General flexural theory
- **Building Materials**, Third Edition by S. K. Duggal