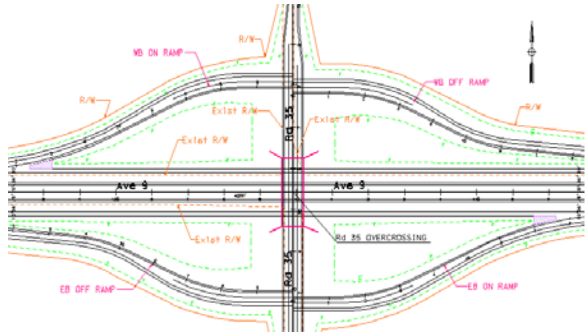
MOO-VING ON!

An interchange assists with improving traffic patterns and rerouting traffic that Fresno and Madera counties currently experience. The Fresno County Transportation Authority (FCTA) has partnered with Loyalty Engineering Consultants for the analysis of alternatives, and design of a new Cross Town Freeway. The new freeway will connect Northeast and Northwest sides of Fresno and Madera at State Route (SR) 99 and SR-168.

Therefore, the interchange at Road 35 and Avenue 9 will help facilitate traffic and ensure that traffic movements are safer and more efficient.

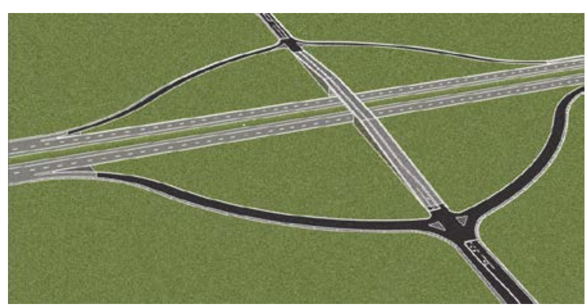
The interchange at Road 35 and Avenue 9 will be a L-2 Spread Diamond Interchange as it allows for the addition of loop ramps in the future. The lane widths will be standard 12 feet lanes per the Highway Design Manual. The appropriate median shoulder width on a 4-lane freeway is 5 feet. With superelevation rates less than or equal to 3%, the shoulder cross slope should be 5% on the outside or greater. A left shoulder cross slope of 2% is considered away from the traveled way and 5% is considered for the right shoulder away from the traveled way. The existing and proposed right of way is indicated in Avenue 9 and Road 35 layout drawing. The interchange is as shown.



Ave. 9 and Rd. 35 Interchange Layout

The right-of-way width for urban freeways is usually 240 to 260 feet. In order to section off access control, the area should be fenced. The cost estimates for all components described above are provided in the cost estimates. A median is placed to separate the opposing lanes of traffic. A median of 46 feet was selected for the interchange. The embankment side slope is considered as 4:1 or flatter. The cross slope is considered as 10:1 or flatter in the median. For the freeway, the vertical clearance is 16.5 feet is considered over the roadbed.

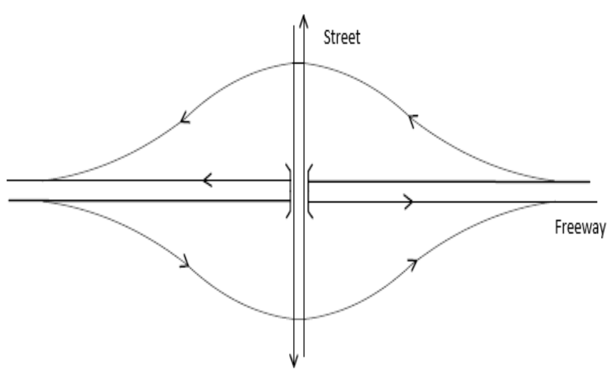
Continuously reinforced concrete pavement (CRCP) will be used as it requires little to no maintenance over its service life. CRCP is a unique type of rigid pavement.



View of Interchange With Overcrossing

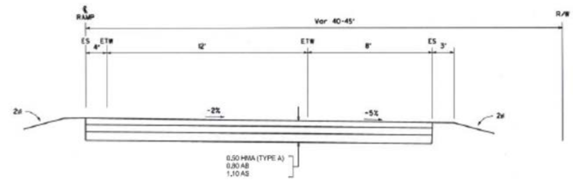
With the growing congestion of traffic in northern City of Fresno and Clovis, an efficient way of travel is needed for vehicles wanting to travel east and west. To do this, a Crosstown freeway was proposed to be designed. One part of the freeway is an interchange at existing Road 35 and Avenue 9. This interchange will serve as a link from northern City of Fresno to the Crosstown Freeway and is a vital freeway to local street interchange.

The interchange at this location will be a type L-2. This will best serve the traffic needs for this interchange and will be the most efficient. The lane widths will be 12 feet. This will include 4-8 feet shoulders and 3 feet of shoulder backing. The embankment will have a 2:1 or flatter slope.



Typical Design of an L-2 interchange

A traffic index of 10 was selected. Hot mix asphalt (Type A) will be used as pavement, aggregate base-class 2 with an R-value of 78 will be used as base and aggregate subbase-class 2 with an R-value of 50 will be used as subbase. The thicknesses of the HMA, AB and AS will be 0.50 feet, 0.80 feet and 1.10 feet respectively.



Ramps Typical Cross Section

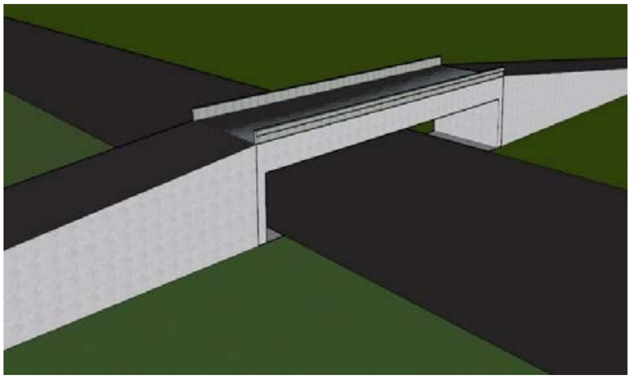
Like most infrastructure projects, the Crosstown Freeway is a large undertaking. It will intersect numerous roads, rail lines, utilities, and much more. It is to be a 4-lane freeway.

One significant intersecting road is Road 35 in Madera that currently intersects with the existing alignment of Avenue 9, which will be converted into much of the new Crosstown Freeway.

Location of Road 35 Overcrossing

With this in mind, Road 35 requires a bridge that will travel over the new Crosstown Freeway (Avenue 9) in Madera. This type of bridge is known as an overcrossing and will allow residents of Madera to continue to utilize Road 35.

The Road 35 Overcrossing will be 150 feet in length and 40 feet in width. It will travel above the new freeway. The bridge will have a height of 16.5 feet above the freeway below.

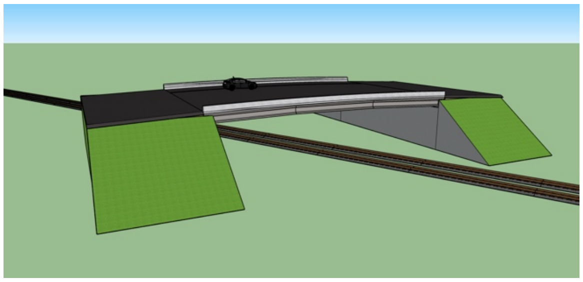


Road 35 Overcrossing at Avenue 9

Innovative new types of sustainable construction materials are being considered, particularly Rubberized Hot Mix Asphalt. This is a newer pavement type that incorporates recycled rubber from used tires into traditional asphalt. It reduces the number of used tires that end up in landfills, helping the environment. Barriers will be included on each edge of the overcrossing for safety.

Loyalty Engineering is confident that local residents will enjoy the new freeway for generations to come, and the added convenience that will result due to the construction of the new overcrossing.

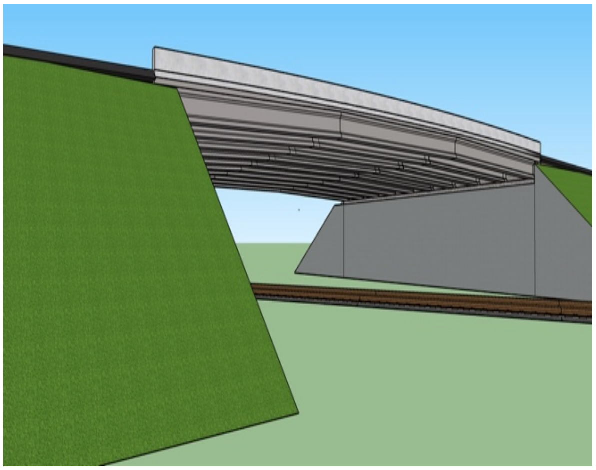
About 0.6 miles east of SR-99, where the freeway will take over the existing Avenue 9 alignment, the country's largest single rail transportation project will intersect the proposed freeway. This high-scale railway project is the well-known High-Speed Rail (HSR). Therefore, a bridge will need to be designed to allow for the proposed freeway to cross the HSR with minimal interferences for either agency. In specifics, an overhead structure will be designed allowing a roadway to cross over the railway.



View of Overhead Structure

The bridge will be designed for the 4-lane freeway, which will have a width of 114 feet.

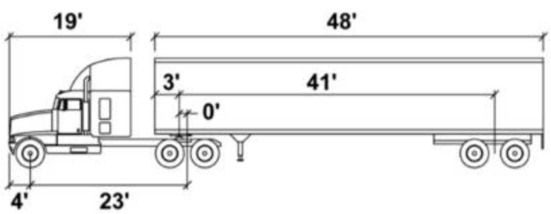
The structure will span a total length of 150 feet. The structure will have a minimum vertical clearance of 27 feet, which is a standard set by the HSR authority. Due to the span of the structure, wide-flange girders (e.g., I-beam) will be used as the structural sections to support the loads.



View of Bridge Girders

Apart from being able to support the structure's self-weight, the freeway will be designed to support the high truck volume, which is usually produced from a freeway.

The design vehicle to be used for analysis will be a STAA truck. An example of an STAA design truck is shown below.

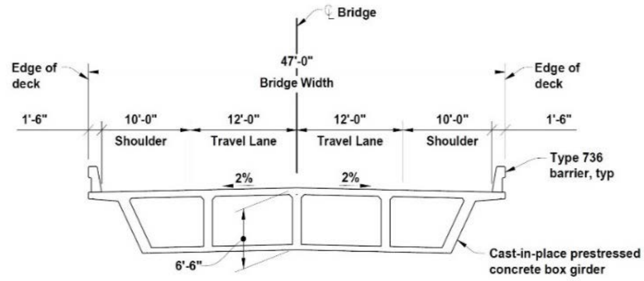


STAA Design Truck

When this structure is completed, traffic utilizing the new Crosstown Freeway will have a great view of the HSR zooming under them!

Two overhead structures will be provided, one for eastbound traffic and one for westbound traffic to cross the BNSF railway. The two structures will be identical to each other to simplify the design. These structures have been designed to meet the standards of both the California Department of Transportation (Caltrans) and the American Association of State Highway Transportation Officials (AASHTO). Cast-in-place prestressed reinforced concrete box girders were determined to be the most economical and preferred option for these structures.

Each overhead has a total width of 47 feet from edge of deck to edge of deck. Each structure will accommodate two 12-foot travel lanes, two 10-foot shoulders and two 1 foot and 6-inch wide barriers. A typical section of the overhead can be seen below.



Typical Section of BNSF Overhead

Both structures have been designed to be single span bridges. The reason for using a single span bridge rather than a multi-span bridge is to prevent the possible collision of a derailed train impacting a supporting column. To safely clear the railroad, a span of 140 feet was determined to be necessary. Each bridge will be supported by abutments at either end.

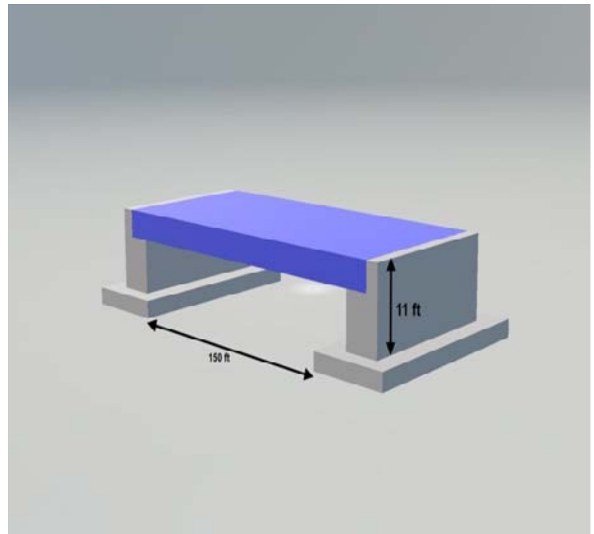
This design focuses on the foundation work for the Burlington Northern Santa Fe (BNSF) Railroad overhead as well as the Road 35 Overcrossing. The foundation includes abutments, piles, and soil slope.

The main design involves determining the abutment dimensions required in the soil provided. A quick run-through of the design includes checking against external stability as well as seismic loading. The external stability checks include overturning which ensures that the abutments will not topple over especially while the load from the freeway is being applied off-center. Another external stability check is sliding which ensures that the foundation doesn't move in the soil when the load is being applied. In addition, this design includes reinforcing the concrete that the abutment is made from as well determining the slope that the fill will follow.

One of the key components in this design is the type of soil that is being used. In the Central Valley, the water table is very low which means that the soil has very low saturation and will require very little treatment once excavated. Also, the soil reported to be in this area is silty sandy gravel. This means the soil has very low cohesion (how well it sticks together) which allows this soil to be good for recycling as backfill which will allow for optimum draining.

This is great soil to use for this project because it will reduce the cost of the project in many ways which will in turn reduce the cost for the tax payers. Public funds are limited when it comes to spending on infrastructure, therefore this is a good thing. This will reduce the cost first by using the same soil for cut and fill instead of paying to import the soil. Another way this will reduce the cost is by increasing the drainage which will reduce damage to the structure over time which will reduce the maintenance cost in later years.

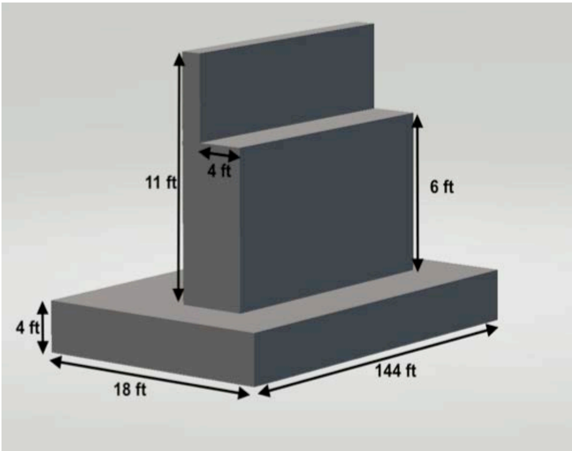
Strong foundation was designed to support the abutments of the overhead bridge. The design was influenced by the findings in the geotechnical report about the properties of the soil. The analysis of the column loads as well as the nature of the infrastructure below the bridge led to a conclusion that the bridge should be supported by two abutments at both ends. An isometric drawing of the bridge is as shown in the following column.



Isometric of the bridge

The bridge is designed to last close to 100 years. The design of the foundation entails the slope stability, abutments. To develop a steep and safer slope, the project team ensured the slope stability by reinforcing the sloped soil. The abutments are made using ultrahigh-performance concrete which requires little maintenance, and it lasts for long. Also, this type of concrete can withstand a load of more than 30,000 psi. This makes it suitable for the required durable base.

The abutments were first designed to minimize the total settlement of the structure. The allowable bearing capacity of the abutments was determined together with the appropriate factor of safety soon after the abutment dimensions were determined. Soil from the site was reused to in the backfill. The slope stability was ensured by reinforcing the sloped soil; this facilitated the development of a safer slope.



Abutment side view

From the calculations, it was evident that the abutments have the required bearing capacity to enable them to withstand the loads from the structure. The design of the foundations will comply with the required standards of California Building Code (CBC) as well as the American Concrete Institute (ACI). The major design attention for the grading plan was to construct the most appropriate elevations and slopes for the finished ground surface such that water is allowed to flow freely into the available drainage structures. Thus, the stormwater drainage design is based on the grading plan. The eventual ground elevations are determined based on the available topographical data as well as the slopes on the site.

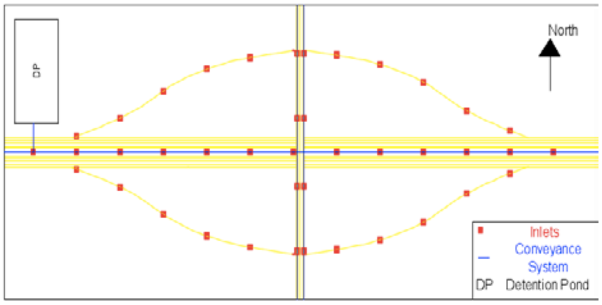
The City of Fresno is the 6th largest city in California. It is home to agriculture, professional sport teams, universities and colleges, and over 500,000 people. In relation, the road and freeways in Fresno experience this congestion from the large population and it results as an inconvenience for the citizens traveling to their destinations. This Crosstown Freeway will alleviate the traffic and provide access to many of the destinations along Northern Fresno to give the citizens of Fresno a enhanced experience when on the road.

To provide adequate safety of the travelers along the freeway, it is necessary that there is an efficient stormwater management system to limit flooding along the freeway, most importantly, reducing the risk of vehicles hydroplaning on the freeway. The system will include three components: collection system, conveyance system, storage facility.

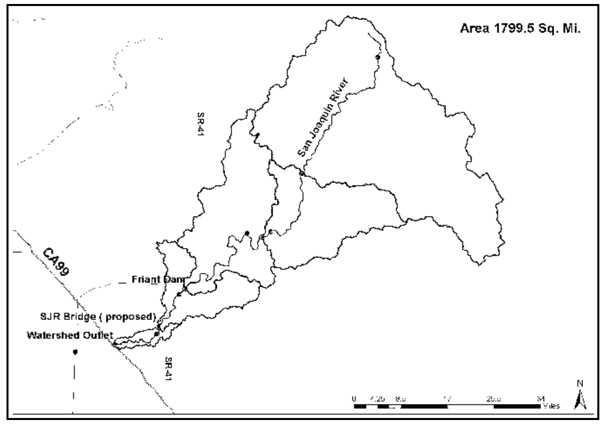
The collection system consists on drainage inlets that will collect rainfall. The conveyance system will connect the drainage inlets by use of pipes, channels, and gutters. Infiltration ditches will be used for the channels over rock-lined channels.

The storage facility will be the destination for the water that will be collected on the freeway. It will serve as a detention pond to store the runoff from a storm, as well as, a percolation pond that will recharge the water table. The detention pond will complement the water table overdraft in the Central Valley. It will be lined with rock, acting as a filtration device the will increase the water quality of the stormwater as it percolates into the ground.

The goal of the Cross Town freeway is to decrease time spent traveling through traffic and alleviate the backlog of traffic on local roads. As we only have one planet, it is important to also ensure that the newly built infrastructure is as sustainable as possible.



Interchange at Access Road 35



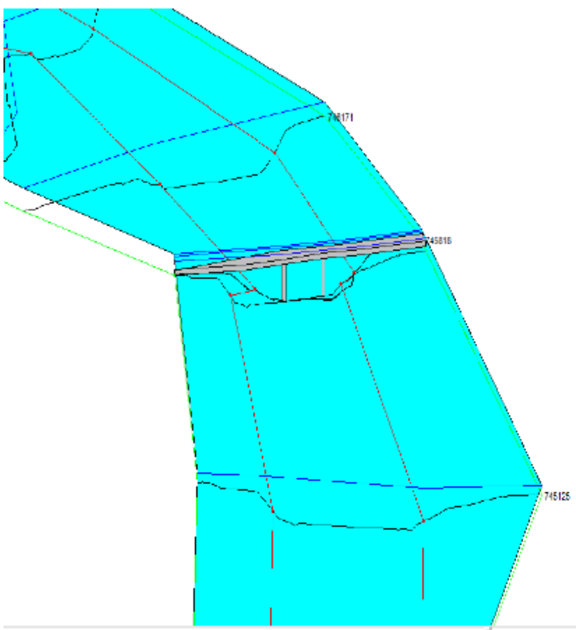
Watershed Delineation

Water discharge or streamflow through particular point on a main water stream for a specific weather event is sometimes complicated to determine. For instant, the proposed freeway bridge crossing San Joaquin River is not flooded when subjected to 100-yr flood event which is considered as an extreme weather condition, and less chance to happen statistically. It is no better way than create a model that is able to simulate the final result after simultaneously processing through multiple constrains, conditions as well as statistical calculations. The hydrograph generated from the model, as a result, will show the rate of flow (discharge) versus time pass through a point on the river where the bridge is proposed to be built.

The model development starts with actual hydrology data collection. The information from Digital Elevation Model (DEM) for the area will be interpreted using Geographical Information System (GIS) software such as ArcGIS in extracting contour map. Furthermore, the watershed boundary will be delineated corresponding to its unique outlet of interest, section under the bridge. One outlet of interest should only have one relative watershed or catchment where water from precipitation will drain to that outlet point. The watershed then is divided into multiple smaller sub-basins. Each sub-basin serves only one sub-outlet within the mother watershed. The main watershed and sub-basins have same function. Chopping them off will benefit the analysis and calculation for more accurate. The model now also is composed from other smaller components, and they are connected by a mainstream or reach. Knowing nature is not uniform in term of soil type, land cover, or flow type will make it more important to do the classification. Another consideration to do so is that to make sub-outlet as close as possible to the real stream gauge that was pre-installed at the stream section. Basically, the measurement from actual gauge is the best reference, the best calibration for conformance of the model. The reliable model will express the best fit result to the actual data.

The model after calibrating will be used to generate discharge hydrograph for different weather event. It also can be used for other hydrology as well as environmental studies in the area. Within the watershed that has been captured by the model, changes of downstream conditions due to physical changes of upstream can be foreseen and addressed accordingly.

A floodplain analysis is essential due to the fact that a new bridge overpass will be added to the floodway of the river (a Bridge Pier). This will cause water levels to rise more than they previously did during a storm incident. Therefore, a computer-generated model with the overpass added to the river floodway was created using HEC-RAS.



The most important study is the event of a 100-year flood. The 100-yr flood is a flood event that has a 1% chance of occurring in any given year. After obtaining the flowrate data for the area of interest it was found that the 100-yr flood is 60K cubic feet per second.

From the generated model by HEC-RAS we know how high the water will rise in the river's floodway with different flowrates. The analysis indicated that the water will rise to 277 ft east of the bridge, and up to 274 ft West of the bridge. These values are very important for the Loyalty Engineering structural design team. Knowing how high the water will rise is needed for the structural design calculations for the bridge overpass on the San Joaquin River.

River flooding leads to many environmental problems for the areas surrounding the River. Studies have indicated that floodwater is usually more polluted than river water. Therefore, understanding how to manage flood zones such as this through modeling is very important.

The Crosstown Freeway project will be a tremendous advantage for Fresno occupants by lessening the travel time from the west to east segments of town. This freeway area will begin from State Route (SR) 99 and terminate at SR 168. It will travel through Avenue 9 and Copper Avenue.

A project of this magnitude requires the cooperation of multiple engineers with different specializations such as water and environmental, structural, transportation, and geotechnical engineers. Therefore, this company is supplying the best service possible with the most efficient design. These structures will provide the most beneficial mode of transportation across the counties of Madera and Fresno.

Loyalty Engineering Consultant Design Team
(Left to right, top to bottom) - Debanjan Sarkar PM, EIT; Jennifer Proctor- Secretary; Tahrima Alam; Rajandeep Johal; Ammar Sabahi; Andrew Flores; Thien Truong, EIT; Ahmed Alsadan; Arahman Alshebl; Isidro Perez, EIT; Matthew Weaver, EIT.