

Wallis Annenberg Wildlife Crossing, Agoura Hills, California

by Robert Rock, Rock Design Associates, and Paul Chung, California Department of Transportation

The Wallis Annenberg Wildlife Crossing is the largest wildlife crossing bridge structure in the world. It provides safe and sustainable passage for wildlife across California State Highway U.S. Route 101 (U.S. 101), reducing the potential for collisions and wildlife mortalities on one of the busiest freeways in the United States. Functioning as an ecological stitch that connects fragmented landscapes, the crossing enables natural movement for California mountain lions and other animals that call the Santa Monica Mountains home, thereby playing a crucial role in maintaining regional biodiversity.

The project was constructed by the California Department of Transportation (Caltrans) in partnership with the Mountain Recreation and Conservation Authority (MRCA), the Santa Monica Mountains National Recreation Area, Rock Design Associates LLC, and the National Wildlife Federation. It crosses U.S. 101 west of Liberty Canyon Road in the city of Agoura Hills in Los Angeles County and connects lands owned and managed by MRCA.

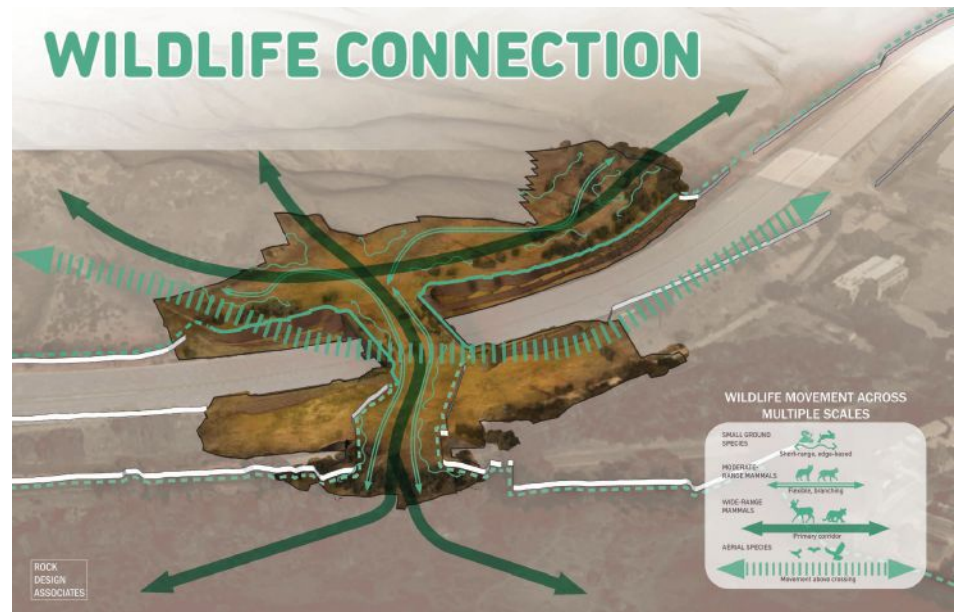
The primary wildlife crossing structure over U.S. 101 is 250 ft long and 174 ft

wide. This two-span vegetated structure crosses 10 lanes of the freeway, carrying more than 6000 yd³ of soil and stone that support the living layer on top. It features a landscape planted exclusively with native plants, offering animals a secure and familiar environment as they move through this open space.

Accelerated Bridge Construction

U.S. 101 is a heavily traveled freeway connecting the California Central Coast to Los Angeles and the Southern California region. Throughout the design and construction process for the wildlife crossing, the project delivery team was

The projected movements of various types of wildlife across the Wallis Annenberg Wildlife Crossing. Figure: Rock Design Associates.



profile

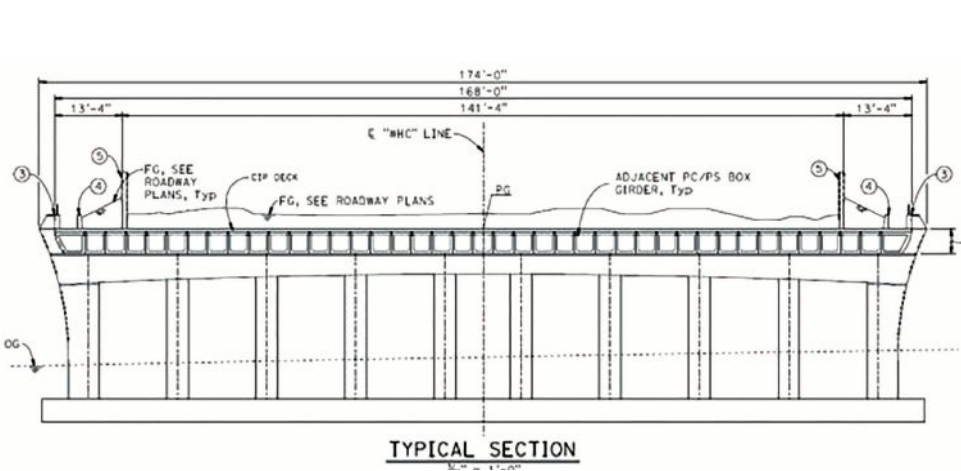
WALLIS ANNENBERG WILDLIFE CROSSING / AGOURA HILLS, CALIFORNIA

BRIDGE DESIGN ENGINEER: California Department of Transportation, Diamond Bar, Calif.

PROJECT DESIGNERS: Lead designer: Rock Design Associates LLC, Chicago, Ill.; project engineer: O'Donna Blackstock, PE, Los Angeles, Calif.

PRIME CONTRACTOR: C.A. Rasmussen, Valencia, Calif.

PRECASTER: Coreslab Structures, Perris, Calif. —a PCI-certified producer

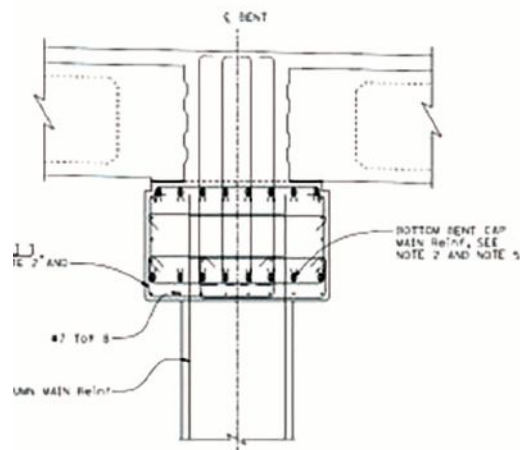


Typical section of the bridge. Note the curved outer surface of the exterior box girders. Figure: California Department of Transportation.

keenly aware of the need to minimize inconvenience for the traveling public. They sought a design that would incorporate bridge construction details and methods that would yield minimal disruption to traffic in both directions.

To accomplish that goal, the design team selected an accelerated bridge construction strategy and specified precast concrete box girders in the design of the superstructure to enable a focused and streamlined on-site construction effort. To further reduce

traffic impacts, the project team specified one-way closures during overnight hours, when traffic volumes were at their lowest. Because precast concrete box girders and a cast-in-place concrete topping slab were used to form the deck, workers could place the 4-ft 10-in.-deep superstructure directly atop the abutments while maintaining a minimum vertical clearance of 16 ft 10 in. Using the precast concrete box girders eliminated the need for the extensive falsework and protection systems typically required with an all-cast-in-place approach.



Reinforcement details of the cast-in-place concrete bent cap. Figure: California Department of Transportation.

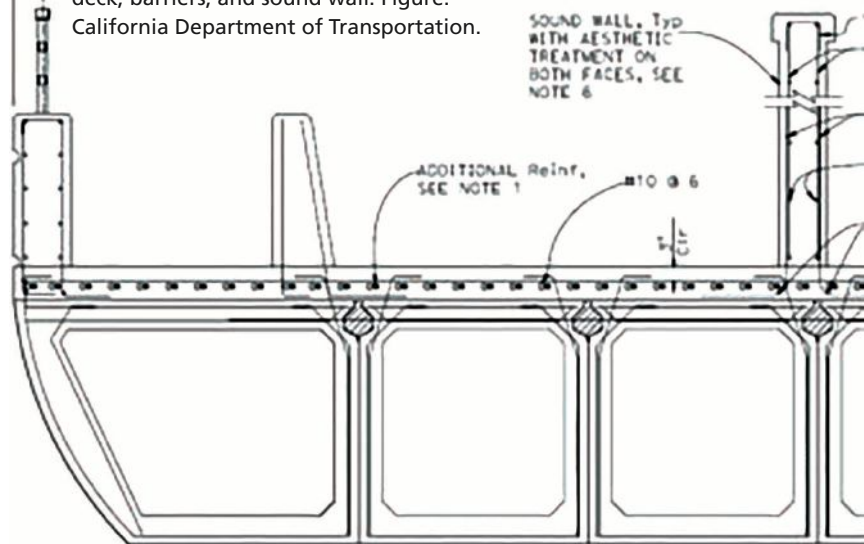
Bridge Design

The superstructure has eighty-two 4-ft 3-in.-deep, 103-ft-long precast, prestressed concrete box girders positioned side by side and topped with a 7-in.-thick cast-in-place concrete deck. Adjacent girders are connected by keyways with projecting bars; no post-tensioning is used. Each box girder is designed with an initial concrete compressive strength of 5500 psi and a final concrete compressive strength of 7000 psi.

Supported by diaphragm abutments and a multicolumn bent in the freeway median, the superstructure girders are integrally connected in the transverse direction by closure placements in a key filled with high-strength, nonshrink concrete grout and the cast-in-place concrete deck and diaphragm. The girders are made continuous in the longitudinal direction through connection by cast-in-place diaphragms at the bent cap and the cast-in-place deck.

The cast-in-place reinforced concrete bent is composed of a transverse drop cap that provides a seat to support the precast concrete girders, with 4-ft 3-in.-square reinforced concrete columns anchored on spread footings. The diaphragm abutments located at

Partial bridge cross section showing some of the reinforcement for the cast-in-place deck, barriers, and sound wall. Figure: California Department of Transportation.



CALIFORNIA DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Two-span, 250-ft-long, 174-ft-wide precast, prestressed concrete box-girder wildlife crossing with cast-in-place concrete bent, columns, and abutments

STRUCTURAL COMPONENTS: Eighty-two 4-ft 3-in.-deep, 103-ft-long precast, prestressed box girders; 7-in. cast-in-place concrete deck; cast-in-place reinforced concrete bent and diaphragm abutments; 4-ft 3-in.-square cast-in-place concrete columns

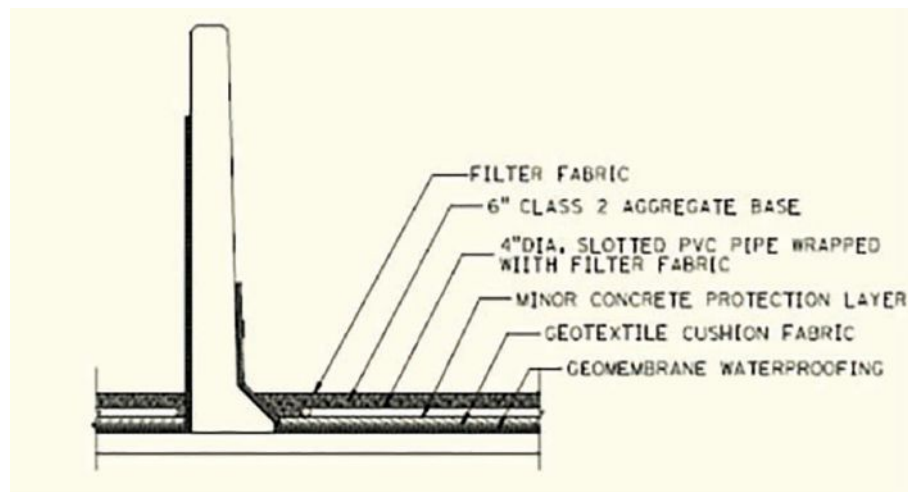
BRIDGE CONSTRUCTION COST: Approximately \$114 million

AWARDS: 50 Most Influential Projects of 2022 by the Project Management Institute; San Fernando Valley Audubon Society 2026 Conservation Award

both ends of the bridge are designed to resist lateral forces and enhance the bridge's stability. Lateral forces include earth pressure from the soil behind the abutment and seismic lateral forces. These abutments are supported on spread footings, the construction of which was complicated by intense rainfall events early in the project.

Design Loads

The design of the superstructure, substructure, and foundation accounts for the dead load of the deck protection materials, vegetation, and soil. Whereas the designs of freeway bridge structures are typically governed by the live load associated with highway traffic, the controlling load in this case is the dead load of the vegetative layer on top of the structure. The unfactored dead load from the engineered soil included a maximum of 2 ft 11 in. of expanded shale at 97 lb/ft³, a maximum of 2 ft of horticultural saturated soil at 120 lb/ft³, and a maximum of 10 in. of Class 1 permeable material at 120 lb/ft³. The design live load uses an HL-93 truck load to account for incidental truck movement for maintenance and emergency activities after the bridge is completed. Seismic design for the structure uses a mean earthquake magnitude of 6.71 and a



The bridge deck and the roadway below are protected by multiple layers, which are also designed to permit drainage. Figure: California Department of Transportation.

design peak ground acceleration of 0.39g. No nonstandard features are required to resist the seismic loads because the design peak ground acceleration is not high.

Deck Layout and Landscape Buffers

The width of the bridge deck accommodates three distinct functional areas. The central deck area serves as the natural habitat for wildlife crossing over the freeway, and each side is bordered by an 11-ft-tall, exterior cast-

in-place concrete sound wall in addition to a robustly vegetated buffer landscape. The sound walls and vegetated buffer landscapes serve as a protective barrier for wildlife traversing the structure by reducing the impact of vehicle noise and artificial lights from the traffic below. The central deck area is overlaid with between 1 and 4 ft of engineered soil to create artificial topography, provide drainage, and support native vegetation. This area contributes to habitat restoration and features indigenous coastal sage scrub plants. The vegetated



AESTHETICS COMMENTARY

by Frederick Gottemoeller

When designing a wildlife crossing, designers typically must hide the artificiality of the crossing from its wildlife users. The Wallis Annenberg Wildlife Crossing posed this design challenge to an extreme degree since the wildlife corridor that crosses U.S. Route 101 and Agoura Road is an entire watershed with flowing and intermittent creeks. This crossing project specifically required complex and innovative design solutions to address two separate areas of concern: First, the water and drainage under the watershed topography that forms the wildlife corridor itself have to be controlled. Second, the crossing—which is carried over the highway and secondary road on two separate structures with a total 125 ft of vertical grade separation from end to end of the watershed—requires sound and visual barriers to separate the natural and highway environments.

The construction that controls water and drainage is all buried and is not a topic for aesthetic discussion. However, the barrier design is aesthetically important. From the wildlife side, the structural edges of the crossing structures themselves need to look just like the rest of the watershed topography. From the highway side, the edges need to look attractive to vehicle occupants and must evoke some recognition of the function of the whole project. This aspect of the crossing design affects road users' reaction to the project itself and will influence public support for future projects of this type.

First, let's consider what the wildlife sees. The central deck area serves as the natural habitat for animals crossing over the freeway, and each side is bordered by robustly vegetated buffer

landscape ending at a concrete sound wall. So, the wildlife should be happy.

Second, let's consider what highway users see. They see the other side of the concrete sound wall, which is fronted by 10 ft of sloped earth on which vegetation is grown to soften the appearance of the wall. Then they see the rounded edge of the first box girder, a concrete parapet wall, and fence support that hides a narrow maintenance walkway. Finally, they see that the soffit of the multicolumn median bent has a slight upward arch, further evoking the mountain landscape. In a quick glance, they take in all rounded surfaces and vegetation recalling the natural environment being carried overhead. That should impress the highway users, reassuring them that their highway dollars are being put to good use.

It seems to me that both the wildlife and the highway users are going to like what they see, and both animals and humans will feel that the Wallis Annenberg Wildlife Crossing is a natural component of their two very different environments.



The first precast concrete girder is placed. Shoring is used for girder support until the bent caps and girders are connected through the cast-in-place concrete keys and placements. Photo: California Department of Transportation.



Construction on the precast concrete girders continues. Photo: California Department of Transportation.



Construction of the cast-in-place concrete sound wall. Photo: California Department of Transportation.



Between 1 and 4 ft of engineered soil creates artificial topography, provides drainage, and supports native vegetation. Photo: California Department of Transportation.

buffer landscapes outside the concrete sound walls also allow for secure access by personnel, facilitating routine inspections and future maintenance of the bridge.

Deck Protection and Drainage System

The bridge deck is safeguarded with multiple protective layers that serve distinct functions in maintaining the deck's integrity and supporting green infrastructure. Starting from the bottom of the profile and working up, a preformed layer of geomembrane waterproofing creates a seamless barrier across the deck surface, preventing water from penetrating into the structural components. This protection is essential to preserve the bridge deck and minimize the potential impact of water on the freeway below. The waterproofing membrane is topped with a layer of geotextile cushion and filter fabric, which is covered by 3 in. of general purpose concrete and 6 in. of Class 2 aggregate base to form the base filtration layers. These layers of fabric and aggregate are designed to permit water to flow through while reducing the potential for soil particles to reach the drainage

system so that drainage atop the bridge deck is consistent.

A perforated polyvinyl chloride pipe drainage system is also incorporated into this profile to efficiently channel water away from the deck, working in tandem with the filter fabric to preserve the deck's structure and functionality. In the first stage of the project, the perforated pipes were tied into a manifold on the north side of the freeway and routed to the storm sewer. As the project's second stage is completed, this connection will be rerouted so that the manifold is disconnected from the storm sewer and allowed to drain into the adjacent landscape. This connection will feed a new ephemeral creek corridor connected to Liberty Canyon Creek, which will facilitate beneficial hydrology and support wildlife movement.

Soil Profile and Hydrology

The design team developed the soil profile to mimic the natural profile on either side of the crossing structure. The engineered soil profile—which is intended to provide essential nutrients while also ensuring proper drainage to enable healthy vegetation growth

on the bridge deck—consists of a series of soil layers that facilitate drainage, host beneficial fungi and other soil microorganisms, and support the vegetated surface. The modest topography atop the bridge is designed to channel positive surface flow during storm events into the new ephemeral creek corridor, tying into the restored hydrology north of the freeway. By supporting plant life, the growing media contributes to the long-term sustainability of the bridge's green infrastructure, enhancing both its environmental benefits and aesthetic appeal.

Aesthetic Design

A project of this scale requires a combination of engineering, science, and artistry. The design team took care to ensure that the design aesthetic was both striking and humble, with subtle design features that allow the wildlife crossing to be immediately recognizable while also blending into the landscape.

The exterior faces of the precast concrete box girders have gently curved surfaces, which were a challenge during



Precast concrete girders in the precast concrete manufacturer's yard. Photo: Coreslab Structures.

reassembly and disassembly limited the available installation time.

The scope of work for stage 2, which is currently underway, includes the vegetated wildlife crossing structure over Agoura Road, relocation of utility lines, earthwork, and restoration of wildlife habitat adjacent to U.S. 101 and Agoura Road. The earthwork operations for the 13-acre site require

the movement of more than 3 million ft³ of earthwork to restore a site with approximately 125 ft of grade change from north to south. 

Robert Rock is president and CEO at Rock Design Associates LLC in Chicago, Ill. Paul Chung is assistant chief of the Division of Program/Project Management for District 7 at the California Department of Transportation in Los Angeles.

The Importance of Color

An engineered wildlife crossing must blend into the existing landscape. Therefore, the design team for this project asked the precast concrete bridge producer to achieve a specific brown color for all the elements of the bridge structure. Typical mixture proportions specifying color have 5 to 10 lb of colorant per cubic yard of concrete. This small amount of colorant does not significantly affect the fresh concrete properties, and adjustments are not typically made to the anticipated concrete properties for quality control purposes.

For this project, to achieve the required brown color, the amount of colorant added was 54.45 lb/yd³, which is slightly over 2 lb/ft³. In the final mixture, the additional colorant changed the unit weight of the concrete by 1.5 lb/ft³, which is close to the allowable variation of 2 lb/ft³ stated in PCI quality control documents.

Quality control personnel noticed this variation. The precast concrete fabricator adjusted the unit weight calculation to include the colorant, which then gave the correct unit weight for the concrete. None of the other concrete properties were affected.

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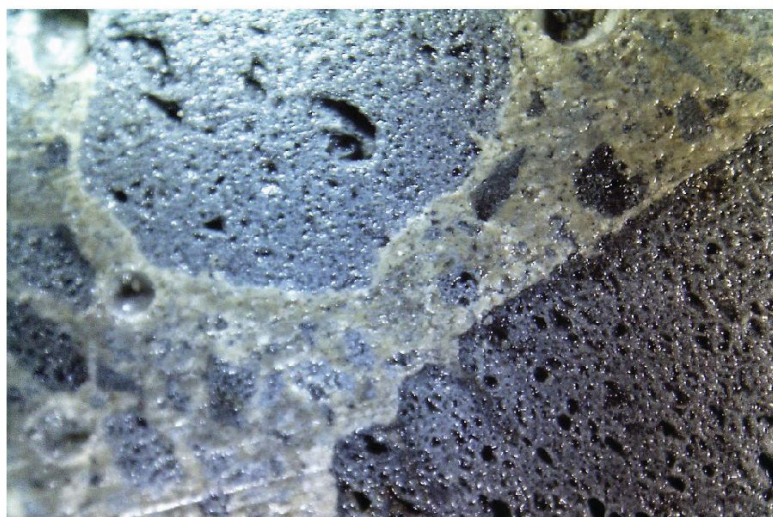
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