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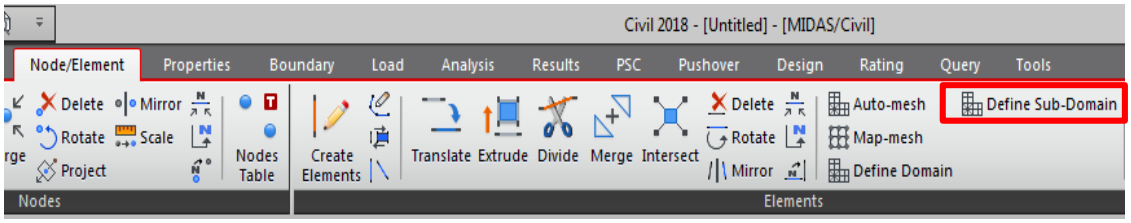
Integrated Solution System For Birdge And Civil Engineering

How can we design Beam(Slab) or Column(Wall) using plate element?

Plate Design is divided into Plate Beam (Slab) design and Plate Column (Wall) desig n, and the existing Beam / Column design is applied (as per AASHTO LRFD 12) to t he plate elements modeled by the user. The design is carried out in sub-domain un its.The maximum positive/negative moment and shear force are calculated by the c oncrete load combination for the elements defined in specific sub-domain.

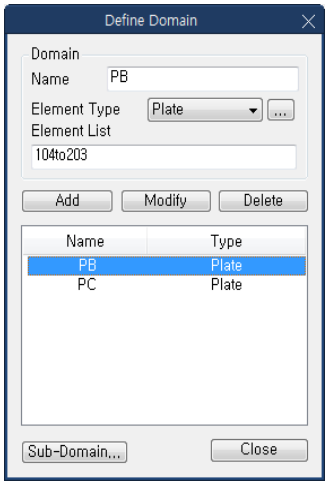
In Plate Design (AASHTO-LRFD12) design, thickness is used as the height and the w idth if used as unit width to perform design. Therefore, the strength and serviceabil ity check results are represent the result from thickness and unit width. The main re bar and shear reinforcement are also converted into the reinforcement required to the unit width

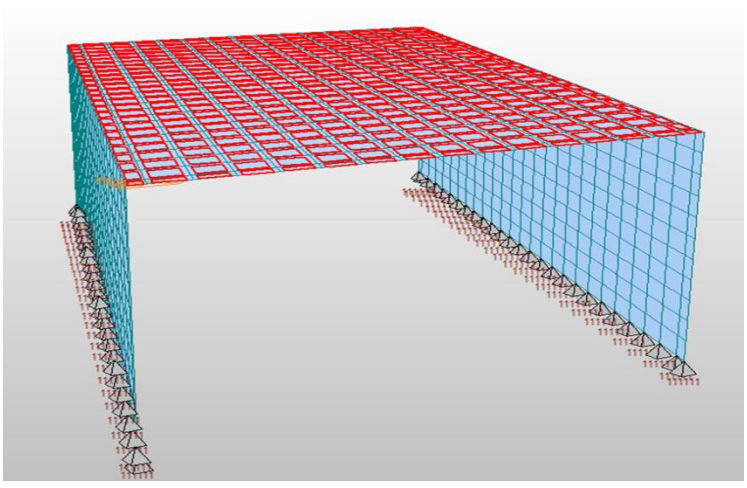
1. Define Domain



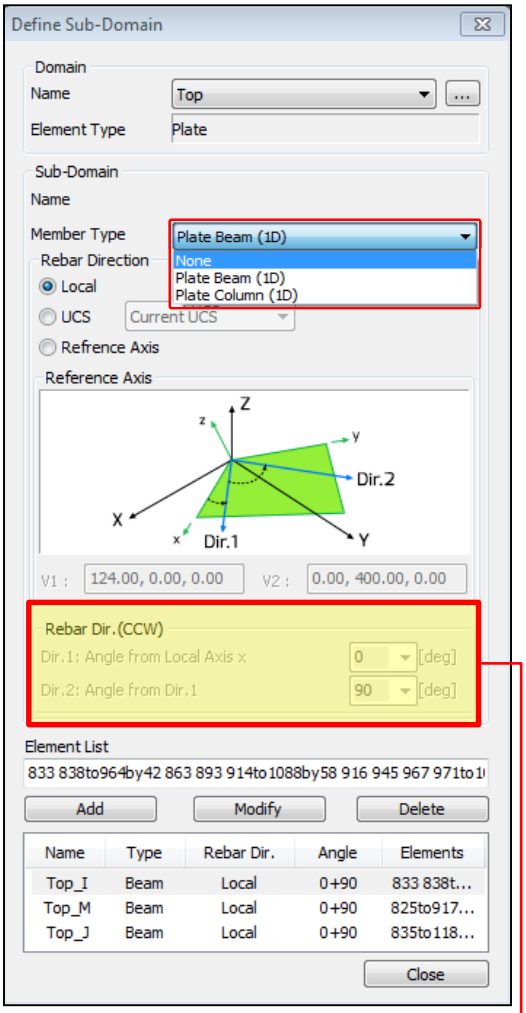
Node/Element > Elements > Define Domain/Sub-Domain

Pre / Post Processing Input Data for Plate Beam Design should be defined. After cr eating the plate element, Domain and Sub-Domain of specific elements should be defined and then Plate Member is assigned.





2. Define Sub-Domain



▶Sub-Domain

Plate Design carries out design in designated sub-domain unit. Member Type is Plate Beam (1D), Plate Column (1D), and it is classified by selecting corresponding Member Type.

- Plate Beam (1D): Select this if you want Slab Design like 1 way Beam.
- Plate Column (1D): Select the Abutment/Side Wall Design like column under only axial force.

▶ Rebar Direction

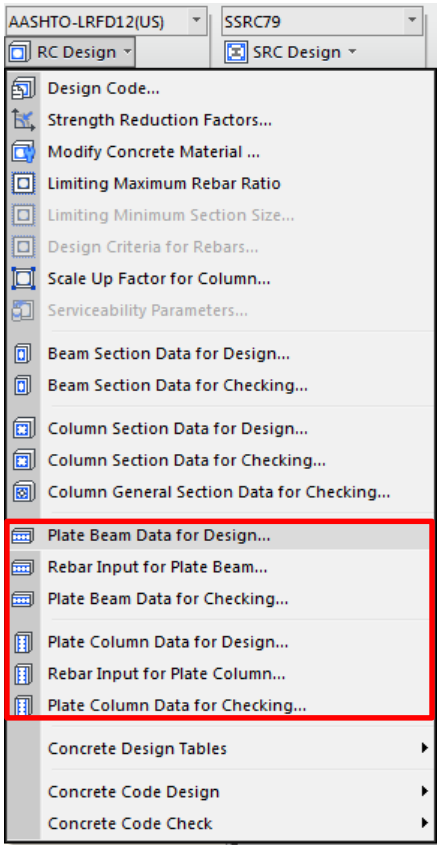
Enter the direction of the rebar.

- **Local :** Use the local coordinate system of the plate element to define the rebar direction
  Dir.1 : Local x-axis
  Dir.2 : Local y-axis

- **UCS :** Select a predefined user coordinate system to define the rebar direction. If no user coordinate system is specified, the global coordinate system is used(Current UCS)
  Dir.1 : UCS X-axis
  Dir.2 : UCS Y-axis

- **Reference Axis :** The user uses the coordinates defined by Reference Axis directly. Select V1 vector to define reference x-axis and select V2 vector to define the plane.
  Dir.1 : Reference x-axis (V1)
  Dir.2 : 90 degree from Reference x-axis

**** Note : This feature is used for the calculation of Wood-Armer moment of specific direction. This will be fixed to default for Plate Design***
(Dir.1 = 0 deg, Dir.2 = 90 deg).



2. Plate Beam / Column Design

▶ Plate Beam Data for Design ...

- This Enter the data required for Plate Column Design.

▶ Rebar Input for Plate Beam...

- Enter the reinforcement pattern to be applied in Beam Ch ecking.

▶ Plate Beam Data for Checking...

- Enter the data required for Plate Beam Checking

▶ Plate Column Data for Design...

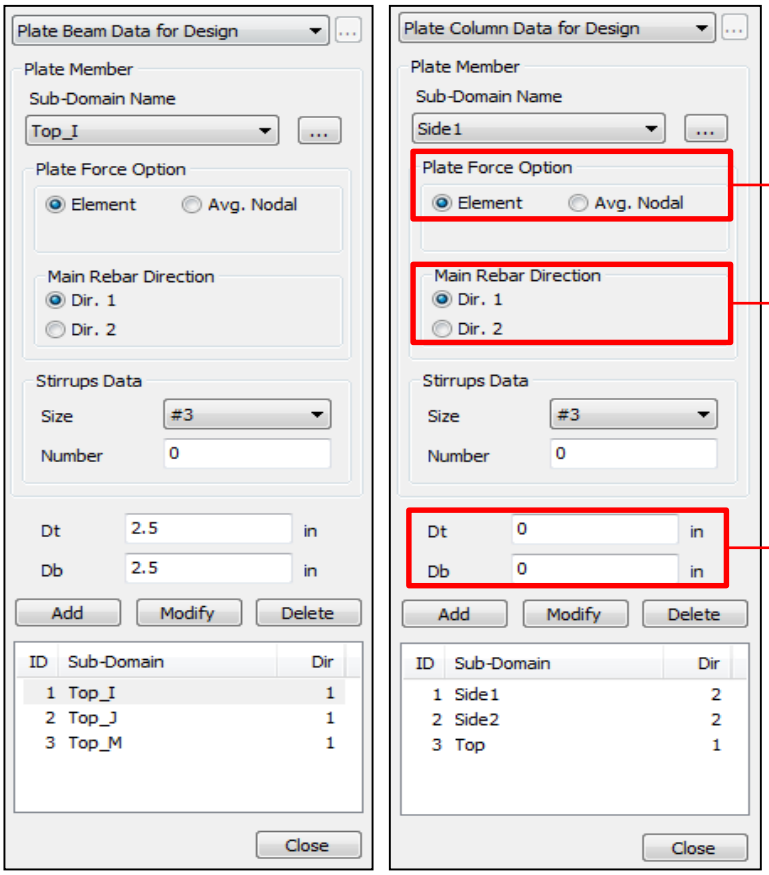
- Enter the data required for Plate Column Design.

▶ Rebar Input for Plate Column...

- Enter the reinforcement pattern to be applied in Column Checking.

▶ Plate Column Data for Checking...

- Enter the data required for Plate Column Checking



Element:
Display the contour using the interna l forces calculated at each node of a n element.

Avg. Nodal:
Display the contour using the averag e internal nodal forces of the contigu ous elements within the same Sub-D omain sharing the common nodes.

Define main rebar direction accordin g to the direction defined at Sub-Do main

Cover Thickness of top and bottom

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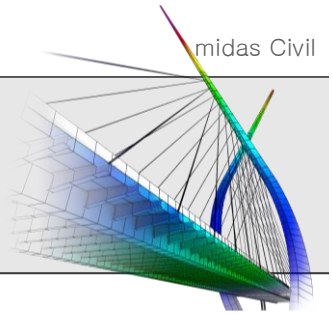


Plate Beam Design Result Dialog

Code : AASHTO-LRFD12 | Unit : kips , in , / in

Member forces are shown in terms of unit length

Sub-Domain	SEL	Major Dir	CHK	Pos	Req_As	Elem.	Node	LCB_M	Mu	Mr	Ratio_M	Elem.	Node	LCB_V	Vu	Vr
Top_I	☐	Dir1	OK	Pos	0.0181	833	C	1	0.00000	7.19464	0.0000	863	C	3	0.54797	1.130
				Neg	0.0792	1020	1464	3	28.7453	29.6082	0.9709					
Top_J	☐	Dir1	OK	Pos	0.0226	927	1443	4	8.64613	8.89366	0.9722	1194	1574	3	0.53053	1.148
				Neg	0.0859	907	1439	3	31.2120	31.9761	0.9761					
Top_M	☐	Dir1	OK	Pos	0.0370	989	1445	4	14.0982	14.4045	0.9787	1007	1506	4	0.36797	1.017
				Neg	0.0181	825	C	1	0.00000	7.19464	0.0000					

☐ Connect Model View

Select All | Unselect All | Re-calculation

Detail... | Graphic... | C:₩Users₩nsk0201₩Desktop | ... | << | Close

Result View Option: ◉ All ○ OK ○ NG

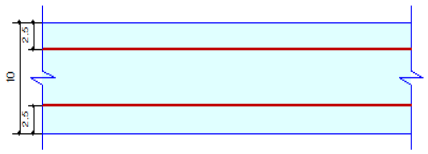
Copy Table

The most critical position of the element is decided according to the largest amount of Reinforcement required (Req_As).

1. Design Condition

Design Type	Plate Beam (1D)
Sub-Domain	Top_I
Design Code	AASHTO-LRFD12
Unit System	kips, in, / in
Material Data	fc = 5, fy = 60, fys = 60 ksi
Thickness	10 in

2. Section Diagram



Element No : 833

Rebar Pattern: Top Required Rebar Area = 0.079249 in²

Bot Required Rebar Area = 0.0181318 in²

Required Stirrups Spacing : No Stirrup

3. Bending Moment Capacity

	Top(Negative)	Bottom(Positive)
Mu	28.75	0.00
Element No.	1020	833
Load Combination	S4_EHmax	S1_EH_max
Mr	29.61	7.19
Check Ratio (Mu/Mr)	0.9709	0.0000

4. Shear Capacity

Element No.	863		
Load Combination	S4_EHmax		
Applied Shear Strength	Vu	= -0.5480	
Shear Strength (Out of plane)	Vr	= 1.13064	
Required Stirrups Spacing	5.97188	in	
Shear Ratio	Vu/Vr	= -0.5480 / 1.13064	= 0.485 < 1.000 ..... O.K

```
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   +============================================================+
   | MIDAS(Modeling, Integrated Design & Analysis Software)     |
   | MIDAS/Civil - Design & checking system for windows         |
   +============================================================+
   | RC-Plate Member(Plate Beam/Column) Analysis and Design     |
   | Based On  AASHTO-LRFD12                                    |
   |                                              (c)SINCE 1989 |
   +============================================================+
   | MIDAS Information Technology Co.,Ltd.          (MIDAS IT)  |
   | MIDAS IT Design Development Team                           |
   +============================================================+
   |           HomePage : www.MidasUser.com                     |
   +============================================================+
   | MIDAS/Civil  Version 8.6.5                                 |
   +============================================================+


  *.DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
--------------------------------------------------------------------------------
  LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
--------------------------------------------------------------------------------
    1  1          SW( 1.250) +          EV( 1.300) +          EH( 1.350)
    2  1          SW( 1.250) +          EV( 1.300) +          EH( 0.900)
    3  1          SW( 1.500) +          EV( 1.300) +          EH( 1.350)
    4  1          SW( 1.500) +          EV( 1.300) +          EH( 0.900)
--------------------------------------------------------------------------------
f
--------------------------------------------------------------------------------
MIDAS/Civil - RC-Plate Beam Design  [ AASHTO-LRFD12 ]                    Civil 2018
================================================================================

    *.MIDAS/Civil - RC- PLATE BEAM Analysis/Design Program.

    *.PROJECT       :
    *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kips, in, /in
    *.SUB-DOMAIN        : Top_I     Member Type = PLATE BEAM(1D),   Dir  = 1  )

    *.DESCRIPTION OF PLATE BEAM DATA :
      Thickness             =       10.000 in.
      Unit Width            =           1 in.
      Concrete Strength (fc)        =       5.000 ksi.
      Main Rebar Strength (fy)      =      60.000 ksi.
      Stirrups Strength (fys)       =      60.000 ksi.
      Modulus of Elasticity (Es)    =   29000.000 ksi.

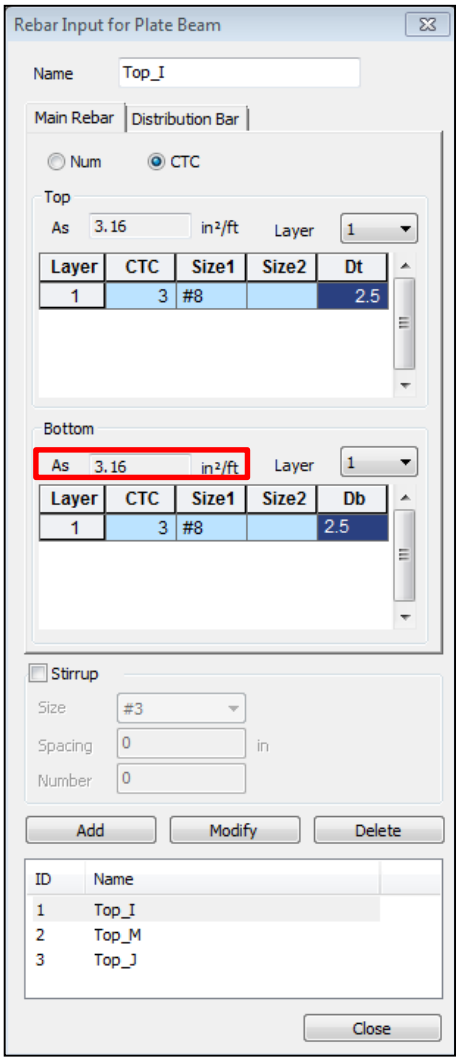
     < Selected Elements >
       All Elements
     < Positive Bending Moment >
        P-Mu =       0.00 in-kips/in., ELEM =   833,  LCB =   1,  NODE = Center
     < Negative Bending Moment >
        N-Mu =      28.75 in-kips/in., ELEM =  1020,  LCB =   3,  NODE =  1464
     < Shear Force >
        Vu   =      -0.55 kips/in.   , ELEM =   863,  LCB =   3,  NODE = Center

    *.REINFORCEMENT PATTERN :
        Dt  =       2.500  (  in. )
        Db  =       2.500  (  in. )
       ------------------------------------------------------
        Stirrups :  No BarNum

================================================================================
  [[[+]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
================================================================================

    ( ). Compute parameter.
        -. phi   =   0.90
        -. Alpha =   0.85
        -. Beta  =   0.80
        -. d     =      7.5000 in.
        -. ecu   =   0.0030
```

Graphic and Detail Report of Design Result



3. Plate Beam / Column Checking

▶ Main Rebar/Distribution Bar

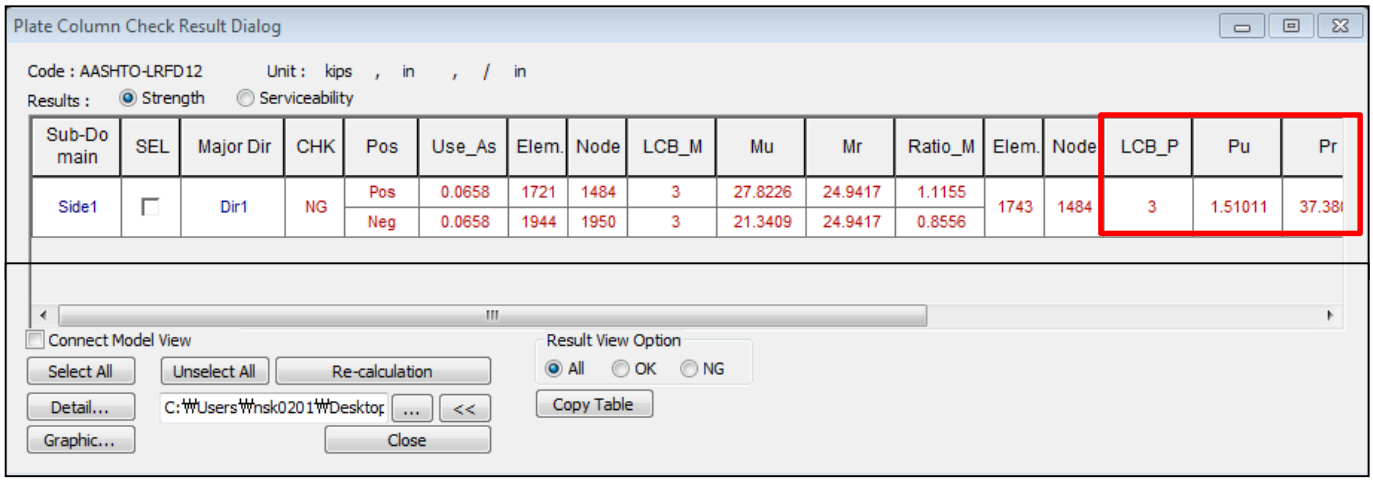
The rebar can be inputted with either the number of rebar (Num) of spacing of rebar(CTC).

**** Note : Distribution bar data must be inputted to create Rebar input data.***

The area of reinforcement (As) is expressed in terms of unit l ength and this is fixed as unit ft or unit m depending on whi ch unit system is chosen by the user.

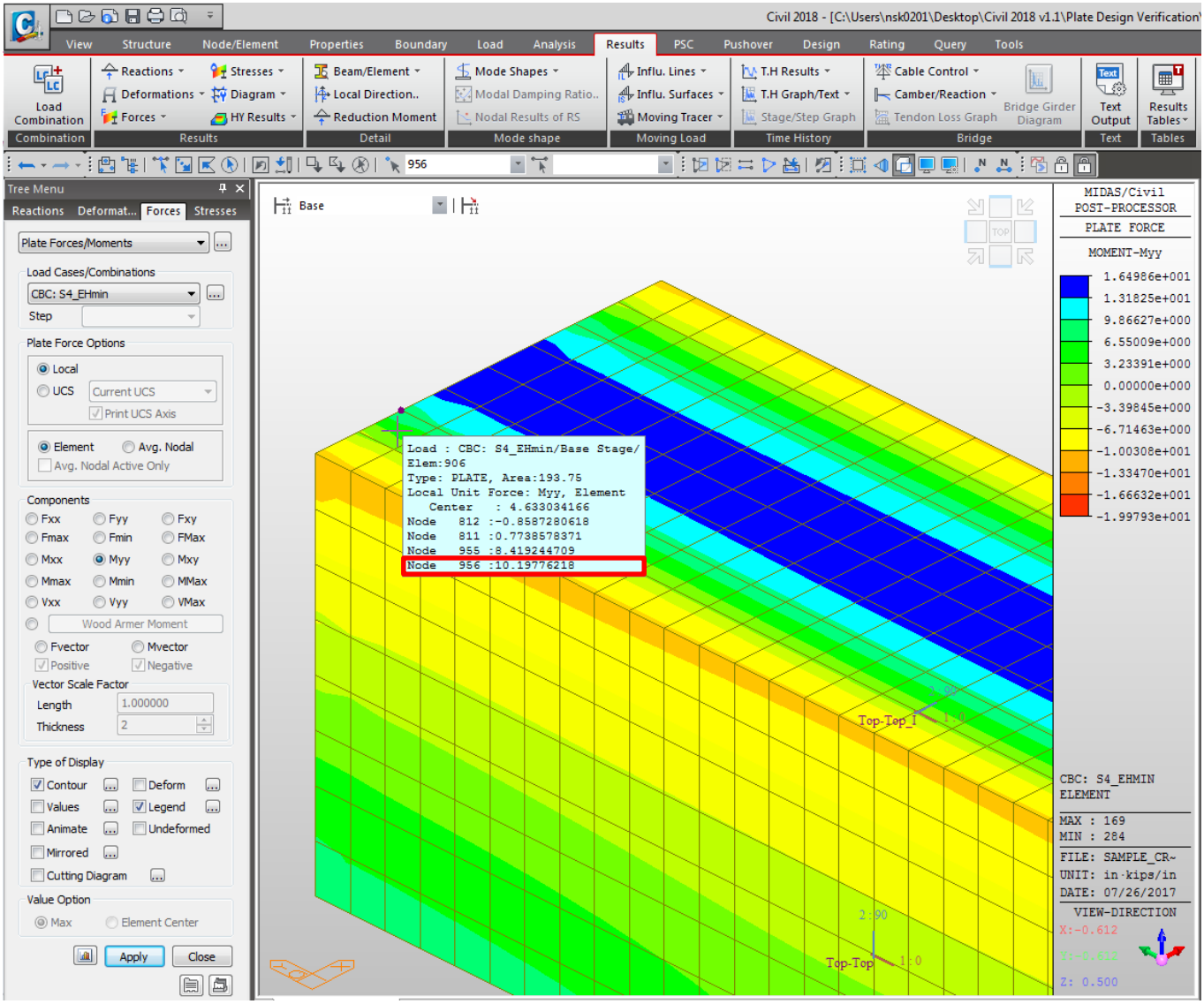
Plate Checking result shows the same member force results u sing the area of reinforcement inputted by the user. The only difference is that axial force result is shown in Plate Column Checking.

The main target of this function is culvert and abutment. Axi al force is not critical when we are designing culvert or abut ment. Therefore this feature does not consider the benefit of axial force in calculation of flexural strength. However the cal culation of axial resistance is provided in checking mode.



Graphic and Detail Report of Design Result

Design result can be double checked with the analysis result. The detail calculation can be checked in Detail report as well.



Analysis Result

Plate Beam Check Result Dialog

Code : AASHTO-LRFD12 Unit : kips , in , / in

Results : Strength Serviceability

Sub-Domain	SEL	Major Dir	CHK	Pos	Use_As	Elem.	Node	LCB_M	Mu	Mr	Ratio_M	Elem.	Node	LCB_V	Vu	Vr
Top_J		Dir1	OK	Pos	0.0658	185	216	4	10.1978	21.3610	0.4774	193	4	4	0.88765	7.290
				Neg	0.0658	193	4	3	13.7431	21.3610	0.6434					
Top_I		Dir2	OK	Pos	0.0658	906	956	4	10.1978	21.3610	0.4774	771	812	4	0.88765	7.290
				Neg	0.0658	771	809	3	13.7431	21.3610	0.6434					

Design Result

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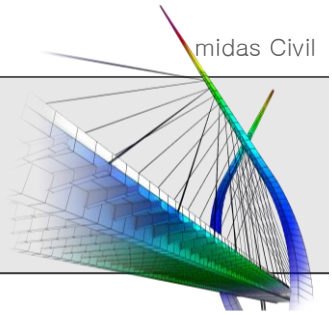

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      |  MIDAS IT Design Development Team                          |
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      |            HomePage : www.MidasUser.com                    |
      +============================================================+
      |  MIDAS/Civil  Version 8.6.5                                |
      +============================================================+


   *.DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
--------------------------------------------------------------------------------
    LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
--------------------------------------------------------------------------------
      1  1              SW( 1.250) +           EV( 1.300) +           EH( 1.350)
      2  1              SW( 1.250) +           EV( 1.300) +           EH( 0.900)
      3  1              SW( 1.500) +           EV( 1.300) +           EH( 1.350)
      4  1              SW( 1.500) +           EV( 1.300) +           EH( 0.900)
--------------------------------------------------------------------------------
```

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MIDAS/Civil - RC-Plate Beam Design  [ AASHTO-LRFD12 ]                    Civil 2018
================================================================================

    *.MIDAS/Civil - RC- PLATE BEAM Analysis/Design Program.

    *.PROJECT       :
    *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kips, in, /in
    *.SUB-DOMAIN        : Top_I     Member Type = PLATE BEAM(1D),   Dir  = 1  )

    *.DESCRIPTION OF PLATE BEAM DATA :
      Thickness             =        10.000 in.
      Unit Width            =             1 in.
      Concrete Strength (fc)        =         5.000 ksi.
      Main Rebar Strength (fy)      =        60.000 ksi.
      Stirrups Strength (fys)       =        60.000 ksi.
      Modulus of Elasticity (Es)    =     29000.000 ksi.

     < Selected Elements >
       All Elements
     < Positive Bending Moment >
        P-Mu =        0.00 in-kips/in., ELEM =   833,  LCB =   1,  NODE = Center
     < Negative Bending Moment >
        N-Mu =       28.75 in-kips/in., ELEM =  1020,  LCB =   3,  NODE =  1464
     < Shear Force >
        Vu   =       -0.55 kips/in.   , ELEM =   863,  LCB =   3,  NODE = Center

    *.REINFORCEMENT PATTERN :
        Dt  =         2.500  (  in. )
        Db  =         2.500  (  in. )
       ------------------------------------------------
        Stirrups :  No BarNum
```

```
================================================================================
  [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
================================================================================

    ( ). Compute parameter.
        -. phi   =   0.90
        -. Alpha =   0.85
        -. Beta  =   0.80
        -. d     =     7.5000 in.
        -. ecu   =  0.0030

    ( ). Compute maximum and minimum reinforcement.
        -. Rhomin1 = (1.2)*Mcr/[ phi*fy*b*d*(d-a/2) ]      =   0.0036
        -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ]        =   0.0000
        -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]               =   0.0036
        -. As_min =  Rhomin * Ag  =      0.0363 in^2/in.
```

```
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================================================================================

    ( ). Search for required reinforcement.....  Unit :  kips.,  in.
        ------------------------------------------------------------------------
          Trial    Assumed As(Top & Bottom)        Mr          Ratio     Status
        ------------------------------------------------------------------------
            1        0.0363                      7.19          0.000      O.K
        ------------------------------------------------------------------------

    ( ). Check moment capacity.
        -. c          =     0.3184 in.
        -. Cc         =       1.08 kips/in.
        -. Ts         =       1.09 kips/in.
        -. Mr         =       7.19 in-kips/in.
        -. Mu/Mr      =      0.000  --->  O.K !
```

```
================================================================================
  [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
================================================================================

    ( ). Compute parameter.
        -. phi   =   0.90
        -. Alpha =   0.85
        -. Beta  =   0.80
        -. d     =     7.5000 in.
        -. ecu   =  0.0030

    ( ). Compute maximum and minimum reinforcement.
        -. Rhomin1 = (1.2)*Mcr/[ phi*fy*b*d*(d-a/2) ]      =   0.0036
        -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ]        =   0.0140
        -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]               =   0.0036
        -. As_min =  Rhomin * Ag  =      0.1563 in^2/in.

    ( ). Search for required reinforcement.....  Unit :  kips.,  in.
        ------------------------------------------------------------------------
          Trial    Assumed As(Top & Bottom)        Mr          Ratio     Status
        ------------------------------------------------------------------------
            1        0.0363                      7.19          3.995      N.G
            2        0.1785                     32.97          0.872      O.K
            3        0.1074                     20.62          1.394      N.G
            4        0.1429                     26.86          1.070      N.G
            5        0.1607                     29.94          0.960      O.K
            6        0.1518                     28.41          1.012      N.G
            7        0.1563                     29.27          0.982      O.K
            8        0.1585                     29.61          0.971      O.K
        ------------------------------------------------------------------------
```

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    ( ). Check moment capacity.
        -. c          =     1.3906 in.
        -. Cc         =       4.73 kips/in.
        -. Ts         =       4.75 kips/in.
        -. Mr         =      29.61 in-kips/in.
        -. Mu/Mr      =      0.971  --->  O.K !

================================================================================
  [[[+]]]   ANALYZE SHEAR CAPACITY.
================================================================================

    ( ). Compute shear parameter.
        -. phi   =   0.90
        -. Av    =   0.0000 in^2/in.
        -. bv    =   1.00 in.
        -. dv    =   7.4648 in.  (for Beta Calculation)
        -. theta =   0.589 Deg.
        -. Epsilon_s = MIN[ (|Mu|/dv + 0.5*Nu + |Vu|)/(Es*As), 0.006 ] =  0.0014
        -. beta  = 4.8/(1+750*Epsilon_s) =  2.3817

    ( ). Compute shear strength of concrete.
        -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =     7.46 in.
        -. Vu    = -0.55 kips/in.
        -. Vc    = 0.0316*beta*SQRT[fc']*bv*dv =   1.26 kips/in.
        -. phiVc  = phi * Vc =   1.13 kips/in.
        -. Vn_lim = 0.25*fc'*bv*dv =   9.33 kips/in.

    ( ). Compute stirrup spacing.
        -. Maximum spacing smax   = MIN[ 0.8*dv, 24 in ] =    5.972 in.
        -. Vu < phiVc/2  --->  Not required shear reinforcement.
        -. Applied spacing s    = smax =    5.972 in.

    ( ). Compute shear strength of reinforcement.
        -. Vs     = Av*fys*dv*cot(theta) / s =     0.00 kips/in.
        -. Vs_lim  = 0.25*fc'*bv*dv - Vc =     8.07 kips/in.
        -. Vs     = MIN[ Vs, Vs_lim ] =     0.00 kips/in.
        -. phiVs   = phi*Vs =     0.00 kips/in.

        -. phiVs > (Vu-phiVc)  --->  O.K !
        -. Av_req  =  Vs / (fys*dv*cot(theta)) =   0.0000 in^2/in.

    ( ). Check tension force in the longitudinal reinforcement caused by shear.
        -. phib    =   0.90
        -. phiv    =   0.90
        -. Vsl     =  MIN[ Vs, Vu/phiv ] =     0.00 kips/in.
        -. As_req  = [ Mu/(phib*dv) + (Vu/phiv - 0.5*Vsl)*cot(theta) ] / fy =   0.0249 in^2/in.
        -. As      =   0.0101 in^2/in.
        -. As_req > As  --->  Under-reinforced !
```

Detail Result