V SLAB HELP SYSTEM

V SLAB - GENERAL

OVERVIEW

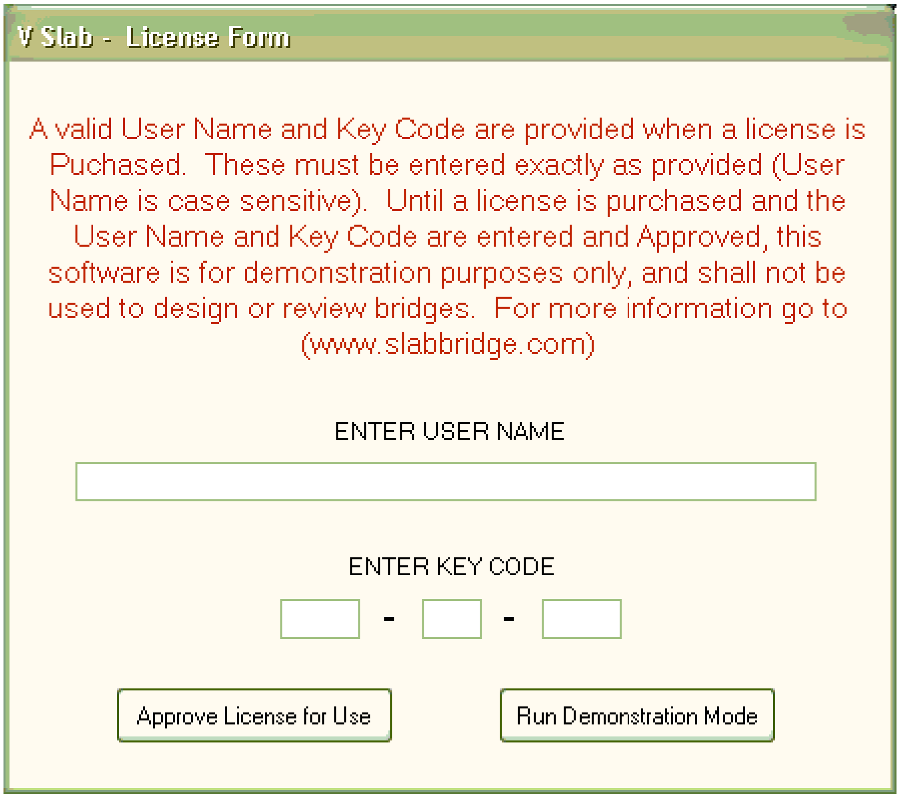
Reinforced concrete slab bridges are both economical and durable. This program was written by a practicing engineer to provide an efficient way to review slab bridge options and rapidly complete detailed designs. The programmer, Kurt Heidenreich, P.E., S.E., is the president of Engineering Resources, Inc. He has served as a bridge engineer for over 20 years. V SLAB is copyrighted under the corporation KJH Consulting, LLC, All Rights Reserved, and is subject to the requirements of the End User License Agreement. For more information, please go to www.slabbridge.com.

This program implements the American Association of State Highway Transportation Officials (A.A.S.H.T.O.) LRFD Bridge Design Specifications, Customary U.S. Units, 4th Edition, with 2008 Interim Revisions. Design requirements and details vary by state as well as by engineer. This software must be used under the direct supervision of an experienced design professional to ensure compliance with Federal, State and local requirements.

For the purposes of this help menu, items included in brackets [ ] are references to the applicable AASHTO LRFD Specification section. The sign convention used in this program assumes positive moments create tension on bottom surface and likewise negative moments create tension on top surfaces.

LICENSED OR DEMONSTRATION VERSION

After installing the program, the software will be set to an initial demonstration mode. When a new project is started, the user will be prompted to enter their License Name and Key Code. These are provided when the user purchases a license. The License Name is case sensitive and must be entered exactly as provided. If accepted by the program, this information will only need to be entered once. You can change this information by clicking on the Key Code Box near the bottom center of the Start Page window.



A valid User Name and Key Code are provided when a license is Puchased. These must be entered exactly as provided (User Name is case sensitive). Until a license is purchased and the User Name and Key Code are entered and Approved, this software is for demonstration purposes only, and shall not be used to design or review bridges. For more information go to (www.slabbridge.com)

If the License information isn't entered, the program will operate in Demonstration Mode. In this mode, the program has limited capacity because it isn't licensed for design use. Once the License Name and Key Code are entered, all program features will become active.

GETTING STARTED / BRIDGE DATA

From the start page, you have the option to Open an existing project or start a New project. Select your choice on the command line along the bottom of the window. The input parameters from previously saved projects are loaded using the Open feature. Only the input parameters are saved. The results of an analysis are not saved as this would require significant memory to store the various arrays of data. The bridge will be reanalyzed when you proceed to the reinforcing layout window using the next button. If New project is selected, default values will be loaded for the most recently saved items. You can choose to skip saving changes to defaults for a specific project by unchecking the “Save As Default Values” checkbox.

Version 2.0

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written by Kurt Heidenreich, PE, SE

Key Code: . . .

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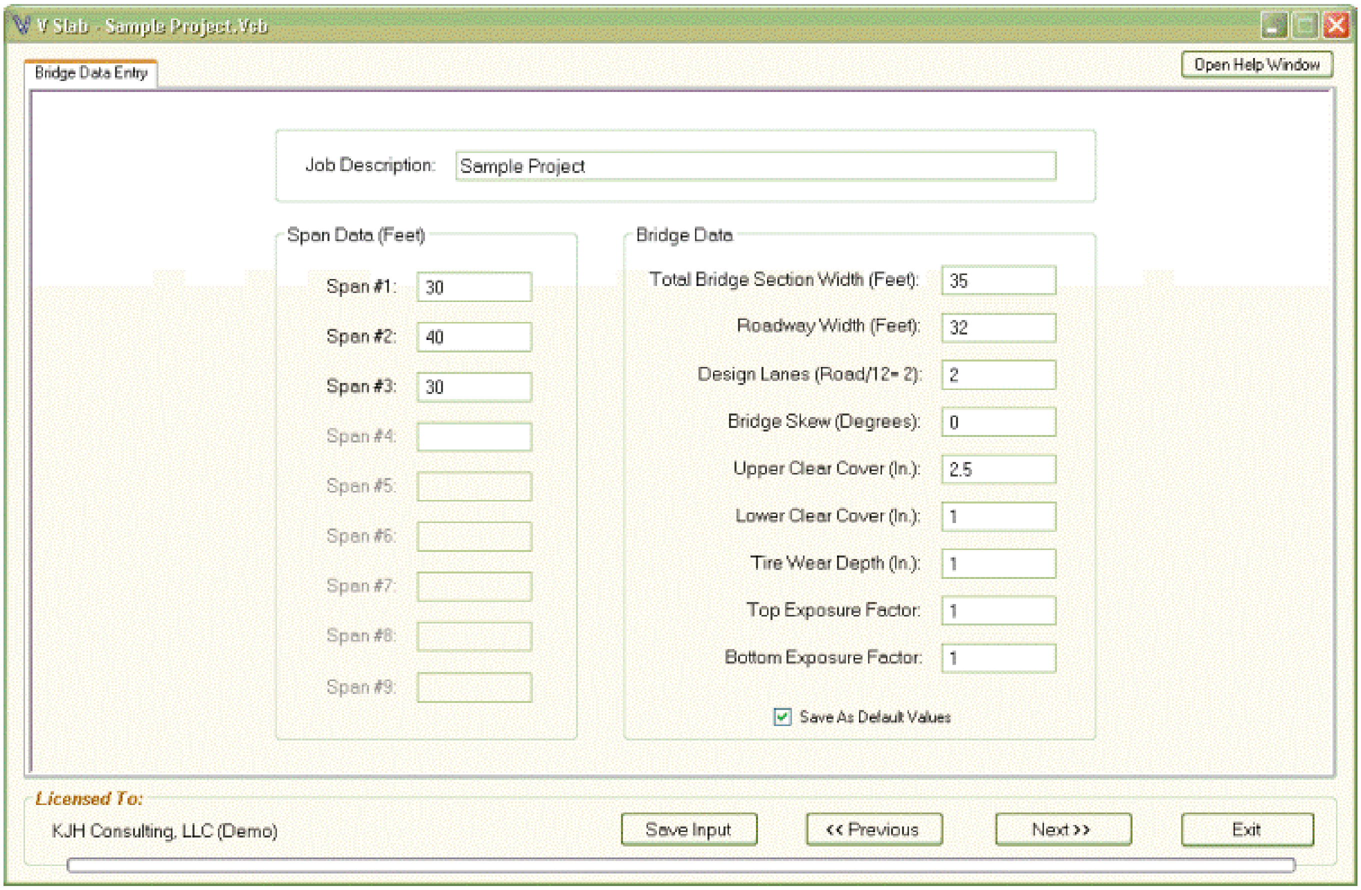
DEMONSTRATION MODE - NOT LICENSED FOR USE

After entering a job description (maximum of 58 characters including spaces), you can begin entering span lengths. Up to nine spans can be entered. The span lengths must be between 10 and 90 feet. If more than one span is entered, adjacent spans are continuous. If you want adjacent simple spans, you must run them as separate projects and complete the substructure design by other means.



Job Description: Sample Project

Span Data (Feet)

Span #1: 30
Span #2: 40
Span #3: 30

Bridge Data

Total Bridge Section Width (Feet): 35
Roadway Width (Feet): 32
Design Lanes (Road/12= 2): 2
Bridge Skew (Degrees): 0
Upper Clear Cover (In.): 2.5
Lower Clear Cover (In.): 1
Tire Wear Depth (In.): 1
Top Exposure Factor: 1
Bottom Exposure Factor: 1

☑ Save As Default Values

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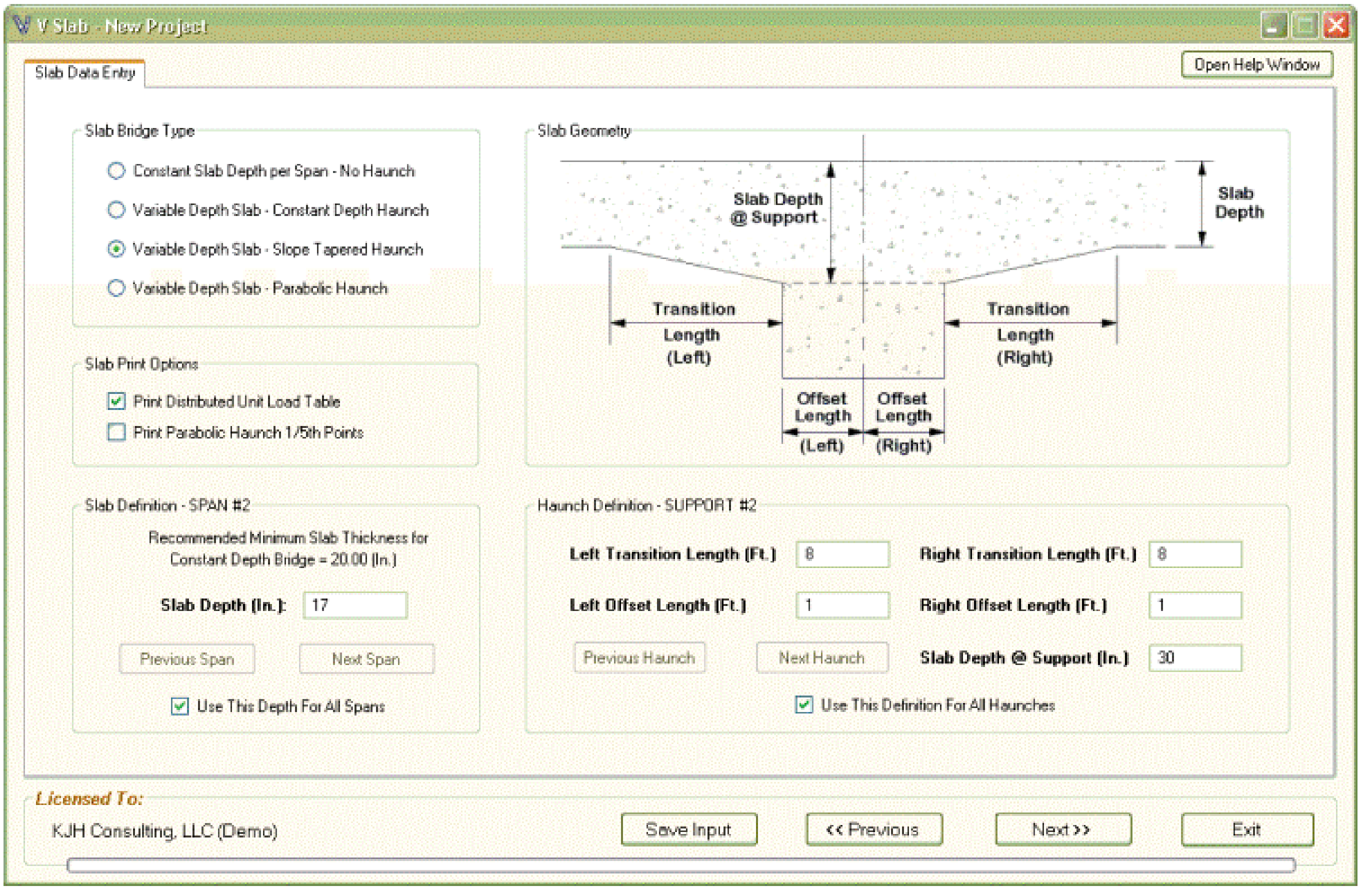
The total Bridge Section Width must be between 12 and 120 feet. The roadway width cannot exceed the total section width. The difference between the bridge width and roadway width is the railing width. The roadway width also serves as the loaded area for the future wearing surface (see load specification section). The number of design lanes is left to the designer, but the value in [3.6.1.1.1] is presented and checked when the user leaves the textbox. Overriding this value affects the design of both the superstructure and substructure. Overriding the calculated value should be completed only after careful consideration of the affects.

The bridge skew must be between 0 and 45 degrees. The upper and lower clear cover must be between 0.5 and 5.0 inches. The tire wear depth must be between 0 inches and the upper clear cover depth.

The exposure factor (γe) is used in equation [Eq. 5.7.3.4-1] for crack control maximum reinforcing spacing. This value is described as 0.75 for Class 2 Exposure and 1.0 for Class 1 Exposure. Since the crack width limits are subject to individual owner requirements, values from 0.5 to 2.0 are allowed in the program. Different values can be provided for top and bottom steel layers to account for potentially different exposure conditions.

SLAB DATA PAGE

When the bridge data page is complete, click the next button to enter the slab data page. The bridge can be designed as a flat slab or one with a variable depth. Variable depth slabs have haunches at interior supports for continuous spans. Three variable depth slab options are available: Constant Depth Haunch, Slope-Tapered Haunch and Parabolic Haunch.



Slab Bridge Type

○ Constant Slab Depth per Span - No Haunch
○ Variable Depth Slab - Constant Depth Haunch
● Variable Depth Slab - Slope Tapered Haunch
○ Variable Depth Slab - Parabolic Haunch

Slab Print Options

☑ Print Distributed Unit Load Table
☐ Print Parabolic Haunch 1/5th Points

Slab Definition - SPAN #2

Recommended Minimum Slab Thickness for Constant Depth Bridge = 20.00 (In.)

Slab Depth (In.): 17

☑ Use This Depth For All Spans

Haunch Definition - SUPPORT #2

Left Transition Length (Ft.) 8
Right Transition Length (Ft.) 8
Left Offset Length (Ft.) 1
Right Offset Length (Ft.) 1
Slab Depth @ Support (In.) 30

☑ Use This Definition For All Haunches

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Variable depth slabs pull positive moments away from the span to the negative moment region over the interior supports where they can be more efficiently carried by the deeper slab thickness. The interior slab can therefore be thinner than the minimum recommended depth by AASHTO as the depth at the interior support is typically thicker than the minimum. This is not only more structurally efficient, but the dead load moments are also reduced due to the distribution of concrete thickness.

NOTE TO DESIGNER: *The program assumes the main reinforcing steel is placed in a mat parallel with the top surface. For positive moment design, the effective depth will be calculated using the slab thickness for the span, and will be constant throughout that span. For negative moment design, the effective depth will change as the haunch depth varies. Supplemental reinforcing in the haunched section is not defined in the program.*

There are 14 design points for each span. For a flat slab these locations are equal to the span length divided by 14. For a variable depth slab, a point will be placed at the end of the haunch and at the offset location. The distribution of the other points depends on the relative length of the span and haunch length.

The structure stiffness matrix and fixed end forces are numerically integrated using Gauss Quadrature for variable depth members. Since the slab dead load is not constant for a variable depth slab, there is an option for printing a unit load table if the designer needs it.

Depending on the haunch layout, the required maximum negative moment steel may not occur over the interior support. The designer should review the calculated required steel at each design point to ensure proper haunch configuration.

For parabolic haunches, the depths at 1/5 points can be printed to ensure proper dimensioning during slab detailing. The equation used to determine the slab depth is determined by calculating a constant “K” which is equal to (transition length^2) / (slab depth @ support – slab depth @ span) . The slab depth at a point “X” measured from the end of the transition is equal to the slab depth in the span plus (X^2) / K.

For example, to find the depth at 6 feet from the end of a 10ft. haunch with a 20 inch slab and 30 inch deep haunch at the support, the following is calculated:

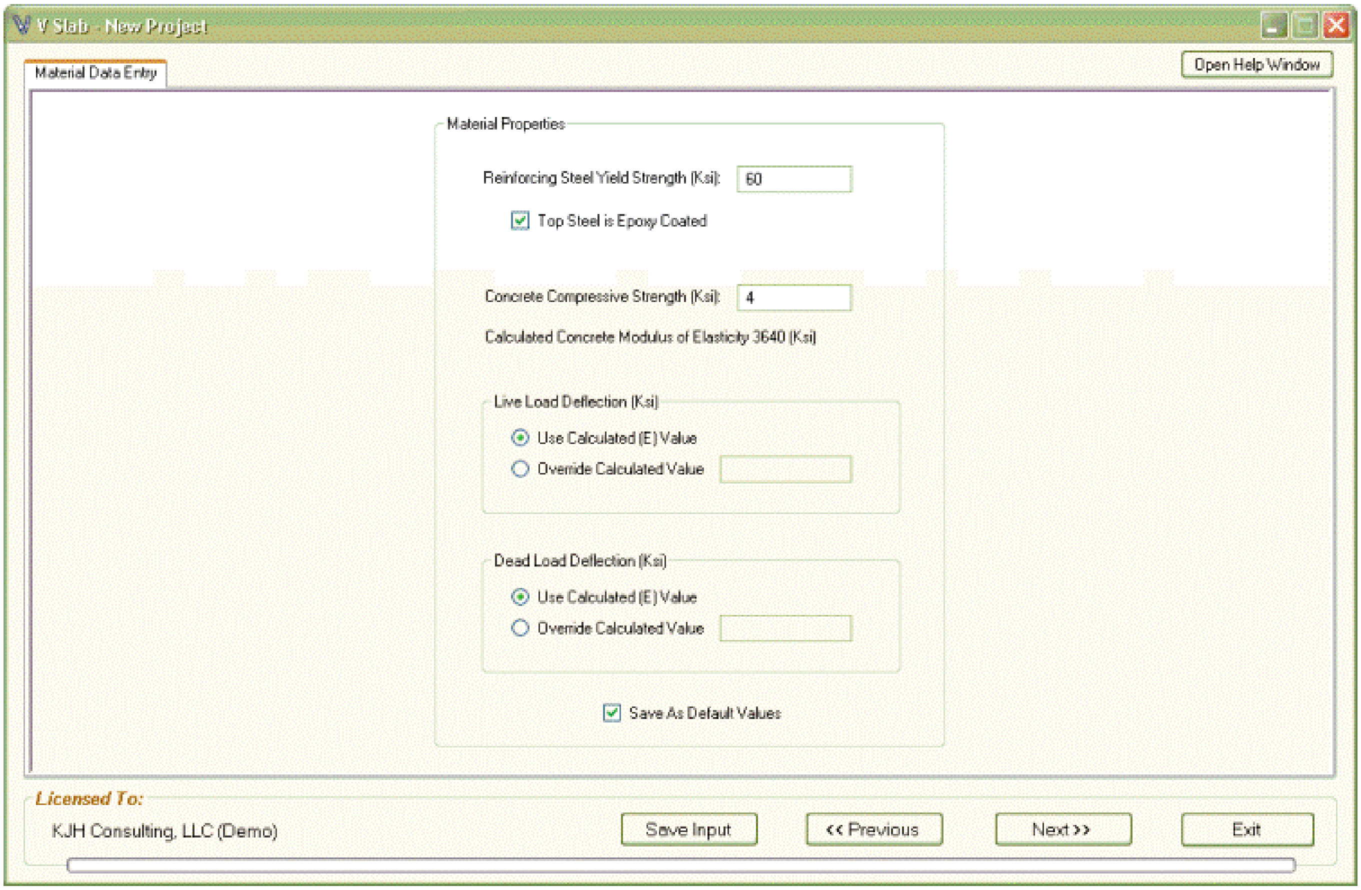
$$K = (10^2) / (30 - 20) = 10$$

$$\text{Haunch Depth (@ 6 Ft.)} = 20 + (6^2) / 10 = 23.6 \text{ inches}$$

Note that the calculation is always from the span side of the transition to the offset location.

MATERIAL PROPERTIES

When the slab data page is complete, click the next button to enter the material data page. Enter the reinforcing steel yield strength and whether the top reinforcing is epoxy coated. Only the top steel has a second cut requiring the development length calculation beyond the first cut. There is an epoxy coating factor in the development length calculation.



Material Properties

Reinforcing Steel Yield Strength (Ksi): 60

☑ Top Steel is Epoxy Coated

Concrete Compressive Strength (Ksi): 4

Calculated Concrete Modulus of Elasticity 3640 (Ksi)

Live Load Deflection (Ksi)

● Use Calculated (E) Value
○ Override Calculated Value

Dead Load Deflection (Ksi)

● Use Calculated (E) Value
○ Override Calculated Value

☑ Save As Default Values

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After the concrete compressive strength is entered, the calculated modulus of elasticity is displayed. This value can be overridden for live or dead load deflection calculations.

Live load deflections are optional and can be owner specific. For this program, the live load deflection calculations are the larger of a single truck or 25% of the truck with full lane loading [3.6.1.3.2]. Deflections are based on service loads (load factor of 1.0) with the dynamic load allowance of 33% applied to the truck portion only. The live load is adjusted for the number of loaded lanes, and gross cross sectional properties of the bridge are used.

The live load deflection can be adjusted to a pseudo-cracked condition by modifying the modulus to a value lower than calculated, see [5.7.3.6.2] for guidance. To account for lower initial concrete strength when the forms are removed, the dead load modulus can also be adjusted.

V SLAB - LOADING

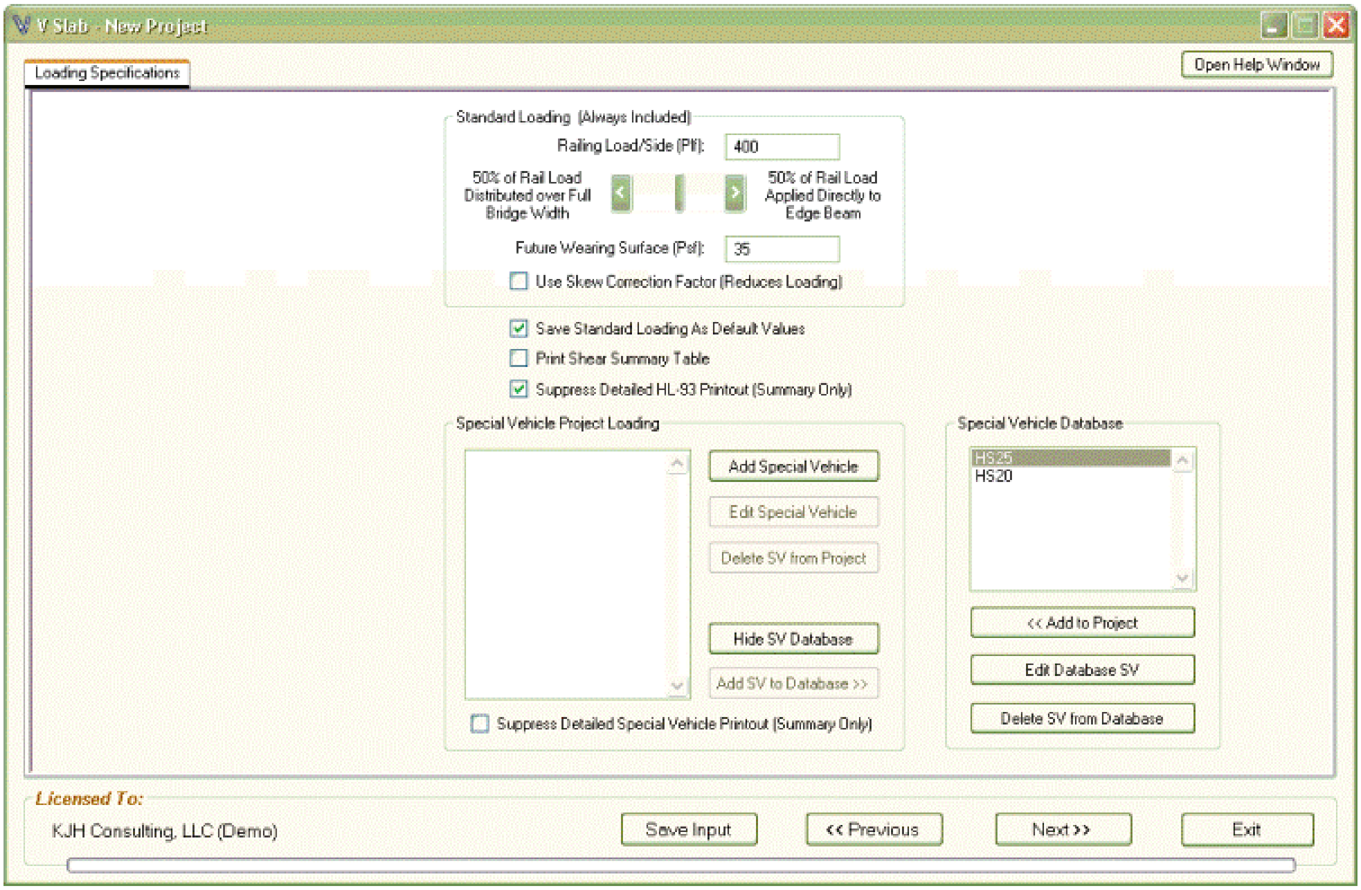
STANDARD LOADING

Once the general bridge data and materials are entered, the applied loading must be specified. The railing load is entered in pounds per foot (plf) and is assumed to be applied on both sides of the bridge. In other words, the total load is twice the plf load entered. This rail load is applied by adjusting the track bar. The specified percentage is distributed over the entire bridge width, and the remaining percentage is applied directly to the edge beam. If the bridge span is long and the width is narrow, the rail loading will tend to distribute more evenly over the width. Therefore, the distribution percentage will be higher. If the bridge span is relatively short compared to the width, the rail load will likely be more concentrated along the edge beam.

It is up to the designer to specify the appropriate percentages. Some transportation departments may require the railing load to be entirely distributed over the bridge width, while others may choose to apply the rail load entirely to the edge beam. The code does not specify a provision regarding this distribution. However, it is the author's opinion the load will be shared based on the three dimensional effect of the span to width ratio.

The future wearing surface is provided in pounds per square foot (psf). It is applied directly to the interior strip width. For the edge beam, it is applied to the roadway portion only. (i.e. if the roadway width is less than the bridge width, the edge beam future wearing surface will be a ratio that reduces the load to account for the railing location)

The code allows an adjustment (reduction) of the live loading to account for bridge skew. Since bridge skew creates a shorter span distance diagonally between the supports, the live load longitudinal superstructure moments are reduced as the skew increases. Select the checkbox if you want the program to reduce the live load moments according to [Eq. 4.6.2.3-3]. It is always conservative to leave this unchecked.



Railing Load/Side (Plf): 400

Future Wearing Surface (Psf): 35

☐ Use Skew Correction Factor (Reduces Loading)

☑ Save Standard Loading As Default Values

☐ Print Shear Summary Table

☑ Suppress Detailed HL-93 Printout (Summary Only)

☐ Suppress Detailed Special Vehicle Printout (Summary Only)

HS25
HS20

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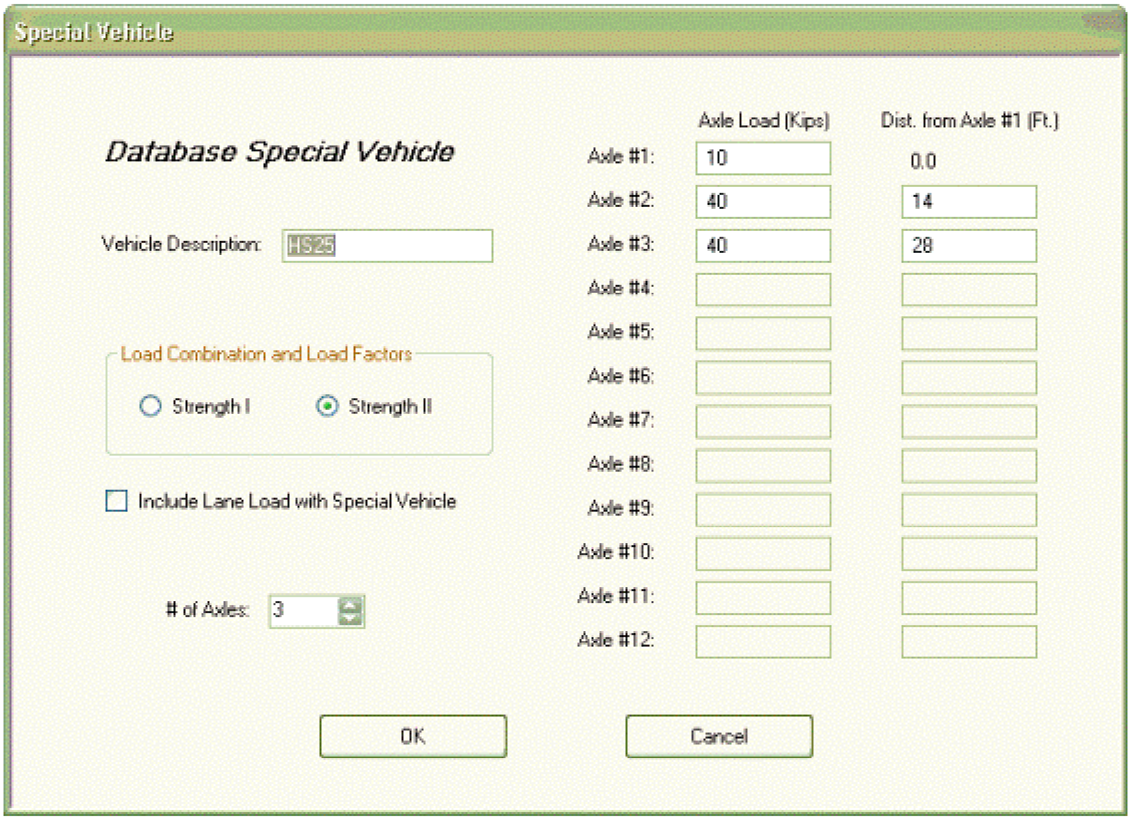
Standard HL-93 loading is always calculated for a bridge. HL-93 loading [3.6.1.3] consists of a tandem, with lane loading or one variable spaced axle design truck, with lane load. In addition, for negative moments and interior support reactions, the provisions of [3.6.1.3.1] for 90% of two trucks spaced at 50 ft. apart with lane loading is checked. Lane loading is pattern applied at tenth points to achieve maximum affects. A dynamic load allowance [3.6.2] of 33% is applied to the truck and tandem (not the lane loads). To reduce the amount of output, you can check the “Suppress Detailed HL-93 Printout (Summary Only)” box. You can save changes to defaults for standard loading by checking “Save Standard Loading As Default Values.”

Fatigue loads are calculated in accordance with [3.6.1.4]. A dynamic load allowance [3.6.2] of 15% is applied to the fatigue truck with a load factor of 0.75. The distribution width for a single lane is used in accordance with [4.6.2.3-1]. This width is multiplied by 1.2 in accordance with [3.6.1.1.2], specifically the commentary regarding fatigue. For fatigue load on the edge beam, the fatigue truck distribution width is applied with the dead load from the edge beam.

If the designer wants to see shear loading values for the superstructure, select the “Print Shear Summary Table” checkbox. A table is provided in the report with factored values for the slab only, and for the design unit width for interior and exterior strips. The strips include dead and live loading.

SPECIAL VEHICLES

In addition to HL-93 loading, the program will analyze special vehicles and design for the maximum resulting load cases. Special vehicles are created at the project level using the “Add Special Vehicle” button. Once created, the vehicle can be added to the special vehicle database that is saved separately from the project file so the vehicle can be added to other projects without having to re-enter the same information. Use the “Show or Hide SV Database” button to access this feature. A vehicle in the database can be added to a project by highlighting it and selecting the “<<Add to Project” button. A special vehicle can be edited as needed after it is created.



Database Special Vehicle

Vehicle Description: HS25

Load Combination and Load Factors
○ Strength I ● Strength II

☐ Include Lane Load with Special Vehicle

# of Axles: 3

	Axle Load (Kips)	Dist. from Axle #1 (Ft.)
Axle #1:	10	0.0
Axle #2:	40	14
Axle #3:	40	28
Axle #4:		
Axle #5:		
Axle #6:		
Axle #7:		
Axle #8:		
Axle #9:		
Axle #10:		
Axle #11:		
Axle #12:		

Special vehicles can be analyzed with or without the standard 640plf lane load included. In addition, Strength I or Strength II load combinations can be used. The 33% dynamic load allowance is applied to the vehicle portion, but not the lane load if included.

To reduce the amount of output, you can check the “Suppress Detailed Special Vehicle Printout (Summary Only)” box.

V SLAB – SUPERSTRUCTURE DESIGN

DESIGN PROCESS

Once the bridge data is complete, selecting the next button will start the bridge analysis routines. The progress bar at the bottom of the command line will display the status of the analysis. The analysis is completed in the following steps:

1. Create the structure model and stiffness matrix.
2. Create influence values.
3. Find HL-93 loading
4. Find Special Vehicle loading
5. Determine Interior and Edge Beam strip loading
6. Calculate slab reinforcing requirements
7. Present reinforcing layout for designer review

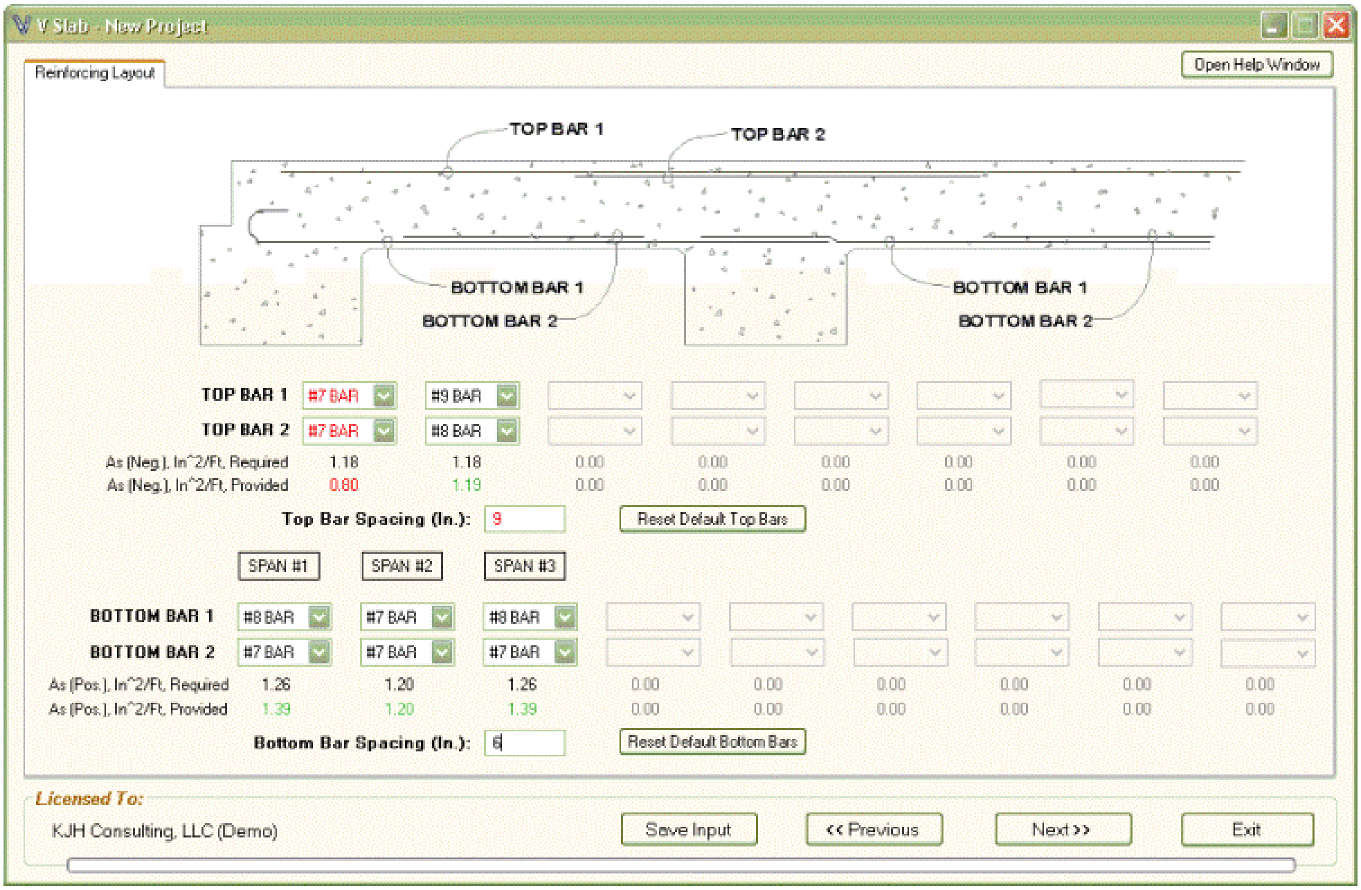
Programming details for loading are not discussed. Appropriate loading details for designers are presented in the previous help section. This section discusses the process of designing slab reinforcing. The program uses a two bar reinforcing pattern for both top and bottom steel. Shear strength calculations are not required by the code [5.14.4.1] since the moment design is in accordance with [4.6.2.3]. If the designer desires to review the shear loading for the superstructure, a shear table can be printed in the report (see Loading Help Section).

INTERIOR STRIP DESIGN

The strip width is calculated in accordance with [4.6.2.3]. Then the maximum negative and positive area of steel are found, and the steel strain is determined for each. If the maximum strain is less than 0.005, the section is not tension controlled [5.5.4.2 & 5.7.2.1]. The program will proceed with the design only if every section is tension controlled so a resistance factor of 0.9 can be used in accordance with [5.5.4.2]. Otherwise, the user will be directed to provide a deeper slab. If this check is satisfied, the required positive and negative area of steel are calculate at every design point. The required area is compared to the minimum area of steel, which is equal to 1.2 times the cracking moment [5.7.3.3.2]. The lesser of the minimum area or 1.33 times the calculated area of steel is provided. The fatigue stress range of the resulting area of steel is checked as specified in [5.5.3.2]. If the stress range is exceeded, the area of steel is increased until it is satisfied.

After calculating the required area of steel at every design point, the maximum values are determined, and a bar spacing with two appropriate bar sizes are selected to satisfy the required area of steel. The maximum spacing is 9 inches in order to satisfy [5.10.3.2] 18 inch spacing when one bar is cut. The bar spacing is checked against the crack control provisions of [5.7.3.4]. If the initially selected spacing exceeds the allowable, the program reduces the spacing and selects new bar sizes until the provisions are satisfied.

The initial bar sizes and spacing are presented to the designer on the reinforcing layout page. The designer can then make modifications to the layout as desired. If the project was previously saved or a reinforcing layout was modified, the new layout will remain unless the user does one of the following things. First, the user changes the number of spans, or secondly the user selects the “Reset Default Top/Bottom Bars” button. This sets the bar sizes and spacing to a computer generated layout described in the previous paragraph.



TOP BAR 1	#7 BAR	#9 BAR						
TOP BAR 2	#7 BAR	#8 BAR						
As (Neg.), In^2/Ft, Required	1.18	1.18	0.00	0.00	0.00	0.00	0.00	0.00
As (Neg.), In^2/Ft, Provided	0.80	1.19	0.00	0.00	0.00	0.00	0.00	0.00

Top Bar Spacing (In.): 9

	SPAN #1	SPAN #2	SPAN #3						
BOTTOM BAR 1	#8 BAR	#7 BAR	#8 BAR						
BOTTOM BAR 2	#7 BAR	#7 BAR	#7 BAR						
As (Pos.), In^2/Ft, Required	1.26	1.20	1.26	0.00	0.00	0.00	0.00	0.00	0.00
As (Pos.), In^2/Ft, Provided	1.39	1.20	1.39	0.00	0.00	0.00	0.00	0.00	0.00

Bottom Bar Spacing (In.): 6

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If the user selects a bar layout or spacing resulting in less area of steel provided than required, the steel area provided will be indicated in red. The color will be green if the steel area is satisfactory. If the crack control spacing is exceeded, the bar sizes and spacing will be red to indicate the problem. An error will be displayed when the next button is selected, until the user corrects the problem.

When a satisfactory reinforcing layout is developed, selecting the next button will finalize the superstructure design. This involves completing interior bar cutoff calculations and determining edge beam reinforcing spacing and bar cutoffs. Transverse top and bottom steel must be provided in accordance with [5.14.4.1]. Temperature steel is defined in [5.10.8].

INTERIOR STRIP BAR CUTOFFS

Cutoffs are in accordance with [5.11]. Bottom Bar 1 is continuous to satisfy [5.11.1.2.2]. Bottom Bar 2 extension, beyond the calculated cutoff point, is in accordance with [5.11.1.2.1]. The crack control spacing is checked at the end of Bottom Bar 2 using only Bar 1 at twice the spacing. If the maximum spacing is exceeded, the bar cutoff is extended until the provisions are satisfied.

Top Bar 2 extension, beyond the calculated cutoff point, is in accordance with [5.11.1.2.3]. The crack control spacing is checked at the end of Top Bar 2 using only Bar 1 at twice the spacing. If the maximum spacing is exceeded, the bar cutoff is extended until the provisions are satisfied. The program find the first design point with no moment (point of inflection) and provides this location as the theoretical location for Top Bar 1 cutoff (the extension length is added). The development length of Bar 1 [5.11.2] is added to the theoretical cutoff point of Bar 2 to ensure the moment capacity is satisfied at that section. The longer of the two cutoffs is provided.

NOTE TO DESIGNER: *Section [5.11.1.2.1] states "No more than 50 percent of the reinforcement shall be terminated at any section, and adjacent bars shall not be terminated in the same section." The commentary to this states "As a maximum, every other bar in a section may be terminated." For programming purposes, top bar 1 was cutoff at the point of inflection since technically no steel is required. If there is no inflection point this is not the case. The location is provided where the temperature and shrinkage steel area could be spliced and meet the required steel area. However, the engineer of record must make the final interpretation of these code requirements.*

EDGE BEAM DESIGN & BAR CUTOFFS

The edge of the slab creates a discontinuity which must be designed as a beam [9.7.1.4]. The width of the edge beam strip is in accordance with [4.6.2.1.4b]. This program does not use the railing, curb, slab drop, etc. for additional strength along this edge. Instead the edge beam is designed as a slab strip carrying one line of wheels, the tributary dead load, and railing as described in the loading section. The railing load includes the portion distributed to the bridge and the portion directly applied to the edge beam.

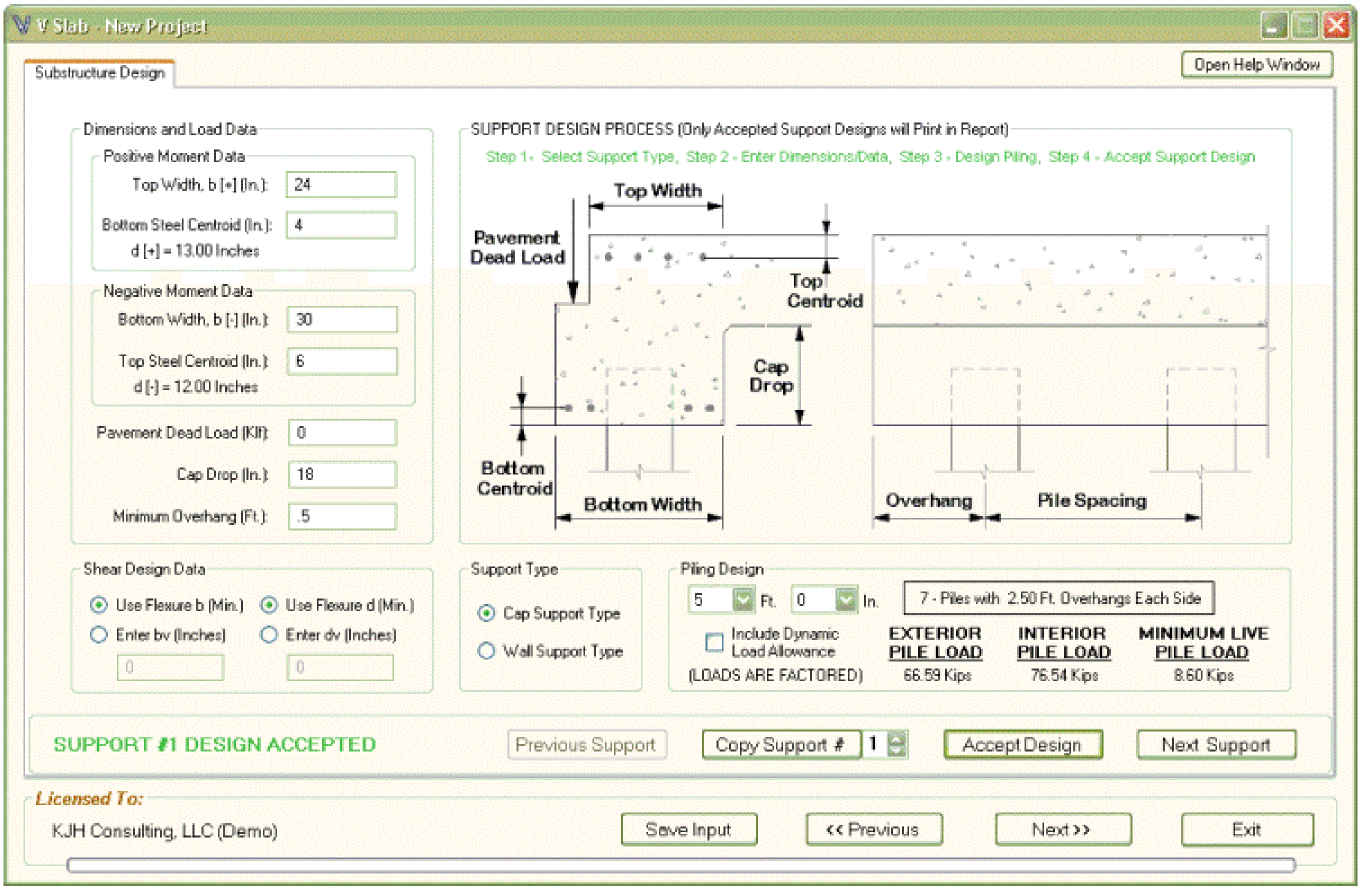
The bar sizes provided in the interior strip are used to determine the required spacing in the edge beam. The spacing must be at least that used in the interior strip. Edge beam bar cutoffs are calculated, including crack control spacing requirements. The designer must decided whether to provide different bar sizes and spaces for the edge beam, or provide the longer of the bar sizes, from the interior or edge beam strip, throughout the bridge and adjust only the spacing. In addition, common practice is to provide at least the outside (exterior edge) top and bottom bars as continuous. Some owners may have additional detailing requirements.

V SLAB – SUBSTRUCTURE DESIGN

SUPPORT TYPE

Each support can be designed as either a cap type or wall type substructure. The cap type support is flexible while the wall type is considered to be rigid. This affects the way the pile loads are calculated as well as the reinforced concrete design.

If a wall type is selected, only the cap drop (which becomes the wall depth), the bottom width, and if it is the first or last support, the pavement dead load will be enabled. The other entry fields are needed for the cap type support.



Dimensions and Load Data

Positive Moment Data

Top Width, b [+] (In.): 24

Bottom Steel Centroid (In.): 4

d [+] = 13.00 Inches

Negative Moment Data

Bottom Width, b [-] (In.): 30

Top Steel Centroid (In.): 6

d [-] = 12.00 Inches

Pavement Dead Load (Klf): 0

Cap Drop (In.): 18

Minimum Overhang (Ft.): .5

SUPPORT DESIGN PROCESS (Only Accepted Support Designs will Print in Report)

Step 1 - Select Support Type, Step 2 - Enter Dimensions/Data, Step 3 - Design Piling, Step 4 - Accept Support Design

Shear Design Data

● Use Flexure b (Min.) ● Use Flexure d (Min.)

○ Enter bv (Inches) ○ Enter dv (Inches)

0 0

Support Type

● Cap Support Type

○ Wall Support Type

Piling Design

5 Ft. 0 In.

7 - Piles with 2.50 Ft. Overhangs Each Side

☐ Include Dynamic Load Allowance

(LOADS ARE FACTORED)

EXTERIOR PILE LOAD	INTERIOR PILE LOAD	MINIMUM LIVE PILE LOAD
66.59 Kips	76.54 Kips	8.60 Kips

SUPPORT #1 DESIGN ACCEPTED

Copy Support # 1

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The cap entries are grouped under the design area where they will be used: positive moment, negative moment or shear design. The effective depths are calculated using the cap drop plus slab thickness minus the steel centroid. For the positive case, the effective depth is reduced by the tire wear depth. This calculation assumes an integral cap type. If the slab bears on a cap, the centroids must be adjusted accordingly until the proper effective depth is achieved. Likewise, the program provides the opportunity to use the minimum flexure values for shear, or the user can override them as required.

When the design is complete, it must be accepted by selecting the “Accept Design” button. The reinforcing is calculated, and the support data will print when the report is prepared. Select “Next Support” or “Previous Support” buttons to navigate to other support designs. To copy the information from another support to the current support being designed, select the “Copy Support” button. The number to the right of the copy button represents the support number to copy from.

PILE DESIGN

The user selects the pile spacing in feet and inches and the program calculates the number of piles and the overhang using the minimum overhang dimension specified. Change the minimum overhang dimension if a different overhang value is preferred. All pile loads are factored. The user can specify if the piling load should include the dynamic load allowance on live loading. This option is included because the piling can be constructed integrally with the superstructure, which may require special loading consideration. The pile loads are provided for exterior, interior and for the minimum live load case. The minimum live load case is provided to ensure piling uplift is identified, if applicable. This case uses a live load factor of 1.75 with a dead load factor of 0.9.

For wall type supports, the dead load reaction is applied evenly to each pile, and the live load reaction is applied over a 10 foot width placed against the edge of the rail. If the bridge has more than one lane, additional lane reactions (acting over a 10 foot width) are placed against the previous lane. The lane contribution is applied to the exterior piles using P/A + M/S for the piles assuming a rigid group. The maximum and minimum exterior pile loads are provided.

For cap type supports, the dead load is applied to the interior piles by tributary width, and to the exterior pile by the lever rule assuming a pin at the first interior pile. The rail load assigned to the edge beam is applied as a distributed load over that width. The live load reaction is reduced by the amount of two factored wheel loads, and the remaining reaction, times the total number of lanes, is applied as a distributed load over the length of the pile cap.

Wheel loads are applied to exterior piles by the lever rule. If there are only two piles, the interior pile load is zero because there are no interior piles. With three or more piles, the interior pile load, positive moment, negative moment and shear are determined assuming a two span continuous condition (conservative). Two wheels per lane, up to a total of six wheels, are placed (6Ft. / axle and 4 Ft. between axle group) at tenth points to determine the maximum load values.

CAP DESIGN

The moments and shears determined as described in the previous section were used to calculate the required areas of steel. The section is checked to ensure it is tension controlled. Minimum steel is calculated as 1.2 times the cracking moment with the section depth equal to the slab thickness plus the cap drop. This information is presented in the report so the designer can determine the appropriate reinforcement amounts if their condition varies from these assumptions.

Shear design is based on the simplified method [5.8.3.3 using 5.8.3.4.1] with Beta = 2.0 for concrete strength calculations. The calculated shear steel area is provided in square inches per foot for both stirrup legs. A sample calculation would be a #4 bar U-stirrup at 6 inches on center (Av = 2 legs x 0.2 sq. in. per leg x {12"/Ft.} / 6" = 0.8 square inches per foot). The reported shear calculations are intended to provide information to assist in developing an appropriate design. The applicable code provisions must be followed regarding minimum shear steel area and stirrup spacing.

WALL DESIGN

Depending of the dimensions and other uses of the wall, detailed design may not be required. The report presents temperature and shrinkage requirements in accordance with [5.10.8]. This minimum steel will be required regardless of any calculated area of steel requirements.

There are many other loads a wall type can be required to carry including: soil pressure, wingwalls, highway surcharge, stream flow, ice, etc. These combinations are beyond the scope of this program. The designer should review the wall condition for other loading and ensure that at least the minimum values are provided.