SHANDONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

本科毕业设计（论文）

荣乌赵家庄中桥方案设计与结构计算

Scheme Design and Calculation of Zhaojiazhuang Medium Bridge on Rongwu Highway

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完成日期:	2025 年 6 月 10 日

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摘 要

本项目为荣乌赵家庄中桥的方案规划与结构设计研究。研究的最终目标是提出一个安全、可靠、实用的桥梁设计方案，既满足功能与安全要求，又基于真实的工程数据与现场条件。在参考长郭中桥的设计基础上，项目充分考虑了最有利的地质与水文条件，力求实现桥梁在实际环境中的最佳性能表现。

1. 设计参数与技术指标：本桥桥面净宽为 8.5 米，另设两侧各 0.75 米的路肩，结构安全等级为一级，设计荷载等级为公路-I 级。桥梁主跨为 20 米，采用设有五道横隔板的钢筋混凝土简支 T 梁结构。主梁计算跨径为 1950 厘米，在结构强度与承载力分析中，对主梁的尺寸、间距及钢筋布置等关键参数进行了详细考虑和精确控制。

2. 方案比较与选择：本项目对四种桥型方案进行了对比分析，分别为钢筋混凝土实心板桥、预应力混凝土箱梁桥、钢-混凝土组合梁桥以及钢筋混凝土简支 T 梁桥。方案比较从结构特性、施工可行性、经济性、耐久性与维护性以及地质适应性等方面进行多角度评估。经综合比选，最终选定钢筋混凝土简支 T 梁桥作为设计方案，因其在施工便捷性、结构耐久性及经济成本控制方面表现优越。

3. 结构设计与计算：在确定 T 梁结构方案后，对桥面、主梁与横隔板等构件进行了深入的结构分析与计算，包括恒载与活载作用计算、内力分析以及配筋设计。同时，对横隔板布置与钢筋配置进行了优化设计，以提高桥梁整体结构的稳定性与耐久性，确保其满足各项安全与性能要求。

关键词：公路桥；方案比选；T 梁桥；结构设计；结构计算。

Abstract

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Keywords: Highway bridge; Scheme comparison; T-beam bridge; Structural design; Structural calculations.

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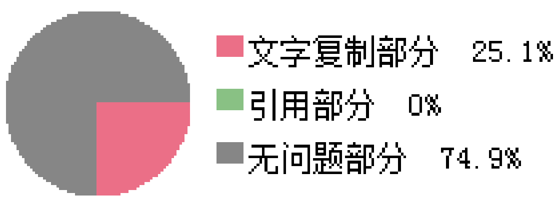

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1. Overview of bridge design

1.1 Project overview

Zhaojiazhuang Medium Bridge is a high way bridge of great significance on Rongwu Highway at points K11+999 on Xiushui X214 County Road''s Maohuang Line and is situated in northwest Xiushui County, Jiangxi Province. The bridge construction will include an overall length of 20 meters with the width of 10 meters. The site is in a low mountainous terrain with compound topography and ground levels ranging from 391.30 to 391.35 meters. Geological and environmental conditions of the region, such as seismicity, rain regime, and topography, were the controlling parameters in determining the design approach and scheme selection for this bridge.

Following thorough comparison and assessment of four other viable structures, the scheme employed is a reinforced concrete simply supported T-beam bridge. The scheme was chosen because it provided the optimal balance between safety, structural performance, economy, integration with the scenic landscape, and adherence to national highway bridge design standards.

The design area, the Xiushui County, is extremely complex geomorphologically with mountainous area, hills, and valleys and encircled by the Kuling and Makubu Mountain Ranges. Presence of the Xiu River and great elevation gradients (75m to 1716.5m) represents a dynamic hydrological condition. The climatic conditions of subtropical monsoon climate with mean annual rainfall of 1577 mm and large flood maxima in spring and summer months demand maximum hydrological and drainage consideration in bridge design. Wind conditions are not satisfactory with a mean annual wind speed of 1.2 m/s, and the seismic conditions of the area are the same as seismic fortification intensity of 6 degrees having a design acceleration of 0.05g and characteristic period of 0.35 seconds.

Geotechnical condition of the bridge site is characterized by several layers of rock and soil having varying stability and bearing capacities. The miscellaneous fill material that is poorly compacted constitutes the first layer. The moderately dense in consistency and moderately variable drift (pebble) stone layer has the standard allowable bearing capacity of 380 kPa. Lower down is constituted by highly weathered sandstone with lower bearing capacity of 350 kPa and fractured rock with rock mass quality grade V. The ideal bearing layer is medium-weathered sandstone with higher bearing capacity of 1500 kPa and 18.6 MPa of uniaxial compressive strength, and it is most significant contribution towards stability of bored pile foundation system.

Ground conditions for groundwater indicate a low level of corrosiveness, thus protection in reinforcement details and concrete mix design for long-term integrity of substructures. In addition, the stable ground conditions preclude consideration of saturated sand liquefaction effects, thus reducing construction complexity as well as seismic design complexity.

1.2 Design basis and main design specifications

(1) Ministry of Transport of the People''s Republic of China (JTG-D60-2015): General Specifications for Highway Bridge and Culvert Design, 2015.

(2) Ministry of Transport of the People''s Republic of China (JTG-3362-2018): Specifications for Highway Reinforced Concrete and Prestressed Concrete Bridge and Culvert Design, 2018.

(3) Yi Jianguo, ed. Bridge Calculation Example Series - Concrete Simply Supported Beam (Slab) Bridge. Beijing: People''s Communications Press, 2020.

(4) Units C , Edition T . AASHTO LRFD Bridge Design Specifications. 2012.

(5) Highway Bridge and Culvert Design Manual - Beam Bridge (Volume 1). People''s Communications Press, 1998

(6) Ye Jianshu, ed. Principles of Structural Design. Beijing: People''s Communications Press, 2020

(7) Yuan Lunyi, Bao Weigang, ed. Application Examples of the Provisions of Highway Reinforced Concrete and Prestressed Concrete Bridge and Culvert Design Specification (JTG D62-2004). Beijing: People''s Communications Press, 2005.3.

1.3 Design technical standards

(1) Line grade: Highway - Grade I; Structural safety level is Level 1;

(2) Bridge deck clearance: 8.5m (clear lane) + 2×0.75m (sidewalk);

(3) Lane load standard: Highway - Grade I load;

(4) Design slope: longitudinal slope *Imax* = 2.5%, transverse slope 1.5%;

(5) Seismic fortification level: according to seismic intensity: VI level;

(6) The route and other relevant standards comply with the design specifications for highway.

1.4 Main materials

(1) Concrete: use T-shape main beam, head, and hinged joints made with grade 30 concrete bridge deck cushion uses C25 concrete;

(2) Steel bars: HRB400 steel bars are used for main reinforcement and the other;

(3) Support: use type rubber bearings for plate, with professional manufactures certified at provincial levels are used.

1.5 Design points

(1) Vehicle load modeling includes transverse load variation along the span to simulate prevailing traffic conditions according to the Highway-I level load design standard.

(2) The disposition of the main beam balances auxiliary members'' weight (e.g., sidewalks, guardrails, and safety barriers) equally in all beams. Welded steel cages are used for strengthening, and the details are in accordance with the national standard drawings.

(3) Transvers beam (diaphragm) design is a function of the worst vehicle load position. The reinforcement details are derived from the existing design specifications and respective reference standards.

(4) The overall bridge design meets the limit condition method, under which the ultimate limit conditions and service conditions in strength, deformation, durability, and stability are met.

2. Scheme and design bridge engineering

2.1 Principles of design bridge structure

Structural design of a real bridge structure is an engineering and systematic syncretism of technical specifications, real engineering standards, and environmental elements of the landscape towards realising making it long-lasting, safe, and economically viable. In the process of structural design of Zhaojiazhuang Medium Bridge of Rongwu Highway, it was a composite process synthesized through embracing national and international design codes, local hydrology and geology data, and constructional convenience guidelines.

Overall, safety, strength, functionality, economy, and aesthetic beauty are the fundamental requirements on bridge structure design. All these requirements determine the final choice of shape, material, structural form, and construction method of the bridge.

(1) Safety and Structural Stability

The basic postulate of bridge structure is to ensure it with safety and stability under the loadings due to dead, live load, wind force, seismic action, temperature fluctuation, and hydrological loading.

(2) Durability and Environmental Adaptability

Durability is the second most important design parameter of a bridge. It means resistance to damage over time, to environmental exposure, traffic, and material aging. Since the site location of the bridge is located in an area with a subtropical monsoon climatic zone where humidity and recurrent rainfall will prevail, the design must be provided with countermeasures to reinforcement corrosion as well as concrete degradation.

(3) Functionality and Serviceability

Overall width of the deck of a bridge shall be able to perform its intended function well enough for its lifetime. This covers traffic lane width, sufficient riding comfort as well as optimal access to the road alignment. Zhaojiazhuang Medium Bridge thus has an overall deck width of 10 meters with provision for two traffic lanes and safety shoulders. Serviceability also includes long-term durability under normal traffic loading without undue cracking, deflection, or vibration.

(4) Economic Efficiency and Constructability

The second basic principle applied in bridge construction is economic efficiency. The system must be able to reduce the overall life-cycle cost, including the initial cost of construction, maintenance cost, and repair cost.

(5) Seismic Performance

Since the site is to be seismic fortification intensity of 6 degrees with minimum design acceleration 0.05g, very high importance must be attached to seismic designs.

(6) Geological and Hydrological Factors

The identification of site conditions is the second critical design requirement. In the geology exploration, they observed that there were medium-hard soils, weathered sandstone, and pebbles of drift. Hydrological situations such as rain, river stages, and ground water conditions were also considered.

(7) Aesthetic and Environmental Considerations

Though structural and functional necessity is of greatest concern, aesthetic appeal and harmony with the environment are also afforded consideration in bridge design today. In addition, the construction processes were planned in order to leave minimal environmental effect. Off-site prefabrication reduces site noise and dust, which is sympathetic to green and sustainable building philosophies.

(8) Compliance with National and International Standards

Throughout the design phase, the project complied with relevant design codes and technical specifications. Chinese national standards such as JTG D60-2015, JTG 3362-2018, and JTG/TF50-2011 were taken as main references. Secondary references provided wherever necessary were used from international standards such as AASHTO LRFD and FHWA Bridge Design Manuals.

These codes have specific requirements for material, structural calculation, load combination, and safety check. The design is not only legal in terms of the requirement by being in compliance with these codes but also ensures consistency and reliability in practice engineering.

2.2 The scheme of comparison

During the initial stage of the bridge structure design of the Zhaojiazhuang Medium Bridge on the Rongwu Highway, the most important choice was possibly how to choose the most appropriate structural form. Since a bridge must be economic, long-lasting, safe, and in harmony with nature, potential structural forms must be compared and studied prior to determining the structure type. The comparison plan helps ensure that the chosen design is not only technically feasible but is also economical and buildable within the current site conditions. Some general categories of bridges were compared and chosen, such as:

1. Reinforced concrete solid slab bridge
2. Prestressed concrete box girder bridge
3. Steel-concrete composite girder bridge
4. Reinforced concrete simply supported T-beam bridge

These schemes were compared in terms of span requirement, constructional complexity, material usage, economy, durability, and maintenance. The aim was to achieve the best compromise among them under Zhaojiazhuang''s conditions.

1. Reinforced concrete solid slab bridge

The reinforced concrete solid slab bridge is an extremely general and conventional form of bridge employed for the construction of short-span bridges. It consists of a solid rectangular cross-section and depends on the mechanism of the reinforced concrete for resisting internal forces. The bridge is usually employed for spans of below 20 meters and has a simple and uncomplicated shape to build.

Advantages:

(1) Simple shape, simple to design and build.
(2) Good integrity, with good internal force distribution.
(3) Low construction cost for short spans.
(4) Lower maintenance in the short term.

Disadvantages:

(1) High self-weight leads to high foundation pressure.
(2) Economically inefficient in spanning close to or greater than 20 meters.
(3) Cracking due to shrinkage and temperature is not easily controlled.
(4) Limited appearances and lesser flexibility for future expansion.

2. Prestressed Concrete Box Girder Bridge

Box girders are among the most extensively used medium to long-span bridge types. Box girders are very torsionally stiff and can span longer distances than solid slab bridges because they have a closed hollow section. Prestressing offers greater control of cracking and deflection. Box girder bridges are extensively used in the construction of urban expressway and highways.

Advantages

(1) Increased structural stability and stiffness.
(2) For long-span and curved structures.
(3) Enhanced ability to carry heavy loads.
(4) Reduced cracking control and reduced deformation due to prestressing.
(5) Enhanced life span if properly constructed.

Disadvantages:

(1) Complicated construction process and formwork.
(2) High-technology machinery and application skills.
(3) Higher cost of construction and material.
(4) Closed box sections are hard to maintain.

3. Steel-Concrete Composite Girder Bridge

A composite steel-concrete bridge utilizes a hybrid mix of steel girders and a reinforced concrete deck slab in the goal of having a structure that combines the advantages of both worlds. Composite bridges are very efficient for medium-span as well as long-span bridges and also facilitate prefabrication and faster installation.

Advantages:

(1) Higher load-carrying capacity with less self-weight.
(2) Better construction with prefabrication.
(3) Better seismic performance due to ductility of steel.
(4) Lower foundation loads due to smaller size of structure.

Disadvantages:

(1) Susceptibility of steel members to corrosion in hostile environments.
(2) Higher long-term maintenance cost.
(3) Higher protective coating and inspection requirements.
(4) More expensive materials and more complex connection details.

4. Reinforced Concrete Simply Supported T-Beam Bridge

Medium-span reinforced concrete T-beams with simple support are most commonly adopted in medium-span bridges, such as between 8 and 20 meters. The member is standard, simple to design, and simple to build. Cross-section is a type of "T", the broad flange is the bridge deck, and the rib is the load-bearing web.

指　　标

疑似剽窃文字表述

1. Beijing: People''s Communications Press, 2020.
(4) Units C , Edition T . AASHTO LRFD Bridge Design Specifications. 2012.

2. People''s Communications Press, 1998
(6) Ye Jianshu, ed. Principles of Structural Design. Beijing: People''s Communications Press, 2020
(7) Yuan Lunyi, Bao Weigang, ed.

3. Beijing: People''s Communications Press, 2005.3.
1.3 Design technical standards
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4. (3) Lane load standard: Highway - Grade I load;
(4) Design slope: longitudinal slope *Imax* = 2.5%, transverse slope 1.5%;
(5) Seismic fortification level: according to seismic intensity: VI level;
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(2) Steel bars: HRB400 steel bars are used for main reinforcement and the o

2. Scheme design and calculation of Zhaojiazhuang Midium bridge on Rongwu highway_第2部分　　总字数：16243

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Advantages:

(1) Adopted for medium-span bridges.

(2) Simple prefabrication.

(3) Economical to build by module fabrication.

(4) Low maintenance and long-lasting.

(5) Easy to meet most national standards and general practices.

Disadvantages:

(1) Less aesthetically pleasing in appearance than the other forms.

(2) Susceptible to local damage if poorly detailed.

(3) Still open to quality improvements at curing.

2.3 Plans comparison

In medium-span highway bridge design, choice of the logical and economic form of bridge is the most important. It offers structural safety, constructability, economy, and durability. For Zhaojiazhuang Medium Bridge of Rongwu Highway, various surfaces were taken into account in terms of span requirements, geology and hydrology conditions, traffic loading, construction process, and life cycle cost. Four types of medium-span bridge typical structures are introduced in this chapter: prestressed concrete box girder bridge, reinforced concrete solid slab bridge, steel-concrete composite girder bridge, and Reinforced concrete simply supported T-beam bridge. They are compared with respect to their structural behavior, buildability, economic cost, durability, and applicability to Zhaojiazhuang Medium Bridge site conditions.

1. Reinforced Concrete Solid Slab Bridge

Steel-reinforced solid concrete slab bridges are the shortest of the longest and most common for short to medium-span bridges, especially up to 20 meters. It consists of a steel-reinforced internal solid concrete slab with bending resistance and cracking control.

(a) Structural Characteristics: Solid slab bridges possess large global stiffness and evenness of stress distribution. Their loads are directly transferred to the abutments or piers by the slab and therefore easy to design as well as to analyze. Since they possess a low height-to-span ratio, they are suitable where there is little vertical clearance. But self-weight is extremely high, which is a disadvantageous consideration where longer spans must be achieved.

(b) Construction Feasibility: Solid slab construction is easy and less plant-intensive. There is no complicated formwork design, and detailing of reinforcement is not complicated either. Prefabrication is not carried out in solid slabs, but cast-in- place on solid foundations can be done. When the span is increased to more than 20 meters, the height of the section has to be significantly increased, making the construction time-consuming and expensive.

(c) Economic Evaluation: Reinforced concrete slab bridges are economic for short lengths (less than 15-20 meters). They are light in material price and easy in formwork. In medium length like the demand of Zhaojiazhuang Bridge of 20 meters, additional depth and reinforcement increase material and cost greater than double.

(d) Durability and Maintenance: Apart from the stiffness and strength, the solid slab bridges are also strong due to the weight and the reinforced concrete within. They will experience shrinkage cracks and thermal cracks but can be prevented by detailing. The maintenance is relatively moderate and is largely for the joint sealing and protection of the surface.

(e) Site Suitability: For the above mentioned 20-meter length and Zhaojiazhuang topography, solid slab bridge would not be favorable considering added dead load and section thickness. Requirement for vertical clearances and for loads on foundation still renders this selection less favorable.

2. Prestressed Concrete Box Girder Bridge

Prestressed concrete box girder bridges widely used in structure economy and appearance for medium and long spans. It has better strength-to-weight ratio and torsion stiffness.

(a) Structural Characteristics: Box girders are one-cell or multi-cells based on the span and the loading. Prestressing reduces tensile stresses and reduces deflection, and there are further spans obtained for smaller cross-section. Box section also gives stability under eccentric and torsional load and thus may be added in case of curved alignment or ramps.

(b) Construction Feasibility: Cast-in-place or precast box girder bridges can be employed. Long spans involve the use of post-tensioning and segmental construction, while precast segments are employed in shorter spans. More precision and specialist methods must be applied to the approach, especially in segmental and cantilever approaches.

(c) Economic Evaluation: The form cost of a box girder bridge is typically higher in less complex schemes with more complex formwork, work focus, and specialist plant. Material efficiency and resilience, however, in the 20 - 40-meter span add to the cost to make it economically competitive. Lifecycle costs are also typically low with better performance and lower maintenance needs.

(d) Durability and Maintenance: Box girders offer superior protection to internal tendons and reinforcement, lowering risk of corrosion. The internal part reduces exposure to external forces. Post-tensioning anchorage areas and segment joints need particular care because they may present greater complexity in inspection.

(e) Site Suitability: For the Zhaojiazhuang Bridge, a span of 20 meters is below the range for which box girders are most suitable. While the structure would be possible, the level of construction complexity would offset gains for such an intermediate span except where special alignment or loads are present requiring greater torsional capability.

3. Steel-Concrete Composite Girder Bridge

Steel-concrete composite girder bridges comprise a steel girder with concrete slab and steel and concrete tensile and compressive strengths. Structural shape is increasingly being utilized as medium to long-span highway bridges globally.

(a) Structural Characteristics: In composite action, compression is dominated by the concrete deck and steel girders resist bending tension. Steel and concrete interaction is facilitated by shear connectors. Composite bridges are employed for self-weight reduction and long spans with shallow superstructure depth.

(b) Construction Feasibility: Steel girder prefabrication conserves on-site construction time. Fabrication is rapid with the use of cranes or launching methods. With the girders already fabricated, concrete deck can be cast in-place. Due to these advantages, close attention will need to be directed towards welding quality, bolt tightening, and assembly properly. The steel members'' protection from corrosion during and after construction will need to be guaranteed.

(c) Economic Evaluation: Steel-concrete composite bridges are slightly material- more expensive than concrete bridges, especially where steel is costly. But quicker construction and reduced foundation load can counteract this. Composite structures clearly have some advantages in minimum disruption schemes in traffic.

(d) Durability and Maintenance: Corrosion of steel member is the primary concern. Galvanizing, protective coating, or weathering steel provides life extension. Maintenance of the deck is identical to any other concrete bridge. Composite bridges are suitable for decades if taken care of, but without corrosion protection monitoring, costly repairs are present.

(e) Site Suitability: The 20-meter span and location of the Zhaojiazhuang Bridge make composite girders economical but unnecessary. For anything short of absolute necessity to rush it into construction, other maintenance and refinement to combat corrosion is not warranted. In tighter schedules or longer span, however, this bridge would be best suited.

4. Reinforced Concrete Simply Supported T-Beam Bridge

It is also one of China''s most routine applications in its highway bridge construction in span ranges 8-20 meters. Its load dissipation is even, with prefab being convenient.

(a) Structural Characteristics: Reinforced T-beams are of the same size and are laid side by side to constitute the bridge deck and are uniformly supported. Reinforced is against tension, and therefore longer spans can be provided and cracking is reduced. The structure is statically determinate and therefore analysis is simple and redistribution of internal forces due to settlement at supports is avoided.

(b) Constructability feasibility: T-beams are prefabricated and rolled on site to be constructed, thereby cutting down on construction time without compromising on quality. Transverse diaphragms and in-situ beam joints should be located where they can transfer load as well as experience maximum continuity. Stringer-beam operation is distinguished by low equipment demands and mature construction techniques.

(c) Economic Evaluation: This type is cost-effective for medium length, especially when standard beam sizes are the case, high-technology construction practices reign, and components are produced in quantity. Cost-effective over worth is very attractive where there are precasting yards available.

(d) Durability and Maintenance: T-beam bridges are extremely long-lasting if well detailed and constructed. Inordinately severe conditions are bearing replacement, waterproofing joints, and end-cracking of the beams. New detailing and materials (e.g., high-strength concrete or epoxy-coated reinforcing bar) enhance durability.

(e) Site Suitability: Taking the design length of Zhaojiazhuang Bridge as 20 meters, reinforced simply supported T-beam bridge is equally well-suited. It meets Grade I load for the highway and is easy to build with the standardized cross- section. It is also appropriate as a substructure to bear T-beams.

5. Summary of Comparison

Span Construction Site Bridge Type Cost Durability Suitability Difficulty Suitability Reinforced Low Concrete Solid ≤ 20 m Simple (short Moderate Moderate Slab spans) Prestressed Medium to Possible but Concrete Box ≥ 20 m High High High not ideal Girder Steel-Concrete Moderate ≥ 20 m Medium High Possible Composite

Girder to High Reinforced Very Concrete Simply8 - 20 *m* Simple Low Moderate suitable Supported T-Beam

Based on the comparison, reinforced concrete simple supported T-beam bridge is the most rational option for Zhaojiazhuang Medium Bridge. It satisfies structural safety, construction simplicity, cost-effectiveness, and long-term performance. The choice is in line with national standards and has enough experience with this kind of designs in China.

3. Bridge deck calculation

3.1 Design data and structural layout

3.1.1 Design data

(a) Bridge Deck Clearance: 8.5 m + 2 × 0.75 m.

(b) Span and Total Length of Main Beam:

Calculated Span: L = 19.50 m;Total Length of Bridge: *l* = 20 m.

(c) Design Load:

1) Live load: Highway-Grade I, as prescribed by JTG D60-2015; Pedestrian uniform load: 3 kN/m2;

2) Dead load: Pavement: 2 cm asphalt concrete layer (g = 23 kN/m3) and C25 concrete cushion (g = 24 kN/m3). Flange plates of T-beams (g = 25 kN/m3).

(d) Materials Reinforcement: HRB400 reinforcement is used for main reinforcement.

3.1.2 Structural layout

The superstructure of the bridge consists of a simply-supported 20-meter-long reinforced concrete T-beam structure. Six spaced-at-1.6-meters precast T-beams carry a continuous bridge deck. The total width of the bridge deck is 10 meters, consisting of an 8.5- meter-long traffic lane and two 0.75-meter-long shoulders. The transverse distribution factor for the centre of the span for concentrated vehicle loads is determined by the eccentric pressure method and the lever rule for calculation of distribution for uniform loads and support members. The cross-section and Longitudinal section of the superstructure are shown in Fig.3.1.

The asphalt pavement is 2cm Concrete cushion is 6~16cm 75 850 75 i=1.5% i=1.5% 100 160 160 160 160 160 16 Fig.1 Cross Section 1950 Fig.2 Longitudinal Section 100 160 18

Figure 3.1 Cross-section and Longitudinal section of the superstructure

3.2 Design of carriageway slab

C25 waterproof concrete is used for bridge deck pavement, with an average thickness of 12 cm and a unit weight of 24 kN/m; the asphalt concrete surface is 2 cm thick, and the unit weight is 23 kN/m.

Monodirectional slab.

Clear span: l0 = 160 - 18 = 142 cm;

Thickness of deck: t = (12 + 18) / 2 = 15 cm;

When calculating bending moment: l = l0 + t = (142 + 15) = 157 cm;

When calculating shear force: l = l0 = 160 - 18 = 142 cm;Impact factor is 1 + μ = 1.3.

3.2.1 Dead load internal force

The longitudinal 1 m wide strip is taken for calculation.

Table 3.1 Permanent actions on the slab strip

Asphalt concrete surface (g1)

C25 concrete cushion (g2)

Dead weight T-beam flanges (g3)

Total

0.02 × 1.0 × 23 = 0.46 kN/m

0.06 + 0.16

2

× 1.0 × 24 = 2.64 kN/m

0.18 + 0.12

2

× 1.0 × 25 = 3.75 kN/m

3

g = Σ *g* = 6.85 kN/m

i-1

The internal force induced by permanent action with simply supported beam:

Bending moment:

11 *M*0*g* = *gl*2 = × 6.85 × 1.572 = 2.11 kN . m 88

Shear force:

11 *Q*0*g* = *gl*0 = × 6.85 × 1.42 = 4.86 kN . m 22

3.2.2 Live load internal force

(a) Calculation of effective distribution width

Put the back wheel on the hinge joint, the load of the back axle P=140 kN, the length of the contact surface rectangle a_2 = 0.20 m, width b_2 = 0.60 m, then:

Thickness of pavement:

H = asphalt concrete pavement 0.02 m + concrete cushion 0.11 m = 0.13 m, then:

The distributing rectangle of the load is with the size of: a_1 = a_2+2H = 0.2+2×0.13 = 0.46 m;

b_1 = b_2+2H = 0.6+2×0.13 = 0.86 m.

The effective work width:

The load is located in the center area of the slab:

l l 1.57 2 *a* = *a*1 + = *a*2 + 2*H* + = 0.46 + = 0.98 m < *l* = 1.05 m 3 33 3

The load is located on the support:

l a′ = *a*1 + *t* = *a*2 + 2*H* + *t* = 0.46 + 0.15 = 0.61 > = 0.52 m 3

The load is located near the support:

a_x = *a′* + 2_x = 0.61 + 2_x

(b) Calculation of live load bending

*P b*1 M_{op} = (1 + *μ*) × × (*l* -) 8*a* 2 140 0.86 = 1.3 × × (1.57 -) = 24.70 kN. m 8 × 1.05 2

(c) Shear calculation of life load l = l_0 = 1.42 m

Then:

l l 1.42 2 *a* = *a*1 + = *a*2 + 2*H* + = 0.46 + = 0.93 m < *l* = 0.95 m 3 33 3

Then a = 0.95 m

l a′ = a_1 + *t* = a_2 + 2*H* + *t* = 0.46 + 0.15 = 0.61 > = 0.47 m 3

There is no overlap, then a’ = 0.61 m

Then:

a - *a′* 0.95 - 0.61 = = 0.17 m 22 *P* 140 A_1 = = = 73.68 2*a* 2 × 0.95 *P* A_2 = (*a* - *a′*)2 8*aa′* b_1 140 = (0.95 - 0.61)2 = 4.06 8 × 0.95 × 0.61 × 0.86 0.86 1.42 - *y*1 = 2 = 0.70 1.42 1 1.42 - × 0.17 y_2 = 3 = 0.96 1.42 Q_{op} = (1 + *μ*)(A_1y_1 + A_2y_2) = (1 + 0.3)(73.68 × 0.70 + 4.06 × 0.96) = 72.12

3.2.3 Internal force combination

(a) Internal force combination in limit state of bearing capacity

Mud = 1.2*Mog* + 1.8*Mop* = 1.2 × 2.11 + 1.8 × 24.70 = 46.99 kN. m *Qud* = 1.2*Qog* + 1.8*Qop* = 1.2 × 4.86 + 1.8 × 72.12 = 135.65 kN. m

0.18 + 0.12 *ℏ* = 1.40 - = 1.25 2 *t*0.15 = = 0.12 < 0.25 *ℏ* 1.25

Mid span bending moment:

Mmid = +0.5*Mud* = 0.5 × 46.99 = 23.50 kN. m

Fulcrum bending moment:

Mfc = -0.7*Mud* = -0.7 × 46.99 = -32.89 kN. m

(b) Internal force combination in normal service limit state

Short term effect combination:

Mfd = *Mog* + 0.7*Mop* = 2.11 + 0.7 × 24.70 = 19.40 kN. m *Qfd* = *Qog* + 0.7*Qop* = 4.86 + 0.7 × 72.12 = 55.34 kN. m

Long term effect combination:

Mfd = *Mog* + 0.4*Mop* = 2.11 + 0.4 × 24.70 = 11.99 kN. m *Qfd* = *Qog* + 0.4*Qop* = 4.86 + 0.4 × 72.12 = 33.71 kN. m

3.3 Reinforcement design

This design adopts the 1 m wide strip for reinforcement calculation.

(a) Reinforcement at fulcrum

C25 concrete and HRB400 reinforcement are selected:

fcd = 11.5 MPa; *ftd* = 1.23 MPa ; *fsd* = 330 MPa ; *εb* = 0.58

If the protective layer is 20 mm, the effective height *ℏ*0 = 140 - 20 = 120 mm, *Md* = -32.89 kN. m. The formulas used for the calculations are according to the article 5.2.2 from the Specification for Design of Highway Reinforced Concrete and Prestressed Concrete Bridges and Culverts.

*x γ*0*Md* ⩽ *fcdbx* (*ℏ*0 -) 2 *x* 1.1 × 32.89 ⩽ 11.5 × 103 × 1.0*x* (0.12 -) 2 *x* = 0.03 m

Verification: *εb ℏ*0 = 0.58 × 0.12 = 0.07 m > *x* = 0.03 m

fsdAs = *fcdb′ fx* 11.5 × 1.0 × 0.03 *As* = 330 *As* = 10.45 cm²

Checking the table of reinforcement section and spacing within 1 m of slab width, when Ø14 reinforcement is selected and when the spacing is 120 mm, the cross-sectional area of reinforcement provided is:

1. ion
   3.1 Design data and structural layout
   3.1.1 Design data
   (a) Bridge Deck Clearance: 8.5 m + 2 × 0.75 m.
   (b) Span and Total Length of Main Beam:
   Calculated Span: L = 19.50 m;Total Length of Bridge: l = 20 m.
   (c) Design Load:
   1) Live load: Highway-Grade I, as prescribed by JTG D60-2015; Pedestrian uniform load: 3

2. ture
   3.2 Design of carriageway slab
   C25 waterproof concrete is used for bridge deck pavement, with an average thickness of 12 cm and a unit weight of 24 kN/m; the asphalt concrete surface is 2 cm thick, and the unit weight is 23 kN/m.
   Monodirectional slab.
   Clear span: l0 = 160 - 18 = 142

3. 1.3.
   3.2.1 Dead load internal force
   The longitudinal 1 m wide strip is taken for calculation.
   Table 3.1 Permanent actions on the slab strip
   Asphalt concrete sur

4. 4.86 kN . m 22
   3.2.2 Live load internal force
   (a) Calculation of effective distribution width
   Put the back wheel on the hinge joint, the load of the back axle P=140 kN, the length of the contact surface rectangle a_2 = 0.20 m, width b_2 = 0.60 m, then:
   Thickness of pavement:
   H = asphalt concrete pavement 0.02 m + concrete cushion 0.11 m = 0.13 m, then:
   The distributing rectangle of the load is w

5. ination:
   $Mfd = Mog + 0.4Mop$ = 2.11 + 0.4 × 24.70 = 11.99 kN. m $Qfd = Qog + 0.4Qop$ = 4.86 + 0.4 × 72.12 = 33.71 kN. m
   3.3 Reinforcement design
   This design adopts the 1 m wide strip for reinforcement calculation.
   (a) Reinforcement at fulcrum
   C25 concrete and HRB400 reinforcement are selected:
   fcd = 11.5 MPa; ftd = 1.23 MPa ; fsd = 330 MPa ; εb = 0.58
   If the protective layer is 20 mm, the effective height $\hbar 0$ = 140 - 20 = 120 mm, Md = -32.89 kN. m. The formulas used for the calculat

6. $\gamma 0Md \leqslant fcdbx$ ($\hbar 0$ -) 2 x 1.1 × 32.89 ⩽ 11.5 × 103 × 1.0x (0.12 -) 2 x = 0.03 m
   Verification: $\varepsilon b \hbar 0$ = 0.58 × 0.12 = 0.07 m > x = 0.03 m
   $fsdAs = fcdb' fx$ 11.5 × 1.0 × 0.03 As = 330 As = 10.45 cm^2
   Checking the table of

3. Scheme design and calculation of Zhaojiazhuang Midium bridge on Rongwu highway_第3部分	总字数：15157
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		是否引证：否

原文内容

Ag = 12.83 cm2 > 10.45 cm2

The size of bending members with rectangular section shall meet the following requirements:

ftd 1.23 *ρmmianx* = {0.45 0.2%} = {0.45 × × 0.2%} = 0.33% *fsd* 330 1283 *ρ* = = 1.069% > *ρmmianx* = 0.33% 1000 × 120

The requirements are met.

(b) Reinforcement at mid-span

Checking the table of reinforcement section and spacing within 1 m of slab width, when Ø14 reinforcement is selected and when the spacing is 120 mm, the cross-sectional area of reinforcement provided is:

Ag = 12.83 cm2 > 10.45 cm2

The size of bending members with rectangular section shall meet the following requirements:

ftd 1.23 *ρmmianx* = {0.45 0.2%} = {0.45 × × 0.2%} = 0.33% *fsd* 330 1283 *ρ* = = 1.069% > *ρmmianx* = 0.33% 1000 × 120

The requirements are met.

(0.51 × 10-3) √*fcu, kbℏ*0 (0.51 × 10-3) √25 × 1000 × 120 = 306.00 kN > *Qud* = 135.65 kN

Therefore, i tis not necessary to calculate the shear bearing capacity of inclined section , and only configure stirrups according to the structural requirements.

Checking calculation of bearing capacity:

fsd As x= fcd b′ f 330 × 0.001045 = = 0.03 11.5 × 1.0 *x Md* = *fcdb′ fx* (*ℏ*0 -) 2 0.03 = 11.5 × 103 × 1.0 × 0.03 × (0.12 -) 2 = 36.23 kN. m > *Mmid* = 23.50 kN. m

The requirement is met.

3.4 Calculation of connecting reinforcement

(a) Calculation effect of flexural member

*Pl*2 *ql*3 *wBP* = -*η*(1 + *μ*) - *η*(1 + *μ*) 16*EI* 24*EI*

η - transverse distribution coefficient of main beam load, η = 0.681;

μ - impact coefficient, 1 + *μ* = 1.3;

Eb - modulus of elasticity of main beam, *Eb* = 2.80 × 104 MPa;

Ib - converted inertia moment of main beam, *Ib* = 11.43 × 10-2 m2;

Rb - bearing reaction under live load; *ℏs*, *As*, *Es* - height, bearing area and elastic modulus of rubber bearing respectively,

ℏs = 4.2 cm; *As* = 36 cm2; *Es* = 4.6 × 102 MPa;

l - length of connecting rod, l = 90 cm; a - distance between two supports, a = 50 cm.

After substitution, the corner and vertical displacement at the left are obtained as follows;P = 140 kN

10.5 × 19.53 *wBP* = -0.681 × 1.3 ×24 × 2.80 × 104 × 11.43 × 10-2 × 1000 = -8.97 × 10-4 10.5 × 19.5 *RB* = 0.681 × 1.3 × = 90.63 kN 2 0.042 × 90.63 0.9 - 0.5 ∆*B*= - × (-8.97 × 10-4) = 4.09 × 10-4 0.036 × 4.6 × 105 2

The corner and vertical displacement at the left are obtained as follow:

140 × 19.53 *w′ AP* = -8.97 × 10-4 - 0.681 × 1.3 ×16 × 2.80 × 104 × 0.1143 × 1000 = -18.84 × 10-4 10.5 × 19.5 + 140 *R′ A* = 0.681 × 1.3 × = 152.60 kN 2 0.042 × 152.60 0.9 - 0.5 ∆′ *A* = - × (18.84 × 10-4) = 1.023 × 10-5 0.036 × 4.6 × 105 2

Calculation of fixed end bending moment of connection rod:

ECIC 6∆*B* 6∆ ′ *A MB* = (+ 4*wBP* + 2*w′ AP* -) *ll l*

ECIC 6 × 4.09 × 10-4 = (+ 4 × (8.97 × 10-4) + 2 × (18.84 × 10-4) 0.9 0.9 6 × 1.023 × 10-5 -) 0.9 = 11.127 × 10-3*ECIC* kN. m *EC IC* 6∆′ *A* 6∆*B M′ A* = (+ 2*wBP* + 4*w′ AP* -) *ll l ECIC* 6 × 1.023 × 10-5 -4 = (+ 2 × (8.97 × 10) + 4 × (18.84 × 10-4) 0.9 0.9 6 × 4.09 × 10-4 -) 0.9 = 7.413 × 10-3*ECIC* kN. m

If the connection rod reinforcement is HRB400 and the diameter Ø20, the reinforcement stress is:

*My d*2 *σA* = , *take y* = = = 1.0 cm, *M* = *M′ A*, *tℏen*: *Ic* 2 2 7.413 × 2 × 103 × 103 × *Ic* × 0.01 *σA* = *Ic* *σA* = 14.82 MPa ≪ *σs* = 195 MPa

4. Calculation of main beam

The main beams are made of C30 concrete:

fck = 20.1 MPa; *ftk* = 2.01 MPa; *fcd* = 14.3 MPa; *ftd* = 1.43 MPa *Ec* = 3.00 × 104 MPa;

The ordinary steel bar is HRB400 steel bar, and the design value of tensile strength is:
f_{sk} = 400 MPa; f_{sd} = 330 MPa ; f'_{sd} = 330 MPa tpavement is 2cm ushion is 6~16cmE_s = 2.00 × 105 MPa;
160 041 18 8211

Figure 4.1 The cross-sectional size of the main beam

4.1 Calculation of dead load internal forces

(1) The self-weight of the main beam

0.12 + 0.18 $g1$ = ((0.18 × 1.40) + ( ) × (1.60 - 0.18)) × 25 = 11.63 kN/m. 2

(2) The self-weight of the diaphragm

For edge beam:

0.12 + 0.18 1.60 - 0.18 0.15 + 0.16 25 $g2$ = [1.00 - ( )] × ( ) × ( ) × 6 × 2 2 2 19.5 = 0.72 kN/m.

For the main beam:

g' 2 = 2 × 0.72 = 1.44 kN/m.

(3) Bridge deck pavement

1 [0.02 × 8.50 × 23 + 2× (0.06 + 0.16) × 8.50 × 24] $g3$ = = 4.39 kN/m. 6

(4) Railing and pedestrian

2 $g4$ = 5 × = 1.67 kN/m. 6

(5) Total

Side girders:

g = $g1$ + $g2$ + $g3$ + $g4$ = 11.63 + 0.72 + 4.39 + 1.67 = 18.41 kN/m.

Medium main beam;

g' = $g1$ + g' 2 + $g3$ + $g4$ = 11.63 + 1.44 + 4.39 + 1.67 = 19.13 kN/m.

Let the distance between the cross-section position and the fulcrum be x. Then the internal force generated by the dead load of the main beam:

gx Mx = (l - x) 2 g Qx = (l - 2x) 2

For edge beams:

x=0 $Q0$ = × 19.50 = 179.50 kN 18.41 2 $M0$ = 0 kN. m

x=l 4 Ql = × (19.50 - 2 ×) = 89.75 kN 18.41 19.50 2 4 4) = 656.29 kN. m 4 42 9.50 4 Ml = × × (19.50 - 19.50 18.41 1

l x = Ql = 0 kN 2 2 1 Ml = × 18.41 × 19.502 = 875.05 kN. m 28

For the middle girder:

x=0 x= x= l 4 l 2 $Q0$ = × 19.50 = 186.52 kN 19.13 2 $M0$ = 0 kN. m Ql = × (19.50 - 2 ×) = 93.26 kN 19.13 19.50 2 4 4 Ml = × 19.50 4 4 Ql = 0 kN 2 Ml = 2 1 8 × (19.50 -) = 681.95 kN. m 19.13 19.50 24 × 19.13 × 19.502 = 909.27 kN. m

4.2 Calculation of internal forces under live load

4.2.1 Mid-span with eccentric pressure method

The load transverse distribution coefficient is calculated using the eccentric pressure method for the mid-span position mc.

The asphalt pavement is 2cm Concrete cushion is 6~16cm 75 850 75 i=1.5% i=1.5% 100 160 160 160 160 160 100 160 18

Figure 4.2 Sc 16 hematic is a diagram of the cross-section of the main beam

(1) The span method

L19.5 = = 2.29 > 2 B 8.50

The eccentric pressure method applies

(2) Identical sections for n=6 T girders distance at 1.60 m give:

6 Σ $ai2$ = $a12$ + $a22$ + $a32$ + $a42$ + $a52$ + $a62$ i=1 = 4.002 + 2.402 + 0.802 + (-0.80)2 + (-2.40)2 + (-4.00)2 = 44.80 m²

(3) Calculate the values of the influence line for beam 1#

1 $aiak$ ηik = Rki = Rik = ±n i n Σi=1 $a2$ 1 4.002 $\eta 11$ = + = 0.52 6 44.80 1 4.00 × 2.40 $\eta 12$ = + = 0.38 6 44.80 1 4.00 × 0.80 $\eta 13$ = + = 0.24 6 44.80 1 4.00 × 0.80 $\eta 14$ = - = 0.10 6 44.80 1 4.00 × 2.40 $\eta 15$ = - = -0.05 6 44.80 1 4.002 $\eta 16$ = - = -0.19 6 44.80

(4) The transverse distribution influence of beam 1 and the least at load arrangement of the vehicle are shown in the figure below:

For beam 1#: $\eta 11$ = 0.52; $\eta 16$ = -0.19

Figure 4.3 Transverse distribution influence line of beam 1# with eccentric pressure method

(5) Place the most adverse live load and calculate the distance x:

x 5 × 1.6 -x = = 5.86 0.52 0.19

The distance from the sidewalk curb to the axis of beam 1#:

Δ= 100 - 75 = 25 cm = 0.25 m

(6) Calculate m_{cq} and m_{cr} for beam 1#

Pedestrian load m_{0r} = Σ′ i ηi

ηr 0.52 = 5.86 + 0.25 + 0.75/2 5.86 0.52(5.86 + 0.25 + 0.75/2) m_{cr} = ηr = = 0.58 5.86

Vehicle load m_{0q} = 1 $\Sigma i \eta i$ 2

5.61 $\eta q1$ = 0.52 × = 0.50 5.86 3.81 $\eta q2$ = 0.52 × = 0.34 5.86 2.51 $\eta q3$ = 0.52 × = 0.22 5.86 0.71 $\eta q4$ = 0.52 × = 0.06 5.86

Then, the transverse distribution coefficient of automobile load:

11 m_{cq} = Σ ηq = × ($\eta q1$ + $\eta q2$ + $\eta q3$ + $\eta q4$) 22 1 = × (0.50 + 0.34 + 0.22 + 0.06) = 0.56 2

(7) Calculate the values of influences line for beam 2#

1 $aiak$ ηik = Rki = Rik = ±n i n Σi=1 $a2$ 1 2.40 × 4.00 $\eta 21$ = + = 0.38 6 44.80 1 2.40 × 2.40 $\eta 22$ = + = 0.30 6 44.80 1 2.40 × 0.80 $\eta 23$ = + = 0.21 6 44.80 1 2.40 × 0.80 $\eta 24$ = - = 0.12 6 44.80 1 2.40 × 2.40 $\eta 25$ = - = 0.04 6 44.80 1 2.40 × 4.00 $\eta 26$ = - = -0.05 6 44.80

(8) The transverse distribution influence of beam 2 and the least at load arrangement of the vehicle are shown in the figure below:

For beam 2#: $\eta 21$ = 0.38; $\eta 26$ = -0.05

Figure 4.4 Transverse distribution influence line of beam 2# with eccentric pressure method

(9) Place the most adverse live load and calculate the distance x:

x 5 × 1.6 - x = = 7.07 0.38 0.05

The distance from the sidewalk curb to the axis of beam 2#:

Δ= 100 - 75 = 25 cm = 0.25 m

(10) Calculate m_{cq} and m_{cr} for beam 2#

Pedestrian load m_{0r} = Σ′ i ηi

ηr 0.38 = 7.07 + 0.25 + 0.75/7.07 2 0.38(7.07 + 0.25 + 0.75/2) m_{cr} = ηr = = 0.41 7.07

Vehicle load m_{0q} = 1 $\Sigma i \eta i$ 2

6.82 $\eta q1$ = 0.38 × = 0.37 7.07 5.02 $\eta q2$ = 0.38 × = 0.27 7.07 3.72 $\eta q3$ = 0.38 × = 0.20 7.07 1.92 $\eta q4$ = 0.38 × = 0.10 7.07

Then, the transverse distribution coefficient of automobile load:

11 m_{cq} = Σ ηq = × ($\eta q1$ + $\eta q2$ + $\eta q3$ + $\eta q4$) 22 1 = × (0.37 + 0.27 + 0.20 + 0.10) = 0.47 2

4.2.2 Supports area with lever method

According to the specification, the lever principle method can be used at the support to obtain the transverse distribution coefficient of the support.

This is as follows:

(1) Calculate the transverse distribution coefficient of beam 1#

The distance from the sidewalk curb to the axis of beam 1#:

Δ= 100 - 75 = 25 cm = 0.25 m

Place vehicle and pedestrian load:

Vehicle load:

1 1 160 - 50 + 100 - 75) m_{cq} = Σ ηq = × ( ) = 0.42 2 2 160

Pedestrian load:

160 + (100 - 75) + 75/2 m_{cr} = ηr = = 1.39 160

(2) Draw the influence line of beam 1#

Figure 4.5 Transverse distribution influence line of beam 1# with lever method

(3) Calculate the transverse distribution coefficient of beam 2#

The distance from the sidewalk curb to the axis of beam 2#:

Δ= 100 - 75 = 25 cm = 0.25 m

Place vehicle and pedestrian load:

Vehicle load:

1 1.0 m_{cq} = Σ ηq = = 0.5 22

Pedestrian load:

m_{cr} = ηr = 0.0

(4) Draw the influence line of beam 2#

Figure 4.6 Transverse distribution influence line of beam 2# with lever method

Table 4.1 Load comparison of the transverse distribution coefficient of variable action

Girder 1# m_{cq} The lever method 0.42 Eccentric pressure method 0.56 m_{cr} 1.39 0.58 0.5 m_{cr} 0 Girder 2# m_{cq} 0.47 0.41

The internal force of the main beam

Calculate m of the side beam:

Middle span: eccentric pressure method (Reliable transverse connections)

L 19.5 = = 2.03 ≥ 2 B 6 × 1.60

Supporting point: Lever principle method

L 19.5 = = 2.03 ⩾ 2 B 6 × 1.60

Vehicle load: mc = 0.56 (middle span), $m0$ = 0.42 (support point)

Pedestrian load: mc = 0.58 (middle span), $m0$ = 1.39 (support point)

4.2.3 Variable loads

Calculation of the lane load and the pedestrian load. Vehicle load consists of lane load and automobile load.

Lane load is adopted in the calculation of integral bridge structure, which consists of a uniform load and a concentrated load: Highway-I

Figure 4.7 Lane load and the pedestrian load

For Highway-I:

Characteristics value of uniform load: qk = 10.5 kN. m

Characteristics value of cencentrated load: Pk = 270 ~ 300 kN

Figure 4.8 Concentrated load

Calculation of moments:

19.5 - 5 Pk = [270 + (360 - 270) ×] = 299 kN 50 - 5

Calculation of shear:

Pk = 1.2 × 299 = 358.80 kN

Table 4.2 Calculate area of influence lines of internal forces

Type Highway-I Pedestrian (kN/m) (kN/m) $M1/2$ 10.5 $Q1/2$ 10.5 $Q0$ 10.5 3.0 3.0 3.0 Area of the 1.L (m² or m) Ω = $l2$ 8 1 = × 19.5² 8 1 = 47.53 m² Ω = × × 19.5 11 22 × 0.5 = 2.44 m Ω = × 19.5 × 1 2 1 = 9.75 m Influence line

(a) Calculation of impact factor

Single beam:

A = 0.3902 m2; Ic = 0.066146 m4 (moment of inertia for mid-span section) G 9.76 G = 0.3902 × 25 = 9.76 kN/m; mc = g = 9.81= 0.995 kN.s2/m 2 C30: E = 3.00 × 1010 N/m2

Fundamental frequency:

π EIC 3.14 3.00 × 1010 × 0.066146 f = √ = √ = 5.83 (Hz) $2l2$ MC 2 × 19.52 0.995 × 103

Impac factor:

μ = 0.1767 In f - 0.0157 = 0.3 1 + μ = 1 + 0.3 = 1.3

(b) Calculate maximum moments and shears of the middle span

2 lanes, then ξ = 1

Vehicle load:

S = (1 + μ) . ξ . ($miqk\Omega$ + $miPkyi$) Sq = (1 + μ) . ξ . ($miqk\Omega$)

Pedestrian load:

Sr = mi . $qr\Omega$

$M1/2$ S = 1.3 × 1 × (0.56 × 10.5 × 47.53 + 0.56 × 299 × 4.875) = 1424.47 kN. m Sq = 1.3 × 1 × (0.56 × 10.5 × 47.53) = 363.32 kN. m Sp = 1424.47 - 363.32 = 1061.15 kN. m Sr = 0.58 × 3.0 × 47.53 = 82.70 kN. m $Q1/2$ S = 1.3 × 1 × (0.56 × 10.5 × 2.44 + 0.56 × 358.80 × 0.5) = 149.25 kN Sq = 1.3 × 1 × (0.56 × 10.5 × 2.44) = 18.65 kN Sp = 149.25 - 18.65 = 130.60 kN Sr = 0.58 × 3.0 × 2.44 = 4.25 kN

Table 4.3 Calculation maximum moments and shear of the middle-span

qk or qr (1 S (kN. m or kN) SectionLoad type Pk (kN) mi Ω or y (kN/m) + μ) Si S Highway – 47.53363.32 10.5 299 1.30.56 1424.47 $M1/2$ Grade I 4.8751061.15 Pedestrian 3.0 – -0.5847.53 82.70 Highway – 2.44 18.65 10.5 358.801.30.56 149.25 $Q1/2$ Grade I 0.5 130.60 Pedestrian 3.0 – – 0.582.44 4.25

Figure 4.8 Maximum shear of the support point

(c) Calculate the maximum shear of the support point

Length of variation of transverse distribution factor:

19.5 - 4.85 × 4 a = 4.85 + = 4.90 m 2

The value of the influence line of the center in the m change area:

1 (19.5 - × 4.9) $\overline{y}$ = 1 × 3 = 0.92 19.5

Then,

a $Q0q$ = (1 + μ) × ξ . qk [$mc\Omega$ + ($m0$ - mc)$\overline{y}$] 2 4.9 = 1.3 × 1 × 10.5 × [0.56 × 9.75 + (0.42 - 0.56) × 0.92] 2 = 70.22 kN $Q0P$ = (1 + μ) × ξ . $miPkyi$ = 1.3 × 1 × 0.42 × 358.80 × 1.0 = 195.90

Then, the maximum shear force of girder 1# under Highway-Grade I:

$Q0$ = $Q0q$ + $Q0P$ = 70.22 + 195.90 = 266.12 kN

The maximum shear force of girder 1# under pedestrian load:

a $Q0r$ = mc . qr . Ω + ($m0$ - mc)qr . $\overline{y}$ 2 4.9 = 0.58 × 3 × 9.75 + (1.39 - 0.58) × 3 × 0.92 2 = 22.44 kN

Table 4.4 Calculation maximum moments and shear of the support point *qk or qr* (1 S (kN) Section Load type kN *Pk* (kN) *m*0 *Ω or y* ( ) + *μ*) *Si S* m Highway- 9.75 70.22 10.5 358.80 1.3 0.42 266.12 *Q*0 Grade I 1.0 195.90 Pedestrian 3 - - 1.39 9.75 22.44

4.3 Calculation of combination internal force

After determining the internal force duet o self-weights, vehicle loads, and pedestrian loads, we should combine them as follows:

Table 4.5 Internal force combination

Ultimate limit
state
Self-weight is
adverse to the
Fundamental bearing capacity
combination
Self-weight is
beneficial to the
bearing capacity
Frequent value
Accidental
combination
Quasi-permanent
value
Serviceability
Frequent combination
limit state
Accidental combination

$S_{ud} = 1.2G + 1.4Q_v + 0.75 \times 1.4Q_P$

$S_{ud} = G + 1.4Q_v + 0.75 \times 1.4Q_P$

$S_{ad} = G + 0.7Q_v + 1.0Q_P$

$S_{ad} = G + 0.4Q_v + 0.4Q_P$

$S_{fd} = G + 0.7Q_v$ (*without impact force*) $+ 1.0Q_P$

$S_{fd} = G + 0.4Q_v$ (*without impact force*) $+ 1.0Q_P$

Table 4.6 The calculation of the design internal force middle beam

Moment M (kN.m) Shear force Q (kN) No. Load *l l l x*=0 *x*= *x*= *x*=0 *x*= 4 2 2 (1) Self-weight 0 681.95 909.27 186.52 0 (2) Vehicle load 0 767.42 1424.47 266.12 149.25 (3) Pedestrian load 0 54.9 82.70 22.44 4.25 (4) 1.2 × (1) 0 818.34 1091.12 223.82 0 (5) 1.4 × (2) 0 1074.39 1994.26 372.57 208.95 (6) 0.75 × 1.4 × (3) 0 57.65 86.84 23.56 4.46 (7) *Sud* = (4) + (5) + (6) 0 1950.38 3172.22 619.95 213.41

4.4 Reinforcement design and strength checking calculation

Considering the convenience of construction, the reinforcement design of each main girder is carried out according to the calculated internal force of the control design listed in Table 4.6.

$Pl2$ $ql3$ $wBP = -\eta(1 + \mu) - \eta(1 + \mu)$ $16EI$ $24EI$
η - transverse distribution coefficient of main beam load, η = 0.681;
μ - impact coefficient, $1 + \mu = 1.3$;
Eb - modulus of elasticity of main beam, $Eb = 2.80 \times 104$ MPa;
Ib - converted inertia moment of main beam, $Ib = 11.43 \times 10-2$ m2;
Rb - bearing reaction under live load; $\hbar s$, As, Es - height, bearing area and elastic modulus of rubber bearing respectively,
$\hbar s = 4.2$ cm; $As = 36$ cm2; $Es = 4.6 \times 102$ MPa;
l - length of connecting rod, l = 90 cm; a - distance between two

5. × 104 MPa;
The ordinary steel bar is HRB400 steel bar, and the design value of tensile strength is:
$fsk = 400$ MPa; $fsd = 330$ MPa ;

6. (4) Railing and pedestrian
2 $g4 = 5 \times = 1.67$ kN/m. 6
(5) Total
Side girders:
$g = g1 + g2 + g3 + g4 = 11.63 + 0.72 + 4.39 + 1.67 = 18$

7. l 2 $Q0 = \times 19.50 = 186.52$ kN 19.13 2 $M0 = 0$ kN. m $Ql = \times (19.50 - 2 \times) = 93.26$ kN 19.13 19.50 2 4 4 $Ml = \times 19.50$ 4 4 $Ql = 0$ kN 2 $Ml = 2$ 1 8 $\times (19.50 -) =$

8. values of the influence line for beam 1#
1 $aiak$ $\eta ik = Rki = Rik = \pm n$ i n $\sum i=1$ $a2$ 1 4.002 $\eta 11 = + = 0.52$ 6 44.80 1 4.00 × 2.40 $\eta 12 = + = 0.38$ 6 44.80 1 4.00 × 0.80 $\eta 13 = + = 0.24$ 6 44.80 1 4.00 × 0.80 $\eta 14 = - = 0.10$ 6 44.80 1 4.00 × 2.40 $\eta 15 = - = -0.05$ 6 44.80 1 4.002 $\eta 16 = - = -0.19$ 6 44.80
(4) The transverse distribution influence of beam 1 and the least at load arrangement of the vehicle are shown in the figure below:
For beam 1#: $\eta 11 = 0.52$; $\eta 16 = -0.19$
Figure 4.3 Trans

9. 22 1 = × (0.50 + 0.34 + 0.22 + 0.06) = 0.56 2
(7) Calculate the values of influences line for beam 2#
1 $aiak$ $\eta ik = Rki = Rik = \pm n$ i n $\sum i=1$ $a2$ 1 2.40 × 4.00 $\eta 21 = + = 0.38$ 6 44.80 1 2.40 × 2.40 $\eta 22 = + = 0.30$ 6 44.80 1 2.40 × 0.80 $\eta 23 = + = 0.21$ 6 44.80 1 2.40 × 0.80 $\eta 24 = - = 0.12$ 6 44.80 1 2.40 × 2.40 $\eta 25 = - = 0.04$ 6 44.80 1 2.40 × 4.00 $\eta 26 = - = -0.05$ 6 44.80
(8) The transverse distribution influence of beam 2 and the least at load arrangement of the vehicle are shown in the

10. 38 = 7.07 + 0.25 + 0.75/7.07 2 0.38(7.07 + 0.25 + 0.75/2) $mcr = \eta r = = 0.41$ 7.07
Vehicle load $m0q = 1$ $\Sigma i\eta i$ 2
6.82 $\eta q1 = 0.38 \times = 0.37$ 7.07 5.02 $\eta q2 = 0.38 \times = 0.27$ 7.07 3.72 $\eta q3 = 0.38 \times = 0.20$ 7.07 1.92 $\eta q4 = 0.38 \times = 0.10$ 7.07
Then, the transverse distribution coefficient of automobile l

11. used at the support to obtain the transverse distribution coefficient of the support.
This is as follows:
(1) Calculate the transverse distribution coefficient of beam 1#
The distance from the sidewalk curb to the axis of beam 1#:
Δ=

12. sverse distribution influence line of beam 1# with lever method
(3) Calculate the transverse distribution coefficient of beam 2#
The distance from the sidewalk curb to the axis of beam 2#:
Δ= 100 - 75 = 25 cm = 0.25 m
Place vehicle and pedestrian load:
Vehicle load:
1

13. 0.42 Eccentric pressure method 0.56 mcr 1.39 0.58 0.5 mcr 0 Girder 2# mcq 0.47 0.41
The internal force of the main beam

Calculate m of the side beam:
Middle span: eccentric pressure method (Reliable transverse connections)
L 19.5 = = 2.03 ⩾ 2 B 6 × 1.60
Supporting point: Lever principle method
L 19.5 = = 2.03 ⩾ 2 B 6 × 1.60
Vehicle load: mc = 0.56 (middle span), $m0$ = 0.42 (support point)
Pedestrian load: mc = 0.58 (middle span), $m0$ = 1.39 (support poin

14. Area of the 1.L (m^2 or m) Ω = $l2$ 8 1 = × 19.5^2 8 1 = 47.53 m^2 Ω = × × 19.5 11 22 × 0.5 = 2.44 m Ω = × 19.5 × 1 2 1 = 9.75 m Inf

15. 0 kN. m $Q1/2$ S = 1.3 × 1 × (0.56 × 10.5 × 2.44 + 0.56 × 358.80 × 0.5) = 149.25 kN Sq = 1.3 × 1 × (0.56 × 10.5 × 2.44) = 18.65 kN Sp = 149.25 - 18.65 = 130.60 kN Sr = 0.58 × 3.0 × 2.44 = 4.25 kN
Table 4.3 Calculation maximum moments and shear of t

16. 92] 2 = 70.22 kN $Q0P$ = (1 + μ) × ξ . $miPkyi$ = 1.3 × 1 × 0.42 × 358.80 × 1.0 = 195.90
Then, the maximum shear force of girder 1# under Highway-Grade I:
$Q0$ = $Q0q$ + $Q0P$ = 70.22 + 195.90 = 266.12 kN
The maximum shear force of girder 1# under pedestrian load:
a $Q0r$ = mc . qr

17. + 1.4Qv + 0.75 × 1.4QP
Sud = G + 1.4Qv + 0.75 × 1.4QP
Sad = G + 0.7Qv + 1.0QP
Sad = G + 0.4Qv + 0.4QP
Sfd = G + 0.7Qv (*without impact force*) + 1.0QP
Sfd = G + 0.4Qv (*without impac*

4. Scheme design and calculation of Zhaojiazhuang Midium bridge on Rongwu highway_第4部分 总字数：15362

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原文内容

4.4.1 The configuration of the longitudinal main reinforcement

According to the maximum design bending moment Mj = 3172.22 kN.m in Table 4.6, carry out reinforcement. Assume that the net protective layer of steel bars is 3 cm, and the cross-sectional dimensions of the main beam are shown in Figure 4.9.

(1) First determine the type of T-shaped section, assuming the distance from the resultant force point of the steel bar to the near section ag = 18 cm, the effective height of the girder $h0$ = 140 - 18 cm = 122 cm.

Assuming x = $h'i$ ($h'i$ is the flange height of the compression zone of the T-shaped section, take $h'i$ = $h1$), the calculated bending moment that the section can bear:

1 ′ h' i Rab(h -) γc i 0 2 1 160 1 = × 14.3 × 1600 × 160 × (1220 -) × 1.25 2 106 = 3338.65 kN. m > 3172.22 kN. m

That is x < h' i, belongs to the first type of the T-shaped section

Figure 4.9 Sectional dimensions of the main beam (unit: cm)

(2) Calculate the height of the concrete compression zone x, it can be seen from the formula:

1x Mj = Rab' ix (h0 -) γc 2 2γcMj x = h0 - √ h02 Rab' i 2 × 1.25 × 3172.22 × 106 = 1220 - √12202 - 14.3 × 1600 = 151.5 mm = 15.15 cm < h' i = 16 cm *and* 15.15 cm < ξjg h0 = 0.55 × 122 = 67.10 cm

So, meet the requirements.

(3) Determine the section area of the tensile steel bar using the following formula:

Rab' ix 14.3 × 160 × 15.15 Ag = = = 105.04 cm2 Rg 330

25⌀25 steel bar is selected, the cross-sectional area is:

Ag = 25 × π × 1.252 = 122.72 cm2 > 105.04 cm2

The reinforcement layout is shown in Figure 4.9 the location of the center of gravity of the reinforcement

a' gi yi y' = Σ Σ a' gi [4.91 × 3.45 × (7.5 + 6.5 + 5.5 + 4.5 + 3.5 + 2.5 + 1.5 + 0.5)] y' = (8 × 4.91) = 13.80 cm

Therefore, the distance between the force application point of the bar and the nearest side of the section is:

ag = 3 + 13.80 = 16.80 cm

Effective height of the main beam:

h0 = 140 - 16.80 = 123.20 cm

Ratio of reinforcement:

Ag 105.04 μ = = = 0.5% > 0.15% b' i × h0 160 × 123.2

Meet the requirements.

(4) Checking of section strength

According to the section actual reinforcement area Ag = 105.04 cm2, the height x of the concrete compression zone can be calculated as:

$RgAg$ 330 × 105.04 x = = = 15.15 cm Rab' i 14.3 × 160

Using tensile design strength for Class I steel bars

Then the section flexural strength is:

1x MP = Rab' ix (h0 -) γc 2 1 151.5 1 = × 14.3 × 1600 × 151.5 × (1232 -) × 1.25 2 106 = 3206.35 kN. m > Mj = 3172.22 kN. m

Therefore, according to this reinforcement main beam is safe.

4.4.2 Configuration of shear bars

According to Table 4.6, the maximum design shear force i sat fulcrum $Q0$ = 619.95 kN in the span is $Q1/2$ = 213.41 kN, assumed to have 4⌀25 the longitudinal bar passes through the fulcrum. So, the fulcrum section ag = 3 + 3.45 = 6.45 cm; h0 = 140 - 6.45 = 133.55 cm. According to the standard beam structure to meet:

Qj ⩽ 0.051 √ Rb h0 0.051 √ Rb h0 = 0.051 × √30 × 18 × 133.55 = 671.50 kN > $Q0$ = 619.95 kN

Therefore, the beam section size meets the requirements, and if the following formula is satisfied according to the code specifications, the beam section can be designed based solely on structural requirements: Qj ⩽ 0.038 Rlb h0, where Rl is the design tensile strength of C30 concrete.

For the fulcrum section:

0.038 Rlb h0 = 0.038 × 1.43 × 18 × 133.55 = 130.63 kN < $Q0$ = 619.95 kN

For mid-span cross-section:

h0 = 123.20 0.038 Rlb h0 = 0.038 × 1.43 × 18 × 123.20 = 120.50 kN < $Q1/2$ = 213.41 kN

Therefore, the calculation indicates that stirrups can be arranged solely based on structural requirements in the beam section near the mid-span, while the shear strength of the inclined section must be calculated for other beam sections. The calculation for shear reinforcement of the inclined section is illustrated in Figure 4.10

(a) Calculated the length of various reinforced beams

Let the length of the beam section with the reinforcement according to the structure be x, Then:

x213.41 - 120.50 = 975 619.95 - 213.41 x = 22.28 cm

Therefore, the beam section length $l1$ of the designed shear reinforcement is:

l 1950 $l1$ = - x = - 22.28 = 952.72 22

According to the code: the maximum shear force is the value of the section h/2 (half beam bridge) distance from the center of the support, concrete and stirrups shear 60% of the burden: bend the steel bar (bend at 45°) to bear 40%.

The calculated shear force $Q'j$ of the section at the center h/2 of the support is:

Figure 4.10 Calculation of shear reinforcement in oblique section (unit: cm)

Knowable by code and Figure 4.10:

ΔQj Q0 - Q1/2 = h/2 l/2

Resolvent:

h (Q0 - Q1) 140 × (619.95 - 213.41) ΔQj = 2 = = 29.19 kN l 1950

Therefore:

Q′ j = 619.95 - 29.19 = 590.76 kN

Therefore, the shear force borne by the inclined bar is:

0.4Q′ j= 0.4 × 590.76 = 236.30 kN

The shear force borne by the stirrup and concrete is:

0.6Q′ j= 0.6 × 590.76 = 354.46 kN > 120.50 kN

Then the length l' of the beam segment with no inclined reinforcement and only stirrups is:

354.46 - 213.41 l′ = × 22.28 - 22.28 = 115.4 cm 213.41 - 120.50

Therefore, it is necessary to set the length l' of the beam section of the oblique reinforcement as:

l 1950 l″ = - l′ - x = - 115.4 - 22.28 = 837.32 cm 22

(b) Diagonal reinforcement design

The center of the erection steel bar is 4.5 cm away from the top edge of the beam, the inclined steel bar is bent according to 45°, and its projected length on the beam axis is:

C = 140 - 4.5 - 6.45 = 129.05 cm

The number of rows of diagonal bar η is:

l ″837.32 η = = = 6.49 C 129.05

Integer η=7, that is to say, 7 rows of oblique bars are set, and the shear force to be borne by the bent bars intersecting with the oblique section can be calculated as follows:

Qw = 0.06Rgw Σ Awsinα

When calculating the first row of bent steel bars, the value of the shear force borne by the oblique bar sat the center h/2 of the distance from the support is Qw = 236.30, then the required cross-sectional area of the first row:

Qw1 236.30 Agw1 = = = 16.81 cm² 0.06Rgwsin45 0.06 × 330 × 0.71

Assuming that the height h' of the diagonal reinforcement is constant, the shear force to be borne by each row of diagonal reinforcement can be calculated according to the following formula:

h′ Qwi = Qw1 [1 - (2i - 3)] 2C1

In the formula i= 2, 3, 4, 5, 6, 7, ... h' is the height of the diagonal bar, the value is: h' = 119 cm

h 140 C1 = l″ - = 837.32 - = 767.32 cm 22

Therefore, it can be included that the calculated shear to be home by the second, third and fourth rows of diagonal rebar and the required cross-section area of rebar area:

119 Qw2 = 236.30 × [1 - (2 × 2 - 3) ×] = 217.98 2 × 767.32 Qw2 217.98 Agw2 = = = 15.51 cm² 0.06Rgwsin45 0.06 × 330 × 0.71 119 Qw3 = 236.30 × [1 - (2 × 3 - 3) ×] = 181.33 2 × 767.32 Qw 3 181.33 Agw3 = = = 12.90 cm² 0.06Rgwsin45 0.06 × 330 × 0.71 119 Qw4 = 236.30 × [1 - (2 × 4 - 3) ×] = 144.68 2 × 767.32 Qw4 144.68 Agw4 = = = 10.29 cm² 0.06Rgwsin45 0.06 × 330 × 0.71

119 Qw5 = 236.30 × [1 - (2 × 5 - 3) ×] = 108.04 2 × 767.32 Qw5 108.04 Agw5 = = = 7.69 cm² 0.06Rgwsin45 0.06 × 330 × 0.71 119 Qw6 = 236.30 × [1 - (2 × 6 - 3) ×] = 71.39 2 × 767.32 Qw6 71.39 Agw6 = = = 5.08 cm² 0.06Rgwsin45 0.06 × 330 × 0.71 119 Qw7 = 236.30 × [1 - (2 × 7 - 3) ×] = 34.74 2 × 767.32 Qw7 34.74 Agw7 = = = 2.47cm² 0.06Rgwsin45 0.06 × 330 × 0.71

It can be seen from the calculation result that the two longitudinal steel bars (2N2) bend at 45 corners as the first row of oblique ribs to provide a cross-sectional area 22.28 cm², smaller than the required program area 16.81 cm².

For this reason, the distance between each row of inclined bars should be adjusted in the future, and the two longitudinal bars should be (2N3) press 45° to bend up at a distance of 65 cm from the first row of oblique ribs, to make up for the lack of cross- sectional area of the first row of diagonal bars, 2Ø8 auxiliary diagonal bars are added between the curved bars of each row of longitudinal main bars to meet the needs of shear resistance of the diagonal bars. See Figure 4.11 for the specific layout.

(c) Check the flexural strength of the normal section after the longitudinal reinforcement is bent

First calculate the bending moment using Mj1/2, Mj1/4, and Mj . According to the parabolic change, the bending moment envelope diagram is drawn, and then the bearing capacity diagram of the longitudinal steel bar is drawn, so as to determine the bending position pf the bent steel bar.

2025 resisting moment of steel bar M is:

x M = 2$RgAg$ (h0 -) 2 0.099 = 2 × 330 × 103 × 4.91 × 10-4 × (1.232 -) 2 = 383.20 kN. m

Resistance bending moment Σ M of the total longitudinal steel bar in the mid-span section is:

0.099 Σ M = 330 × 103 × 78.54 × 10-4 × (1.232 -) 2 = 3064.83 kN. m

Figure 4.11 illustrates the verification of the beam's overall bearing capacity. The bending starting point of the curved steel bar should be positioned at least h0/2 beyond the section of the steel bar that is unnecessary according to the bending strength calculations. As depicted in Figure 4.11 the bending position of the steel bar complies with the requirements.

Figure 4.11 Checking the bearing capacity of the whole beam

(d) Stirrup design

According to the reinforcement ratio of the longitudinal tensile main reinforcement at the fulcrum of the main beam, P = 100μ is small, and the mid-span is large, 4Ø8 four- leg stirrups and 2Ø8 double-leg stirrups are respectively $Ak4$ = 2.012 cm2, $Ak2$ = 1.006 cm2, the calculation formula for the stirrups spacing is:

0.0033(2 + P) √ $RAkRgkb$ h02 Sk = 2 (cm) (Q' j)

For the fulcrum, the longitudinal main reinforcement is 5Ø25, Ag = 24.544 cm2

h0 = 140 - 3 - 3.45 = 133.55 cm Ag 24.544 μ = = = 0.1021 b h0 18 × 133.55 P = 100μ = 100 × 0.1021 = 10.21

Q' j= 590.76 kN, plug it into the formula:

0.0033 × (2 + 10.21) × √30 × 2.012 × 330 × 18 × 133.552 Sk0 = 590.76 2 = 134.79 cm

For the span, the longitudinal main rib is 12Ø32, Ag = 78.54 cm2

h0 = 123.2 cm Ag 78.54 μ = = = 0.0354 b h0 18 × 123.2 P = 100μ = 100 × 0.0354 = 3.54

Q' j= 213.41 kN, plug it into the formula:

0.0033 × (2 + 3.45) × √30 × 1.006 × 330 × 18 × 123.2 2 Skl = 2 213.41 2 = 196.18 cm

According to the regulations, for thin-walled flexural members, the stirrup spacing should be less than ¾ of the beam height and not exceed 50 cm. Additionally, with the length range of h/2 on both sides of the support center, the stirrup spacing should exceed 20 cm. Therefore, the stirrup spacing for the entire beam can be selected as follows

Sk = 20 cm except 10 cm near the support, and the distance from 4 limbs to 2 limbs is 3,5 m away from the fulcrum. Checking the calculation of the stirrup reinforcement ratio:

For the fulcrum:

Ak4 2.012 μk0 = = = 0.0112 > μmin = 0.0018 bSk0 18 × 10 Ak2 1.006 $\mu kl/2$ = = = 0.0028 > μmin = 0.0018 bSk0 18 × 20

(e) Checking of shear strength of the oblique section

According to the regulations, the section located at h/2 (half of the beam height) from the support center, at the bending point of the tension area steel bars, where the number or spacing of stirrups changes, and where the web thickness of the flexural member varies, should be checked for shear capacity. The shear strength of the oblique section is illustrated in Figure 4.12

At the distance h/2 from the support is section 1-1, Shear force:

Q1-1 = 411.42 kN

Bending moment:

M1-1 = 695.82 kN. m

3.4 m away from the center of the support is section 5-5, which is the bending starting point of the fourth row of curved steel bars

Shear force:

Q5-5 = 301.92 kN

Bending moment:

M5-5 = 1646.45 kN. m

And Q1-1, Q5-5, M1-1, M5-5 are calculated values through the maximum shear force and the corresponding bending moment in the normal section at the top of the oblique section.

Figure 4.12 Checking the shear strength of the oblique section

The maximum shear force can be determined through interpolation after computing the horizontal projection length C of the oblique section, and the corresponding bending moment can be obtained proportionally from the bending moment envelope diagram. When calculating the horizontal projection length C of the oblique section, the w value can be approximately C ≈ h0 (available average).

133.55 + 123.2 C = = 128.38 cm 2

When the flexural member is equipped with stirrups and bent steel bars, the checking formula for the shear strength of the oblique section is:

Qj ≤ Qhk + Qw

In the formula Qhk is the common shear resistance of the concrete and stirrup in the inclined section:

$Q_{\hbar k}$ = 0.0349$b\hbar 0$√(2 + P) × √$R\mu kRgk$, P, μk, Qw are the same meaning as before oblique section 1-1: Reinforcement ratio of longitudinal reinforcement

24.544 P = 100μ = 100 × = 1.06 18 × 128.38 Ak 2.012 μk = = = 0.0056 bSk 18 × 20 $Q\hbar k1$ = 0.0349 × 18 × 128.38 × √(2 + 1.06) × √30 × 0.0056 × 330 = 448.86 kN $Qw1$ = 0.06 × 330 × 12.272 × 0.707 = 171.79 kN $Q\hbar k1$ + $Qw1$ = 448.86 + 171.79 = 620.65 kN > 411.42 kN

Oblique section 4-4:

58.905 P = 100μ = 100 × = 2.55 18 × 128.38

The stirrup changes from 4 limbs to 2 limbs in the range of oblique 4-4:

Ak 1.006 μk = = = 0.0028 bSk 18 × 20 $Q\hbar k4$ = 0.0349 × 18 × 128.38 × √(2 + 2.55) × √30 × 0.0028 × 330 = 387.01 kN $Qw4$ = 0.06 × 330 × 12.272 × 0.707 = 171.79 kN $Q\hbar k4$ + $Qw4$ = 387.01 + 171.79 = 558.80 kN > 301.92 kN

According to the design experience, if the longitudinal tensile steel bars and bent steel bars are arranged in accordance with the structural requirements of the code, the bending strength of the oblique section can be guaranteed without checking.

4.4.3 Crack width checking calculation

For reinforced concrete flexural members with T-section, the maximum crack width can be calculated according to the following formula:

σg 30 + d $\delta fmax$ = $C1C2C3$ ( ) Eg 0.28 + 10μ

$C1$ - consider the coefficient of steel bar surface shape for threaded steel bars, $C1$ = 1.0;

$C2$ - consider the coefficient of load action, long-term load action, $C2$ = 1 + 0.5 $M0$, where $M0$ M is the bending moment under long-term load and M is the bending moment under full-service load;

$C3$ - a coefficient related to the form of a member, when a flexural member has a web, $C3$ = 1.0;

d - diameter of the longitudinal tensile bar Ag;

μ - the ratio of reinforcement is calculated according to the following formula, μ = Ag , when μ > 0.02 is used, the value is μ = 0.02; $b\hbar 0$+(bi-b) $\hbar i$

bi, $\hbar i$ - width and thickness of tension flange;

σg - the stress of a tensile steel bar under service load, calculated according to the formula, M σg = . 0.87$Ag\hbar 0$

Below is the calculation to determine if the maximum crack width in the main beam span under normal environmental conditions and long-term load meets the requirements, considering the load group cooperation.

I[$\delta fmax$] = 0.2 mm

Value $C1$ = 1.0 (threaded steel bar).

Under the action of load combination I:

$M0$ $C2$ = 1 + 0.5M 670.19 = 1.0 + 0.5 × 670.19 + 725.40 + 53.26 = 1.231

Value $C3$ = 1.0 (flexural member having web), d = 25 mm

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	HATIM SAFA - 《大学生论文联合比对库》- 2023-06-15	是否引证：否
5	Scheme design and calculation of Wangcun Middle-span bridge on Rongwu freeway	16.6%（2570）

原文内容

Ag 58.87 μ = = = 0.03 > 0.02 $b\hbar 0$ + (bi - b) $\hbar i$ 18 × 123.2

Taking μ = 0.02

M (670.19 + 725.40 + 53.26) × 106 σg = = = 229.61 MPa 0.87$Ag\hbar 0$ 0.87 × 5887 × 1232 Eg = 2.0 × 105 MPa

So, the load combination is I,

229.61 30 + 25 $\delta fmax$ = 1.0 × 1.231 × 1.0 × × ( ) 2.0 × 105 0.28 + 10 × 0.02 = 0.16 mm

4.4.4 Main beam deformation checking calculation

The deflection of a reinforcement concrete flexural member under short-term load can be calculated using material mechanics based on the specified stiffness of the member.

For simple supported beams:

5$ML2$ f= 0.85$EI01$

L - calculated span;

M - bending moment under service load (static and live load bending moment);

$I01$ - the cracked section is converted to the moment of inertia.

11 $I01$ = nAg($\hbar 0$ - x)2 + b' i, $x3$ - (b' i - b)(x - t)³ 33 $E\hbar$ = 3.0 × 104 MPa, n = 10

Determine the section type of this type, hypothesis x = $\hbar'$ i = 17.5

1b' $i\hbar'$ 2i = 1× 160 × 17.52 = 24500 cm3 < nAg($\hbar 0$ - $\hbar'$ i) 22 nAg($\hbar 0$ - $\hbar'$ i) = 10 × 58.87 × (123.2 - 17.5) = 62225.59 cm³

Calculation shows x > 17.5, it belongs to the Class I T-section

nAg(b' i - b) $\hbar i$ A= b 10 × 58.87 + (160 - 18) × 17.5 = 18 = 170.76 nAg(b' i - b) $\hbar'$ $i2$ + 2$Ag\hbar 0$ B= b (160 - 18) × 17.52 + 2 × 10 × 58.87 × 123.2 = 18 = 10474.62

x = -A + √$A2$ + B = -170.76 + √170.762 + 10474.62 = 28.32 cm 11 $I01$ = nAg($\hbar 0$ - x)2 + b' i. $x3$ - (b' i - b)(x - t)³ 33 11 = 10 × 58.87 × (123.2 - 28.32)2 + × 160 × 28.323 - (160 - 18)(28.32 - 17.5)3 33 = 6451020,01 cm4 = 0.0645 m4

According to the code, when verifying the deformation of the main beam, the load excludes the dead load and the Highway-Grade I load excludes the impact force.

The deformation caused by static and live load and crowd load:

5$ML2$ f= 0.85$EI01$ 725.40 5× (+ 670.19) × 19.52 = 1.232 0.85 × 3 × 107 × 0.0645 L 1950 = 1.46 cm > = = 1.22 cm 1600 1600

The pre-camber should be set with a value of:

12 5 (Mg + 2 $M\hbar ig\hbar way$-I) L fy = 48 × 0.85$E\hbar I01$ 1 725.40 5 (670.19 + ×) × 19.52 = 2 1.232 48 × 0.85 × 3 × 107 × 0.0645 = 0.0232 m = 2.32 cm

Therefore, it should be made into a smooth curve

5. Calculation of diaphragm

5.1 Calculation of diaphragm

In a simply supported reinforced concrete beam bridge without the transverse beam, the transverse beam or the connection must be sufficiently strong to tie the main beams together and enhance the overall stability of the structure. The transverse beam of the midspan section is subjected to the maximum loads since it is the most stressed location. Structural calculations thus concentrate on the internal forces of this location. The design of the other transverse beams can then be determined with certainty from these midspan calculations.

With θ = 0.031 and √a = 0.414 (obtained from the main beam values), the transverse bending moment influence coefficients $\mu 0$ and $\mu 1$ at the center point of the bridge width (beam position f = 0) can be determined from the G - M method by using the corresponding table. With these influence coefficients, the bending moment influence line coordinates $B\mu\alpha$ for mid- span of a single wide transverse beam are computed, for example, in Table 5.1. Because the data of 0~(-B) is symmetric with data 0~B, i tis not listed in the table.

The bending moment of the mid-span section width transverse slat affects the coordinate value $B\mu\alpha$.

Table 5.1 Values of bending moment coefficient under constant load

Calculation

B

$\mu 0$

-0.145

$\mu 1$

-0.100

$\mu 1$ - $\mu 0$

0.045

($\mu 1$ - $\mu 0$)√α

0.029

$\mu\alpha = \mu 0 + (\mu 1 - \mu 0)\sqrt{\alpha}$
-0.116
$B\mu\alpha(m)$
-0.522
$B\mu\alpha \times a(m2)$
-2.532
Load position
¾B
½B
¼B
0
-0.125 -0.001 0.120 0.250
-0.045 0.025 0.110 0.220
0.080 0.026 -0.010 -0.030
0.051 0.017 -0.006 -0.019
-0.074 0.016 0.114 0.231
-0.333 0.072 0.513 1.040
-1.615 0.349 2.488 5.044

Note: B = 4.5 m in the table is half of the bridge width and a = 4.85 m is the beam spacing.

The following formula can be used to convert the concentrated load into the peak value of a sinusoidal load:

2 πxi $P = L\Sigma$ $PisinL$

P - is the peak value of sinusoidal;

Pi - is the value of the concentrated load;

xi - is the distance between the concentrated load Pi and the fulcrum;

L - to calculate the span.

The arrangement of Highway-Grade I loads along the bridge span should maximize the force on the crossbeam in the middle span, as shown in Figure 5.1.

Figure 5.1 Load distribution along the bridge span (unit: cm)

The peak value of sinusoidal load of longitudinal wheel weight is:

2 πxi $Pq = L\Sigma$ $PisinL$ 2 60 5.75 120 9.75 120 8.35 = × (sin π + sin π + sin π) 19.5 2 19.5 2 19.5 2 19.5 2 = × (30sin0.295π + 60sin0.5π + 60sin0.428π) 19.5 2 = × [30 × 0.8 + 60 × (1 + 0.975)] 19.5 = 14.62 kN/m

The peak value of sinusoidal of crowd load is:

2qr L πx 2qr L πx L $P\lambda$ = ∫ sin dx = [cos] L 0 L L π L0 2qr 2L 4qr = (-) = - L π 3.1416 = 3.82 kN/m

5.2 Bending moment calculation of diaphragm

Using the computed values of $B\mu\alpha \times a$ in Table 5.1, bending moment influence line of transverse beam can be plotted. Load is imposed on the most severe transverse position, as shown in Figure 5.2

Figure 5.2 Bending moment influence line of the beam

Midspan bending moment for the different loading cases, with span of 8.5 meters and impact factor of 1 + μ = 1.3, is given by:

Mq = (1 + μ)Pq Σ $B\mu\alpha \times a$ Mq(+) = 1.3 × 14.62 × (5.044 + 2.488 + 1.419 + 0.349 + (-2.074)) = 137.34 kN/m Mq(-) = 1.3 × 14.62 × (-2.074 + 2.488) = 7.87 kN/m $M\lambda = P\lambda$ Σ $B\mu\alpha \times a$ -2.532 + (-2.074) = 3.82 × [× 2] 2 = 3.82 × (-4.61) = -17.61 kN/m

Load combination:

Bending moment effect line is nearly symmetrical in positive and negative regions, and dead load effects will cancel each other automatically. Dead load contributions can therefore be neglected in structure analysis. Therefore:

Mq = 1.4Mq(+) = 1.4 × 137.34 = 192.28 kN/m

Negative moment combination:

1.4$M\lambda$ = 1.4 × (-17.61) = -24.65 kN/m

Therefore, the internal force of the beam: the positive bending momen tis controlled by the Highway-Grade I load:

M(+) = 192.28 kN. m

The negative bending moment is controlled by crowd load:

M(-) = -24.65 kN. m

5.3 Reinforcement and strength checking calculation of diaphragm

(a) Positive moment reinforcement: width b' of the beam wing plate is:

2λ + b = 2 × 140.8 + 18 = 299.60 cm

b + 12$\hbar w$ = 18 + 12 × (17.5 + 3) = 264 cm

According to the specification requirements, take b' = 264 cm small value, take a = 8 cm, then $h0$ = 75 + 3 - 8 = 70 cm:

1x Mj ⩽ Rab' x ($h0$ -) γs 2 1 x 192.28 = × 14.3 × 2.64 × x × (0.70 -) × 103 1.25 2 x = 0.009

Then, x = 0.010 m

This is given by the formula:

$RgAg$ = $R\alpha b'$ x 14.3 × 2.64 × 0.010 Ag = 330 = 1.14 × 10-3 m2 = 11.4 cm2

4Ø25 steel bars are selected, Ag = 19.64 cm2

The flexural steel bar is divided into layers, the center of the lower steel bar is 5 cm from the bottom edge of the beam, and the center distance of the two layers of steel bar is 6 cm, then a = 5 + 3 = 8; $h0$ = 70 cm, then:

330 × 19.64 x = = 1.72 cm 14.3 × 264

ξg × $h0$ = 0.55 × 70 = 38.5 cm > x = 0.010 m

So, meet the requirements.

Checking of section strength:

1x Mp = Rab' x ($h0$ -) γc 2 1 0.010 = × 14.3 × 103 × 2.64 × 0.010 × (0.70 -) 1.25 2 209.90 kN. m > Mj = 192.28 kN. m

(b) Negative moment reinforcement:

Use a = 3 cm; $h0$ = 75 - 3 = 72 cm

1x Mj ⩽ Rab' x ($h0$ -) γc 2 1 x 24.65 = × 14.3 × 0.18 × x × (0.72 -) × 103 1.25 2

Then, x = 0.016 m

This is given by the formula:

$RgAg$ = $R\alpha b'$ x 14.3 × 0.18 × 0.016 A' g = 330 = 1.25 × 10-4 m2 = 0.125 cm2

2Ø12 steel bars are selected, A' g = 2.26 cm2

Then:

330 × 2.26 x = = 2.90 cm 14.3 × 18

Checking of section strength:

1x Mp = Rab' x ($h0$ -) γc 2 1 0.0290 = × 14.3 × 103 × 0.18 × 0.0290 × (0.72 -) 1.25 2 42.13 kN. m > Mj = 24.65 kN. m

(c) Checking calculation section reinforcement:

19.64 $\mu 1$ = × 100% = 0.350% 264 × 20 + 18 × 18 10.05 $\mu 2$ = × 100% = 0.775% 18 × 72

$\mu 1$, $\mu 2$ are greater than the minimum reinforcement ratio of tensile steel bars stipulated in the code 0.15%.

5.4 Shear calculation and reinforcement of diaphragm

For determining the shear force in the beam, transverse load distribution influence line of main beam can be determined by using the eccentric load method. Since the shear forces tend to be larger near the edges of a bridge, normally it will be okay to determine the shear force only on the right-hand side of No. 1 and No. 2 main beams. From these, the shear influence lines at these two locations can be drawn. The shear ordinate of the shear influence line at the right side of the No. 1 main beam can be calculated using the following:

P = 1 is applied when the section is calculated to left, $\eta\theta 1$ 1i= $\eta 1i$ - 1

P = 1 is applied when the section is calculated to right, $\eta\theta 1$ 1i= $\eta 1i$

The vertical mark value of the shear influence line of the right section of the No.2 main beam can be calculated as follows:

P = 1 is applied when the section is calculated to left, $\eta\theta 2$ 2i= $\eta 1i$ + $\eta 2i$ - 1

P = 1 is applied when the section is calculated to right, $\eta\theta 2$ 2i= $\eta 1i$ + $\eta 2i$

According to the above method, the shear influence lines of the section of No.1 and No.2 main beams section are the most unfavorable load position on the Highway-Grade I load corresponding influence line.

The figure shows the most unfavorable load position of the road-II class load on the corresponding influence line, and the shear force of the section is calculated as follows.

The shear force of the right section of the No.1 main beam under the action of the load $Qq1$:

$Qq1$ = (1 + μ)Pq Σ ηq × a = 1.3 × 14.62 × (0.50 + 0.34 + 0.22 + 0.06) × 4.85 = 103.24 kN

Shear force of the right section at No.2 main beam under the load $Qq2$:

$Qq2$ = (1 + μ)Pq Σ ηq × a = 1.3 × 14.62 × (0.37 + 0.27 + 0.20 + 0.10) × 4.85

= 86.65 kN

It can be seen from the calculation results that the shear force of the right section of the No.1 main beam under the action of automobile load is the largest, so the design shear force value is:

$Qmax$ = 1.4 × 103.24 × 86.65 = 125.24 kN

Shear checking according to the standard:

0.051√$Rb$$h0$ = 0.051 × √30 × 18 × 75 = 377.11 kN 0.038$R1b$$h0$ = 0.038 × 1.43 × 18 × 75 = 73.36 kN

The calculated shear Qj = 125.24 kN is somewhere in between, so the beams need to be equipped with shear bars. It is assumed that the shear reinforcement is all stirrup and the single limb stirrup Ø8 is selected Agk = 2 × 0.503 = 1.006 cm2

When the shear resistance of concrete and stirrup in inclined section is combined, the shear resistance is calculated according to the following formula:

$Q ℏ k = 0.0349 b ℏ 0 \sqrt{(2 + P)} \sqrt{R\mu k R g k}$

In the formula:

Ag 19.64 $P = 100\mu = 100 \times = 100 \times = 1.454$ $b ℏ 0$ 18 × 75

Because:

$Agk\ \mu k = bSk$

Therefore:

$Agk\ Sk = b\mu k$ $(0.0349) 2 b ℏ 02 (2 + P) \sqrt{R R g k A g k}$ $Sk = (Q ℏ k)2$ 0.00122 × 18 × 752 × (2 + 1.454) × √30 × 330 × 1.006 = (130.44)2 = 45.60 cm

Take Sk = 45 cm, then:

1.006 μk = = 0.12% > $\mu kmin$ 18 × 45.60

So, meet the construction requirements of the specification.

6. Special research "Bridges as cultural narratives: How aesthetics reflect regional identity"

6.1 Introduction

6.1.1 Background and context

Bridges have always been a vital piece of infrastructure, bridging people and enabling the movement of people and products throughout the region. apart from their very important utilitarian function of transportation, bridges are also very important to the culture. Bridges as highly conspicuous structures as icons tend to represent the culture, history, and identity of the region in which they are built. While the engineering and purpose of a bridge are of paramount significance, those aesthetic choices made while it is being built have important parts to play in how it will be perceived by the public eye. In the vast majority of cases, the appearance of a bridge goes beyond its functional use to take on a role symbolic of local pride and cultural heritage.

Bridges have always been made not only to portray technological innovation but culture as well. Bridges'' look, from the refined stone arch bridges of the Roman Empire to modern steel cable-stayed bridges, have mirrored society''s progress, innovation, and culture. Bridge design look is increasingly a compulsory mode of expression to represent a region''s character, its heritage, and legitimize cultural myths.

6.1.2 Bridge construction aesthetics

Its physical attractiveness and symbolism are based on various factors, i.e., geographical, historical, and cultural. Materials used in construction, the shape and structure of the bridge, and adornments all are the contributors to its physical attractiveness and symbolism. For instance, the utilization of local materials, i.e., wood, stone, or metal, will give a feeling of belongingness to natural local materials and history. The bridge design, whether it is an arch, a beam bridge, or a cable-stayed bridge, can represent the engineering skill and sophistication of the time or era.

Second, bridge aesthetics in bridge building is not arbitrary but is related to something in cultural values in society within the region. In certain cases, bridges are built to represent history, individuals, or personalities that the nation holds in high esteem. Bridges will incorporate elements of myths in the location or artistic elements that remind one of heritage in culture building the identity within the region in other cases.

6.1.3 Bridges as cultural symbols

Bridges are symbolic because public structures that are usually seen from a distance and crossed by millions daily. Bridges symbolize not just material bridging of places; they symbolize social bridging and emotional bridging. Bridges symbolize progress, balance, and strength. There is that one symbolic bridge in every big city like San Francisco''s Golden Gate Bridge or Australia''s Sydney Harbour Bridge that is part of the city''s character and used to symbolize the regional character.

Here, bridges are cultural indicators of what and whom people value and aspire and build them to be. Their shape form, such as size and ornamentation, can say a lot about a region''s ideals, history, and culture. They are therefore strong cultural accounts of the public''s past, present life, and future.

6.1.4 Regionalism and cultural identity in bridge design

Cultural identity is a complex phenomenon comprised of common values, practices, and beliefs which typify a specific people. It is normally projected onto geography, history, language, and tradition. Regional identity in bridge building is achieved by the aesthetic in bridge designing and constructing a bridge. This is achieved through the use of materials which are locally sourced, design features which express the local culture, and local building techniques.

Bridge design regionalism is a particular concern currently, as internationalisation of construction fashion has coincided with the aspiration to export styles and forms of architecture along with principles of style that do not have the need to be locally inspired in an acceptable cultural way. In contrast to this, tremendous interest has now been generated in the construction of bridges of particular local culture, regional style. Possessing local significance, they are source and pride of the residents.

指　　标

疑似剽窃文字表述

1. = 2.0 × 105 MPa
So, the load combination is I,
229.61 30 + 25 $\delta fmax$ = 1.0 × 1.231 × 1.0 × × ( ) 2.0 × 105 0.28 + 10 × 0.02 = 0.16 mm
4.4.4 Main beam deformation checking calculation
The deflection of a reinforcement concrete flexural member under short-term load can be calculated using material mechanics based on the specified stiffness of the member.
For simple supported beams:
5$ML2$ f= 0.85EI

2. (123.2 - 28.32)2 + × 160 × 28.323 - (160 - 18)(28.32 - 17.5)3 33 = 6451020,01 cm4 = 0.0645 m4
According to the code, when verifying the deformation of the main beam, the load excludes the dead load and the Highway-Grade I

3. y = 48 × 0.85$E\hbar I$01 1 725.40 5 (670.19 + ×) × 19.52 = 2 1.232 48 × 0.85 × 3 × 107 × 0.0645 = 0.0232 m = 2.32 cm
Therefore, it should be made into a smooth curve
5. Calculation of diaphrag

4. ion f = 0) can be determined from the G - M method by using the corresponding table. With these influence coefficients, the bending moment influence line coordinates $B\mu\alpha$ for mid- span of a single wide transverse beam are computed, for example, in Table 5.1. Because the data of 0~(-B) is symmetric with data 0~B, i tis not listed in the table.
The bending moment of the mid-span section

5. -0.045 0.025 0.110 0.220
0.080 0.026 -0.010 -0.030
0.051 0.017 -0.006 -0.019
-0.074 0.016 0.114 0.231
-0.333 0.072 0.513 1.040
-1.615 0.349 2.488 5.044
Note: B = 4.5 m in the table is half of the bridge width and a = 4.85 m is the beam spacing.
The following formula can be used to convert the concentrated load into the peak value of a sinusoidal load:
2 πxi P = $L\Sigma$ $PisinL$
P - is the peak value of sinusoidal;
Pi - is the value of the concentrated load;
xi - is the distance between the concentrated load Pi and the fulcrum;
L - to

6. regions, and dead load effects will cancel each other automatically. Dead load contributions can therefore be neglected in structure analysis. Therefore:
Mq = 1.4Mq(+) = 1.4 × 137.34 = 192.28 kN/m
Negative moment combination:
1.4$M\lambda$ = 1.4 × (-17.61) = -24.65 kN/m
Therefore, the internal force of the beam:

7. m small value, take a = 8 cm, then $\hbar$0 = 75 + 3 - 8 = 70 cm:
1x Mj ≤ Rab' x ($\hbar$0 -) γs 2 1 x 192.28 = × 14.3 × 2.64 × x × (0.70 -) × 103 1.25 2 x = 0.009
Then, x = 0.010 m
This is given by the formula:
$RgAg$ = Rab' x 14.3 ×

8. ected, A' g = 2.26 cm2
Then:
330 × 2.26 x = = 2.90 cm 14.3 × 18
Checking of section strength:
1x Mp = Rab' x ($\hbar$0 -) γc 2 1 0.0290 = × 14.3 × 103 × 0.18 × 0.0290 × (0.72 -) 1.25 2 42.13 kN. m

> M_j = 24.65 kN. m
(c) Checking calculation section reinforcement:
19.64 μ_1 = × 100% = 0.350% 264 × 20 + 18 × 18 10.05 μ_2 = × 100% = 0.775% 18 × 72
μ_1, μ_2 are greater than the minimum reinforcement ratio of tensile steel bars stipulated in the code 0.15%.
5.4 Shear calculation and reinforcement of diaphragm
For determining the shear force in the beam, transverse load distribution influence line of main beam can be determined by using the eccentric load method. Since the shear forces tend to be larger near the edges of a bridge, normally it will be okay to determine the shear force only on the right-hand side of No. 1 and No. 2 main beams. From these, the shear influence lines at these two locations can be drawn. The shear ordinate of the shear influence line at the right side of the No. 1 main beam can be calculated using the following:
P = 1 is applied when the section is calculated to left, $\eta\theta 1\ 1i = \eta 1i - 1$
P = 1 is applied when the section is calculated to right, $\eta\theta 1\ 1i = \eta 1i$
The vertical mark value of the shear influence line of the right section of the No.2 main beam can be calculated as follows:
P = 1 is applied when the section is calculated to left, $\eta\theta 2\ 2i = \eta 1i + \eta 2i - 1$
P = 1 is applied when the section is calculated to right, $\eta\theta 2\ 2i = \eta 1i + \eta 2i$
According to the above method, the shear influence lines of the section of No.1 and No

9. d the shear force of the section is calculated as follows.
The shear force of the right section of the No.1 main beam under the action of the load Q_{q1}:
$Q_{q1} = (1 + \mu) P_q \sum \eta_q \times a$ = 1.3 × 14.62 × (0.50 + 0.34 + 0.22 + 0.06) × 4.85 = 103.24 kN
Shear force of the right section at No.2 main beam under the load Q_{q2}:
$Q_{q2} = (1 + \mu) P_q \sum \eta_q \times a$ = 1.3 × 14.62 × (0.37 + 0.27 + 0.20 + 0.10) × 4.85
= 86.65 kN
It can be seen from the calculation results that the shear force of the right section of the No.1 main beam under the action of automobile load is the largest, so the design shear force value is:
Q_{max} = 1.4 × 103.24 × 86.65 = 125.24 kN
Shear checking according to the standard:
$0.051\sqrt{R}bh_0$ = 0.051 × √30 × 18 × 75 = 377.11 kN $0.038R_1bh_0$ = 0.038 × 1.43

10. en the shear resistance of concrete and stirrup in inclined section is combined, the shear resistance is calculated according

6. Scheme design and calculation of Zhaojiazhuang Midium bridge on Rongwu highway_第6部分　　总字数：16634

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原文内容

6.1.5 Aesthetic decision making in contemporary bridge design

Contemporary bridge design today is no longer just a matter of cost and function; it''s a matter of how the structure engages with the place and how the place''s character is embedded in the structure. As regions and cities evolve on a daily basis in the current era, visual solutions adopted at bridges can have phenomenal effects on the cultural value of the bridge. Different situations tackle all such issues, including requirements for sustainability, innovation of forms, and rising expectations of cultural heritage value.

For instance, incorporating modern design features typical of the surrounding culture or using sculpture and painting to render the bridge more graceful would instill cultural significance in the bridge. Modern bridges are thus also becoming icons of culture that preserve regional identity in their crossing points.

6.2 Historical context

6.2.1 Early development of bridges and their role in ancient civilizations

Bridges were a thousand years old, the earliest ones simple forms like rocks or logs crossing streams or canyons. But civilization brought technology, and bridges became a part of city living. Egyptians, Mesopotamians, and Greeks all had bridge technology and engineering, usually imposing their world view on the structures.

During ancient Egyptian periods, bridges were built so that people could cross and exchange goods across the Nile River. Stone and wood were the material on which the first bridges were built, and the bridges were very functional and practical in looks and beauty rather than being pleasing to the eye. The significance of the bridges in ancient times, however, is that they would contribute to the shaping of the ancient cities, and that would allow further shaping of the cultural identity of the civilization.

Similarly, the Romans were also early bridge builders, developing the construction of arches to extremes, thus allowing more span and strength. Roman bridges such as France''s Pont du Gard were functional and a reflection of Roman engineering expertise. Roman innovations and uses of long-span, long-duration bridges and concrete in engineering had their effect on bridge building. Most Roman bridges such as Rome''s Ponte Milvio were grand cultural monuments that were testaments to Roman technical superiority and dominance. The bridges, moreover, were constructed to be included in the city design, highlighting the magnificence of the city and of imperial authority.

6.2.2 Middle ages: Essentially utilitarian bridges with symbolic function

During the Middle Ages, bridges were symbolic rather than functional. Most of most of Europe''s bridges used to have enormous political or religious ceremonies, and Florence''s Ponte Vecchio bridge represented power and authority. Bridges used to be made of wood or stone, and their construction was usually dictated by prevailing religion and culture.

Bridges in medieval England were built as a component of the defensive structure or fortress. The majority of such bridges had gated walls and walls that could be shut to keep the enemy out. These kinds of bridges represented medieval concepts of defense and security but also feudalism with authority vested in the hands of a limited number of lords and kings.

The Gothic era was characterized by the addition of sophisticated stonework and decoration to bridge building. Bridges like the Old London Bridge, lined with rows of houses and shops, were the epitome of urban life. The decoration, for example, in the form of pointed arches and ornate carving, was a reflection of the religious and artistic mentality of the times. The bridges also symbolized the commercial centers, which symbolized the growing primacy of trade and commerce in medieval Europe.

6.2.3 Renaissance and baroque periods: Bridges as works of art

Renaissance and Baroque were the times when the paradigm was shifting towards the understanding of bridges by the one. There was reawakening of interest in classical antiquity during the Renaissance, and bridge construction became more sophisticated and advanced design. Bridges were more admired both technically and artistically by engineers, architects, and other individuals who have those qualities of symmetry, proportion, and harmony characteristic of the time.

One of the finer Renaissance drawings is Venice''s Rialto Bridge, which was quite a balance between utility and aesthetics. Antonio da Ponte constructed the Rialto Bridge in the late 16th century as a single high-flying stone arch, and shops were set on its sides. Other than being a facility for the transport of people and goods across the Grand Canal, the bridge was also a display of Venice''s economic power and artistic dominance.

The Baroque period, which succeeded the Renaissance period, saw bridges constructed even more complicated and ornamental than those of their predecessors. Baroque bridges were huge bridges with highly carved, fountains, and heavily ornamented adornments in a display of strength and power of the affluent. Ponte Sant''Angelo in Rome, constructed from a series of angel statues, is the ultimate Baroque bridge. These bridges were designed to be both awe- inspiring and frightening, a testament to the authority of the state and the church.

6.2.4 Industrial revolution and emergence of bridge building as new discipline

The Industrial Revolution significantly changed the process of bridge construction with advancements in new materials and technologies. The application of iron and steel significantly changed the process of constructing bridges by. enabling the construction of more elastic, larger, and stronger bridges. The first iron bridges, such as the Iron Bridge of Shropshire, England, brought a revolution in bridge engineering. and construction of modern bridge. designs.

As the process of industrialization kept on going, the need for transportation efficiency grew higher. Railroads, above all else, had to have long, powerful bridges constructed over rivers, valleys, and other barriers. Bridges of these types began to value function and efficiency, but the majority of others were constructed as symbolic reminders of expansion or industrialization. The Brooklyn Bridge itself in New York City is one such example, an engineering marvel that utilized revolutionary technology when it came to beauty like its towering Gothic-style arches.

Bridges were not only functional structures in the past; nowadays, they started symbolizing the higher aspirations of industrialized nations. With industrialization and urbanization, bridges then symbolized modernity and advancement. They were built so that their structure comprised not just functional but also aesthetic aspects, symbolizing advancements in technology.

6.2.5 The 20th century: The meeting point of art and engineering

The 20th century also witnessed a revolutionary transformation in bridge construction, and greater importance was given to art and imagination and innovation. New materials like reinforced concrete were found, and engineers'' technical abilities increased, facilitating the construction of more diversified and colorful types of bridges.

San Francisco Golden Gate Bridge is among the greatest favorites of 20th-century bridge construction. Completed in 1937, the Golden Gate Bridge is not only an engineering masterpiece but a cultural symbol. Its beautiful Art Deco appearance and rich orange color have contributed to its being among the world''s most famous bridges. The Golden Gate Bridge was a symbol of American innovation and progress, and its beauty has made it a cultural symbol that transcends time.

Second-half 20th-century postmodernism and deconstructivist architectural movement designed bridges that gained popularity, with unconventional and experimental shape being provided to them. Sydney Harbour Bridge and French bridge Millau Viaduct are two excellent examples of bridges falling under these categories, whose new shape diverged from traditionally acceptable shape of what a bridge should look like. These contemporary bridges are the epitome of redefining 20th-century culture and technology, symbolizing both the experimentation of necessity and beauty to shatter the engineering horizon.

6.2.6 Modern bridge design: Interweaving function and aesthetic expression

Nowadays, bridge building continues to advance, with architects and engineers increasingly interested in constructing bridges not just as functional structures but as works of art. During the 21st century, there has been greater sensitivity towards cultural identity as an aspect to be taken into account when building bridges, with the majority of contemporary bridges having local design elements that pay homage to the past and heritage of the areas being crossed.

Contemporary bridges desire to become a part of as unobtrusively as possible into the site setting, reconciling nature landscape, place myth, and imagination of the local populace. New sources of construction technology have arisen as well as city centers desiring green buildings. Like the Oresund Bridge linking Denmark and Sweden, contemporary bridges are syntheses of new engineering capability and cultural interpretation but not merely as transport conduits but also as symbols of territorial identity.

6.3 Aesthetic elements in bridge design

Bridge building is a marriage of engineering and aesthetics, function vs. beauty. Through the ages, bridges have not only been seen as utilitarian crossings but as works of engineering, symbols of culture, and beauty. Though the most obvious function of a bridge is to transport human beings and commodities, the beauty of a bridge is sometimes more than its utilitarian purpose. Aesthetic factors in bridge construction are considerations in how a bridge reacts to the landscape, how lovely it is to the human sense of sight, and how well it demonstrates the technological and cultural capability of its constructors.

Beauty of a bridge is primarily defined by a long list of factors including the natural surrounding environment in which a bridge is built, beliefs in a place, material and architectural type utilized. Beauty of bridge construction has been evolving through time, wherein earlier bridges have been functionally oriented, but later on, designed with regards to purpose as well as look. Nowadays, application of art design methods onto bridges is one of the ways bridges go beyond utilitarian construction and turn into symbols that are charged with technological accomplishment and cultural identity.

6.3.1 Form and structure: The pillar of aesthetic bridge design

The easiest to design aspect of a bridge will likely be the shape of the bridge. Shape is that overall appearance and form of the bridge and could be arches, beams, cables, or all three combined. Shape within a bridge is characterized by more than structural language such as load-carrying capacity and stability, but also visual language such as balance, proportion, and visual harmony.

Architecturally, the arch has been the most significant shape employed in bridge building. The Romans, and other early cultures, initially used the smooth curve of the arch. The Romans made good use of the arch in bridges. The beauty of the arch is not just as a shape with its pleasing form, which has endured for centuries. These ancient Roman bridges like the Pont du Gard in France exemplify this balance between aesthetics and function. The arch, in addition to being necessary for functionality, is also an aesthetically visual indicator of stability and strength and therefore one of the most enduring types of bridge construction.

Contemporary designs like suspension and cable-stayed bridges also utilize the cables to suspend the bridge deck. These are highly aesthetically appealing forms of bridges because towers and cables lead to dynamic form compared to horizontal and slab-like deck shape. San Francisco Golden Gate Bridge is a good example of the manner in which suspension bridge form can be married between genius in engineering and beauty. The elegant curve of the bridge cables and the stunning red color have turned the bridge into an engineering wonder and an artistic masterpiece.

6.3.2 Materials and texture: The power of choice in perception

The material used for construction of a bridge determines how beautiful the bridge is. All the construction materials such as stone, steel, concrete, and wood have various textures, colors, and surface finishes which all contribute to the visible appearance of the bridge. The material used for construction determines the technological status of the period and also the cultural function of the bridge constructors.

Stone was the most conventional material used for building bridges in the past. Even the Roman aqueducts, which have been out of commission, were also extremely decorative, since they were stone bridges. The more rough surface finish and more complex carvings of the stone provided a texture that contained an element of aesthetic beauty to bridges. Stone in bridges also became the values of longevity and permanence and thus the value of grandeur and timelessness.

The Industrial Revolution arrived in the form of bridge mass production with iron and steel. The metals enabled bigger and longer bridges with finer and more beautiful lines. The beauty of steel can be seen in New York City''s Brooklyn Bridge and Paris''s Eiffel Tower. The industrial, minimalist aesthetic would be conferred by the steel bridges, where the smooth surface area and huge geometric forms. Although the steel bridges are less decorated than the older stone bridges, they have a piece of innovation and novelty to them, and that too is just as lovely.

Concrete, which was so popular in the 20th century, provides a material that is functional and can be produced in numerous different forms. Concrete in bridge building provides for functional and sculptural elements to be incorporated into the building process. A good example is the Millau Viaduct in France, with its sinuous, flowing lines and imposing height, utilizing concrete to provide a breathtaking bridge that is such a harmonious integration into the landscape.

Wood, although not being used so much in the building of bridges nowadays, has also been utilized in certain circumstances, such as rural bridges or foot bridges. Wood bridges with their organic and natural nature can establish a warmer, more friendly relationship with nature and itself. In Japan, local cultural and aesthetic tradition is native to wooden bridges like the Kintai Bridge, and their materiality and structure are greatly prized for the ways in which they are able to interact with nature and culture.

6.3.3 Colour and visual presence: Contribution to the character of the bridge

Colour is also an essential part of bridge beauty since colour has the capability of completely altering the appearance of an object as well as how individuals perceive it within its surroundings. Colour choice on a bridge can be done for any combination of reasons such as cultural identification, environmental intention, and merely a try to provide some sort of visual statement.

Colour in most cultures is highly symbolic. Red, for instance, in China is forever a sign of good luck, happiness, and wealth. The cultural significance has also witnessed the use of red colour in the construction of some of China''s most symbolic bridges like the Lupu Bridge in Shanghai. Red bridge colour is not only beautiful but symbolic of cultural significance and belief, passing on the structure symbolism.

Alternatively, there are other bridges painted softer or more natural colors such that they can be blended in with the environment. For example, Sydney Harbour Bridge is painted grey in such a way that it can be merged with the natural environment of Sydney Harbour. In such a situation, the intention is to have the bridge merge with the environment, not draw attention to itself. Even the minimalist use of colors has also been able to add to the beauty of the bridge, and focus is laid more on the structure and form of the bridge than color.

Vivid contrasting hues have in some city places served as a means of emphasizing bridges as symbols. Red, as that of the Golden Gate Bridge, for instance, is not just part of its charm but also of its symbolic significance as a most iconic bridge in the world. Color also serves functional purposes, including visibility during fog or nighttime, and is particularly beneficial to coastal or mountain location bridges.

7. Scheme design and calculation of Zhaojiazhuang Midium bridge on Rongwu highway_第7部分　　总字数：16624

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原文内容

6.3.4 Proportion and scale: Building and surroundings in harmony

Proportion and proportionality are of utmost significance in aesthetical design of a bridge. Proportion of the bridge refers to comparative size of an element of a bridge, i.e., beam size, tower size, and span size. Harmonious and symmetrical proportion is of utmost significance while designing a well-looking bridge. Extremely small or extremely large bridges, in comparison to the environment, appear foolish or contradict visual harmony of the environment.

The breadth of a bridge is also something that is connected to the environment and once more to why the bridge is built. A city center bridge in a metropolitan area, like the Brooklyn Bridge, must be wide and tall because it needs to support the heavy traffic as well as pedestrian flow. But in the situation of a landscape or rural-type setting, a small bridge, such as a footbridge over a brook, will be suitable to enable the bridge to be incorporated into the landscape.

Modern bridge designers and engineers use proportions to design proportionate structures that blend with nature and the surrounding. Proportions of towers and cables of suspension bridges, for example, are calculated accordingly to create a perception of stability and beauty. Relative piers-to-span-length proportions in Millau Viaduct, for example, were used with the objective of conveying the bridge''s relationship with its natural environment such that the structure has a graceful yet monumental presence.

6.3.5 Bridge design and cultural symbolism

Apart from their technical and aesthetic values, bridges also possess profound cultural meaning and symbolism. Symbolically, bridges have been employed for centuries to symbolize the convergence of two distant places, societies, and even cultures. Bridges have been employed by most societies to symbolize transformation from one form to another, i.e., from matter to spirit or from one political or social order to another.

The bridge has, in some cultures, been used as a symbol of crossing and bridging. In Japan, traditionally the case has been that the bridges have been Shintoistic with an emphasis on crossing and passage of boundaries. Wooden bridges of Japanese gardens, such as the ancient temple bridge of Kiyomizu-dera in Kyoto, are gateway symbolic bridges to enlightenment. These bridges usually consist of natural formations and flowing curves, which provide a sense of harmony between the world and the soul world.

So too in the West are bridges such as New York City''s Brooklyn Bridge symbols of ingenuity, tenacity, and progress. The Brooklyn Bridge, which opened in 1883, was a wonder of its time, an American test of endurance and industrial power. Today it is a functioning transportation link but also a symbol, a representation of the dreams of American tenacity and ingenuity.

6.3.6 Future bridge aesthetic elements

With new materials and methods of building now being discovered and technology continuing to advance, future bridge building can only be enhanced in appearance. The future of bridge building can have more emphasis on green materials and green technology and even more innovative ways of building with the same emphasis on function as on esthetics.

Designers will take the application of artistic expression to bridge design even further, with new technologies such as 3D printing, intelligent materials, and responsive illumination to produce structurally efficient yet stunningly lovely bridges. Increasing the focus on sustainability in modern bridge design will also see green bridges that can integrate into the surrounding environment become a reality, increasing their aesthetic appeal.

6.4 Case studies in bridge aesthetics

Giving order to aesthetics as a way to fill the space of bridge design is not magic but a dramatic act that gets accomplished in bridges of myth throughout the world. Bridge design will have numerous considerations to make, from structural to environmental, but aesthetics are the ones that will make a bridge an architectural and cultural landmark. In this chapter, several of the most significant examples of bridge case studies in which aesthetics have taken precedence will be covered, as well as the ways in which a bridge''s looks can communicate culture, influence the visual environment, and symbolize technological ability. All of the case studies will provide proof of how a range of such attributes such as form, material, size, color, and symbolism have been used to design structures which are both functional and iconic

In this case, case studies that have been selected are examples of bridges over different locations, times, and schools of thought and provide evidence of the variance of solutions to the problem of balance between form and functionality in the practice of bridge engineering.

6.4.1 Case study 1: The Golden Gate Bridge (USA)

1. Overview

The Golden Gate Bridge, which was finished in 1937, is a suspension bridge of international fame and a tale of form and beauty at the expense of function in bridge design. San Francisco''s world''s most beautiful and world''s most famous bridge, the Golden Gate Bridge, is located in California. The Golden Gate Bridge crosses Golden Gate Strait to connect San Francisco city with Marin County in the north. Its breathtaking Art Deco loveliness, in flowing curves and shining hue, has made it iconic not only for San Francisco city but for American engineering expertise.

2. Aesthetic Considerations

(a) Form and Structure: Golden Gate Bridge is a suspension bridge whose cables are suspended from two enormous towers and suspending the deck. Even the towers themselves are aerodynamically curved, giving a sense of sophistication to the bridge. Suspension cables give smooth curved lines which cover the brutal horizontal deck. The brutal contrast structure of horizontal deck and vertical towers gives a sense of smoothness and sophistication to the bridge.

(b) Color: The Golden Gate Bridge''s color—and unofficially but aptly "International Orange"—was chosen specifically so that the bridge would stand out even amidst San Francisco''s famously common fog over the bay. It''s also a striking statement of design. The vividly colored bridge is both visual dramatic contrast with nature and strong visual signifier, in the unfolding of the bridge in the organization of the view over the bay, and as striking visual landmark. The color also has symbolism, paralleling the symbolic role of the bridge itself as an American industrial prowess, power, and artistry of the decade of the Great Depression.

(c) Symbolic and Cultural Value: The Golden Gate Bridge is not just a bridge but has become symbolic of San Francisco itself, maybe even the country. Its beauty, by itself, irrespective of it being a journey path, is symbolic of the feeling of progress, unity, and determination.

3. Impact and Legacy

The Golden Gate Bridge was one of the greatest engineering achievements of the 20th century. Its construction also influenced numerous other bridges around the world, and it is one of the world''s most photographed structures. It has also influenced numerous artists, architects, and designers who have sought to replicate its beauty and how it harmoniously coexists with nature.

6.4.2 Case study 2: Sydney Harbour Bridge (Australia)

1. Overview

Sydney Harbour Bridge, opened in 1932, is the most recognizable landmark in Australia. The bridge spans Sydney Harbour to connect Sydney''s central business district with the North Shore. Alternatively referred to as the "Coathanger" due to its form, the Sydney Harbour Bridge is a steel through arch bridge and one of the key parts of Sydney''s transport infrastructure.

2. Aesthetic considerations

(a) Form and Structure: The dramatic, arch-shaped appearance of Sydney Harbour Bridge is a symbol and part of Sydney city as much as its symbol is today. The choice of an arch was made on structural economy alone but also due to it being beautiful. The huge arch form over water lends the bridge its commanding and majestic presence. Symmetry of the forms and the smoothness of the arch lead to beauty easily adaptable in the environment.

(b) Materiality and Texture: The use of steel in the building of the Sydney Harbour Bridge provided the bridge with an industrial and contemporary look. The coarse texture of steel, coupled with its massive size, highlights the technological advancements of the time. The metallic grey hue of the bridge is distinctive but fitting to the environment and is a good contrast to it in its visibility in the skyline without being overwhelming to the eyes.

(c) Cultural Significance: Sydney Harbour Bridge has also been an expression of Australian national pride and technological advancement. It has not only symbolized the technological advancements of the 1930s, but as an expression of solidity and stability of the Australian nation. The bridge is actually the symbol of the city''s image, showing it to the world in terms of art and media, and as the centerpiece of the New Year''s Eve celebration annually when its fireworks illuminate the world.

3. Impact and Legacy

Sydney Harbour Bridge is globally renowned as an engineering feat and artistic marvel. Its style has been the cause of it being a nation symbol. Sydney identity embraces the bridge, and bridge architecture has continued to influence other great icon bridges the way functionality can birth enduring cultural icons.

6.4.3 Case study 3: The Millau Viaduct (France)

1. Overview

The Millau Viaduct, completed in 2004, is a cable-supported road bridge over the Tarn River in southern France. It is 343 meters (1,125 feet) tall and the tallest bridge in the world. It was designed by British architect Norman Foster and French engineer Michel Virlogeux. It was built to facilitate easier movement of traffic in the region more conveniently and simplify travel time over the mountain region.

2. Aesthetic Qualities

(a) Form and Structure: The Millau Viaduct is a modern bridge architecture. The tall, slender piers hold up a series of slender, aerodynamic cables that appear to float over the valley floor. The simple style of the bridge is so seamless within its natural context that it gets difficult to spot itself, far from fading in a visually noticed fashion although being the astounding and fascinating engineering wonder it stands for. The sheer proportions of the bridge are so attuned to evoke lightness as well as stability despite having dimensions gargantuan enough.

(b) Material and Texture: Concrete as a material for the bridge and tower deck allows for the structural soundness and sculptural beauty. The plain smooth lines of the concrete are offset by the riverine and hill-like ruggedness but are themselves part of the landscape''s beauty. The color of the concrete is chosen to blend in with the natural colors of the surroundings so that the bridge gets integrated into nature and does not overpower it.

(c) Cultural Significance: Millau Viaduct is not just a technologically advanced transportation route but also a monument to technological sophistication and humanenuity to merge with nature. Its raw beauty is a testament to the French culture''s love for beauty and aesthetics, and the bridge is a cultural symbol in the area. The construction of the bridge in the landscape changes the landscape in a manner that the land environment is now a tourist destination and pride of the people of the area.

3. Impact and Legacy

Millau Viaduct represents the pinnacle of bridge engineering during this age, the finest specimen of trailblazing engineering to provide us with a breathtaking structure that is well in tune with nature. It redefined bridge architecture parameters and shaped the shape of bridges for the world''s future. It established the benchmark of what can be achieved in terms of form and function.

6.4.4 Case study 4: Ponte Vecchio (Italy)

1. Description

Ponte Vecchio, constructed in the 14th century, is a medieval arched bridge on the Arno River in Florence, Italy. Ponte Vecchio stands out on the aspect that it has shops integrated into its construction, and thus it is one of the world''s most peculiar bridges to enable commerce. It is presently one of Florence''s most popular destinations with millions of tourists flocking yearly.

2. Aesthetic Factors

(a) Form and Architectural description in the past: Ponte Vecchio''s form is typical of medieval architecture because of the stone build and arches. Ponte Vecchio was never changed in form since it was from centuries ago, and the reason why it still remains as a shopping district even today is an indication of its human touch. The small stores to either side of Ponte Vecchio are also part of the overall appearance of the bridge, their plastered front and old-style type of work contributing to its appearance.

(b) Material and Color: Stone made, Ponte Vecchio assumes the look of the past and age and is incorporated into the old city building cityscape context of Florence. Worn with time, the color of the stone contributes to the old-time look of the bridge.

(c) Symbolism: Ponte Vecchio represents the history of Florence and historic balance of Florence with commerce and craftsmanship. Ponte Vecchio is also a symbol of cultural flowering of Florence where commerce, architecture, and art are integrated. Ponte Vecchio itself has also symbolized the city, the distinctive architecture being the reason why Florence is a cultural and historical center.

3. Impact and Legacy

Ponte Vecchio is the world''s most famous bridge and remains a significant cultural and historical icon. It illustrates how a bridge can be more than merely a functional transportation route but part of a city''s architecture and culture. Its enduring beauty as a work of art has impacted the design of other ancient bridges and remains a source of inspiration to architects and artists worldwide.

6.5 Cultural narratives through aesthetic choices

Not only are bridges utility structures designed, but also they carry deeper cultural, historical, and symbolic significance. Bridges can be utilized to tell tales, establish local identity, and form goals of societies and persons who build them when built. Whether pride in bridging gaps over geography, witness to past achievement, or acknowledgment of a city or nation''s dream for tomorrow, bridges will be willing to express themselves as signs of culture that invest meaning into society''s ideals and values.

As an aesthetic aspect of bridges, what the design says is a major consideration in choosing a representation of the socio-cultural environment. These bridges are physical connections across the landscape and symbolic connections to a society''s past, present, and future. Here, we look at the part played by cultural narratives in adding to the role of bridging design and how aesthetic factors contribute to adding to shaping cultural values, enhancing local identity, and managing the visual landscape for inhabitants and visitors.

6.5.1 The role of bridges in cultural identity

The appearance of a bridge can be an indication of the cultural and social nature of a place. From material construction as symbolic, through to why and how it was built, bridges may symbolize values, heritage, and the aspirations of the builder. For example, the old-fashioned stone bridges of yesteryear will symbolize strength and tradition, while cable-stayed or suspension bridges will symbolize technology advancement and sophistication. Bridges are no longer just roads for traveling—culturally, they are tangible forms of a place''s history, pride, and sense of place.

1. Materiality as Cultural Expression

The material chosen to build a bridge will most likely reflect an area''s cultural and technological heritage. Local materials can be used as a way of emphasizing an area''s sense of place, i.e., stone, brick, or wood for old bridges. Materials will gain a sense of place, confirming the building or agricultural past of an area. Contemporary bridge building using novel materials like steel, glass, and concrete, however, testifies to a new morality of embracing globalization and change. The Ponte Vecchio bridge of Florence, Italy, uses stone so that it can be built into the Renaissance buildings of the city to enable it to achieve continuity with the old buildings. The Millau Viaduct is found in France, and it makes use of steel and concrete to display a new face that is fitting for the country''s emphasis on technological progress and design excellence.

8. Scheme design and calculation of Zhaojiazhuang Midium bridge on Rongwu highway_第8部分　　总字数：8029

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2. Form and Structure as Local Symbols

Form and design of a bridge are also essential in symbolizing cultural narratives. Sydney Harbour Bridge arch forms, for instance, are not merely abutments to a bridge; they symbolize Australians'' strength and toughness. Curvy forms of Golden Gate Bridge in the same way symbolize American boldness and cleverness of 1930s engineering. Forms are addressing local group identity and become place character visual signs.

Other contemporary bridges such as the Millau Viaduct are minimalist structures in which beauty resides in aerodynamic, high-tech curves and flawless blending into the landscape. French concepts of art, perfection, and harmony with nature are included in visual attractiveness, and reassert regional cultural identity as one of human engineering imbued with beauty.

3. Iconography and Symbolism in Bridge Design

Bridges also represent wider cultural myths. The Golden Gate Bridge, for example, represents San Francisco and American grittiness. The bridge represents the city''s personality and the American values of grittiness, ingenuity, and advancement. The bridge also represented American grittiness, with red and scale representing the city''s personality as possessing the American values of grittiness, ingenuity, and advancement.

Similarly, China''s Shenzhen Bay Bridge is not just a signature infrastructural icon but also proof of China''s fast-tracked modernization and ascension to economic prominence. The design of the bridge represents the epitome of the nation''s aspiration to wed high technology and foliage in the context of urban planning in China''s future.

6.5.2 The history and tradition story in the design of bridges

Bridges are frequently designed with a sense of history, either by the use of historical themes in form or as memorial bridges to honor an historical event or a cultural milestone.

There are histories that bridges bear, connecting them to the history of an area, and reminding people of war, triumph, and accomplishment past.

1. Remembering Historical Events through Form

The construction of bridges also makes history, penning and rewriting the cultural evolution, strife, and victory of a people. The Gov. Mario M. Cuomo Bridge that took over from the Tappan Zee Bridge in New York was originally built to reduce the traffic jams in the New York City-suburban corridor. Although the bridge was not built to commemorate some historic occurrence, the fact that it was a real live bridging structure for the region and that it did operate to fulfill the function of contributing to economic and cultural growth only reinforced the reality that it would be an enduring image of the development of the region.

Similarly, the Brooklyn Bridge of New York City continues to stand as an example of technological ingenuity and desire in the late 19th century. It was the initial steel wire suspension bridge constructed and a testament to John A. Roebling''s brilliance as an architect. It is not only a crossing of the East River anymore; it''s also a symbol of American ingenuity, persistence, and the city''s rise to global prominence.

2. Preservation of Cultural Heritage in Bridge Construction.

Apart from reminding us of the past, bridges are a preservation technique of culture as well. Bridges such as the Ponte Vecchio in Florence with shops on one side and pedestrians walking through are typical of medieval days when commerce and cleanliness existed together. The bridge is still a cultural bridge of Florentine heritage and city identity.

Similarly, Scotland''s Forth Railway Bridge built in the latter half of the 19th century is both a cultural symbol and an engineering marvel. Its creation in cantilevered steel girders was an indicator of United Kingdom industrialization and has been a witness to Scotland''s industrial past.

6.5.3 Future expectations: Between tradition and modernity

Bridges do not get made in order to look back into the past; bridges are made to look ahead into the future. As cities around the world continue growing and growing, bridge design more and more involves looking to the future of technological progress, sustainability, and city living.

The elements of bridge design will be dreamscape visions for future design, for the environment, and for world-connectedness.

1. Future Design: Innovation and Sustainability

The Millau Viaduct itself stands as an outstanding example of design engineering as innovation and sustainability. As the world''s tallest bridge, its thin profile reduces its visual presence but enhances its structure. Not just the bridge is an engineering work of art in itself, but it is also an example that teaches us lessons on sustainability and thus a beacon of what to expect in bridge design in the future.

Similarly, Singapore''s Supertree Grove, not a bridge or a living being but an engineering concept of nature in the city, uses the most advanced technology and design to unite man-made construction and nature within the city. Interior space design within the Supertrees is carried out with the intention of symbolizing the dreamt future—the one in which natural and man-made systems have room and supplement each other in a symbiotic manner.

2. Symbolizing a Global Vision

Global city bridges are a vision of global interconnection. The Hong Kong- Zhuhai-Macau Bridge, for instance, is a symbol of China''s rising role in the world economy. Its existence is a symbol of a vision to collaborate between cities and states to pursue economic and cultural exchange and bridge a chain of lands once isolated by water.

For instance, China Danyang - Kunshan Grand Bridge is the world''s longest bridge, exemplifying China''s leadership in bridge construction as well as its encouragement to improve transportation infrastructure to help facilitate economic and social development throughout the country.

Reference

[1] Alexander, C. (1979). The timeless way of building. Oxford University Press.

[2] American Association of State Highway and Transportation Officials (AASHTO). (2012). AASHTO LRFD bridge design specifications (Units C, Ed. T).

[3] Brown, D. J. (1994). Bridges: Three thousand years of defying nature.

[4] Chen, W. F., & Duan, L. (2000). Bridge engineering handbook. CRC Press.

[5] Ching, F. D. K. (2014). Architecture: Form, space, and order (4th ed.). John Wiley and Sons.

[6] Federal Highway Administration (FHWA). (2012). Bridge design manual. U.S. Department of Transportation.

[7] Frampton, K. (1983). Towards a critical regionalism: Six points for an architecture of resistance. In H. Foster (Ed.), The anti-aesthetic: Essays on postmodern culture (1998 ed.). The New Press.

[8] Habraken, N. J. (1998). The structure of the ordinary: Form and control in the built environment (J. Teicher, Ed.). MIT Press.

[9] Ingold, T. (2021). The perception of the environment: Essays on livelihood, dwelling and skill. Routledge.

[10] Jencks, C. (2005). The iconic building: The power of enigma. Frances Lincoln.

[11] Kostof, S. (1991). The city shaped: Urban patterns and meanings through history. Thames & Hudson.

[12] Leonhardt, F. (1968). Aesthetics of bridge design. PCI Journal.

[13] Ministry of Housing and Urban-Rural Development of the People' s Republic of China. (2018). Code for seismic design of buildings (GB 50011-2010) (2016 edition).

[14] Ministry of Transport of the People''s Republic of China. (2011). Specifications for geological survey for highway engineering (JTJ C20-2011).

[15] Ministry of Transport of the People''s Republic of China. (2011). Technical specifications for concrete structures of highway bridges and culverts (JTG/TF50-2011).

[16] Ministry of Transport of the People''s Republic of China. (2013). Seismic code for highway engineering (JTG B02-2013).

[17] Ministry of Transport of the People''s Republic of China. (2014). Technical standards for highway engineering (JTG B01-2014).

[18] Ministry of Transport of the People''s Republic of China. (2015). General specifications for highway bridge and culvert design (JTG D60-2015).

[19] Ministry of Transport of the People''s Republic of China. (2015). Highway engineering hydrological survey design specification (JTG C30-2015).

[20] Ministry of Transport of the People' s Republic of China. (2018). Specifications for highway reinforced concrete and prestressed concrete bridge and culvert design (JTG 3362-2018).

[21] Ministry of Transport of the People' s Republic of China. (2018). Highway survey specification (JTG C10-2018).

[22] Ministry of Transport of the People' s Republic of China. (2019). Highway engineering concrete structure corrosion protection technical specification (JTG/T3310-2019).

[23] Moughtin, C. (2003). Urban design: Street and square. Architectural Press.

[24] People''s Communications Press. (1998). Highway bridge and culvert design manual - Beam bridge (Volume 1).

[25] Petroski, H. (1997). Design paradigms: Case histories of error and judgment in engineering.

[26] Powell, K. (1999). Architecture reborn: Converting old buildings for new uses. Rizzoli International Publications.

[27] Rapoport, A. (1990). The meaning of the built environment: A nonverbal communication approach. Sage Publications.

[28] Tuan, Y. F. (1977). Space and place: The perspective of experience. University of Minnesota Press.

[29] Ye, J. (Ed.). (2020). Principles of structural design. People' s Communications Press.

[30] Yi, J. (Ed.). (2020). Bridge calculation example series - Concrete simply supported beam (slab) bridge. People' s Communications Press.

[31] Yuan, L., & Bao, W. (Eds.). (2005). Application examples of the provisions of highway reinforced concrete and prestressed concrete bridge and culvert design specification (JTG D62-2004). People' s Communications Press.

[32] Zhou, J., & Sedon, M. F. (2025). A sense of place: Reinterpreting cultural identity of modern bridges

in Yangzhou through printmaking. ResearchGate.

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