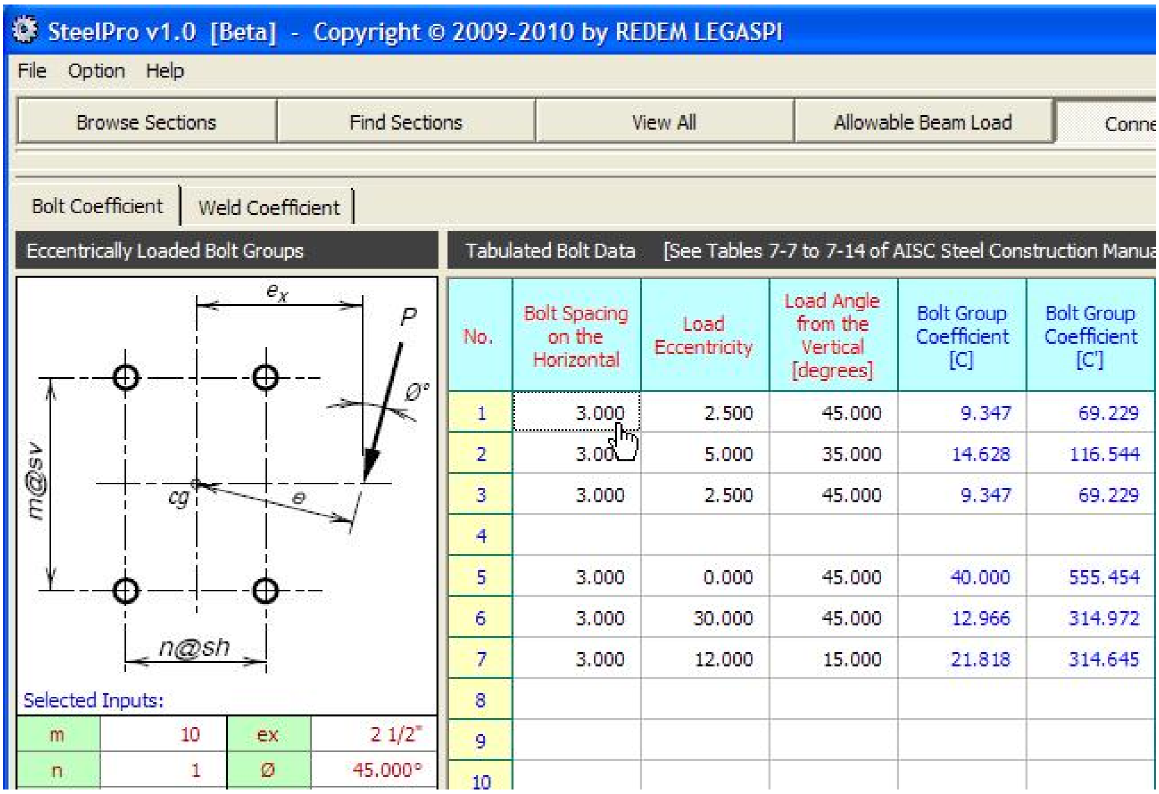
SHORTCUT TO CALCULATING THE VALUE OF BOLT GROUP COEFFICIENT

In the design of Bolted Connection, calculating the Strength of a Bolt Group using I.C. Method (Instantaneous Center of Rotation) is a nightmare for most engineers. The process involves the determination of the value of '***C***' that corresponds to the effective number of bolts in a Bolt Group subjected to Eccentric Load. Having no closed-form formula, the value of C is very infuriating to calculate; it requires the use of tables (Tables 7-7 ~ 7-14 in AISC 13th Edition) provided for by AISC Steel Construction Manual. The use of these tables to determine the value of C offers both ease and difficulty. The process becomes difficult when search values do not concur with the values on the tables – requiring designers to resort to 'inaccurate' linear interpolation.

Over a long period of time, in almost daily basis, I have struggled using this apparently crude method in my design work. In my desire to make my job much simpler and easier, I wrote Visual Basic Code (VBA) and finally solved the problem on finding the value of C without the use of tables. The program code is based on the discussion on pages 7-6 to 7-8 of AISC Steel Construction Manual 13th Edition. If you are a user of SteelPro's 'Connection Design Section' (as shown), the code that does the calculation of Bolt Group



Coefficient is the very same Visual Basic Code below. The code maybe embedded into your Excel Workbook and recognized by Excel as user function -- behaving like any other excel built-in mathematical functions that calculate values in response to user's input. With the code implemented to your spreadsheet, all you have to do is to supply the necessary function arguments into assigned cells in your spreadsheet. Finally, you get rid of the cumbersome use of Bolt Coefficient Tables.

For complete instructions on how to embed the VBA Code into your Workbook, please visit my very young blog:

http://engineersviewpoint.blogspot.com/2010/01/test.html
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VBA Code for Calculating the Value of Effective Bolt Coefficient

```
Option Explicit

Type BoltInfo
   Dv As Double
   Dh As Double
End Type

'''Effective Bolt Coefficient
Function BoltCoefficient(Bolt_Row As Integer, Bolt_Column As Integer,
Row_Spacing As Double, Column_Spacing As Double, Eccentricity As
Double, Optional Rotation As Double = 0) As Double
    Dim i, k, n As Integer
    Dim mP, vP, Ro As Double
    Dim Mo, Fy As Double
    Dim xi, yi As Double
    Dim Ri, x1 As Double
    Dim y1, Rot As Double
    Dim Rn, iRn As Double
    Dim Rv, Rh As Integer
    Dim Sh, Sv As Double
    Dim Ec As Double
    Dim Delta, Rmax As Double
    Dim BoltLoc() As BoltInfo
    Dim Stp As Boolean
    Dim J As Double
    Dim FACTOR As Double

    Rv = Bolt_Row
    Rh = Bolt_Column
    Sv = Row_Spacing
    Sh = Column_Spacing

    ReDim BoltLoc(Rv * Rh - 1)

    On Error Resume Next
```

```
    Rot = Rotation * 3.14159265358979 / 180
    Ec = Eccentricity * Cos(Rot)

    If Ec = 0 Then GoTo ForcedExit

    n = 0
    For i = 0 To Rv - 1
        For k = 0 To Rh - 1
            y1 = (i * Sv) - (Rv - 1) * Sv / 2
            x1 = (k * Sh) - (Rh - 1) * Sh / 2
            With BoltLoc(n)
                .Dv = x1 * Sin(Rot) + y1 * Cos(Rot) '''Rotate Vertical Coordinate
                .Dh = x1 * Cos(Rot) - y1 * Sin(Rot) '''Rotate Horizontal Coordinate
            End With
            n = n + 1
        Next
    Next

    Rn = 74 * (1 - Exp(-10 * 0.34)) ^ 0.55
    Ro = 0: Stp = False
    Do While Stp = False
        Rmax = 0
        For i = 0 To Rv * Rh - 1
            xi = BoltLoc(i).Dh + Ro
            yi = BoltLoc(i).Dv
            Rmax = Application.WorksheetFunction.Max(Rmax, Sqr(xi ^ 2 + yi ^ 2))
        Next

        Mo = 0:  Fy = 0
        mP = 0:  vP = 0
        J = 0
        For i = 0 To Rv * Rh - 1
            xi = BoltLoc(i).Dh + Ro
            yi = BoltLoc(i).Dv

            Ri = Sqr(xi ^ 2 + yi ^ 2)
            Delta = 0.34 * Ri / Rmax
            iRn = 74 * (1 - Exp(-10 * Delta)) ^ 0.55
            Mo = Mo + (iRn / Rn) * Ri '''Moment
            Fy = Fy + (iRn / Rn) * Abs(xi / Ri) * Sgn(xi) '''Vertical
            J = J + Ri ^ 2
        Next
        mP = Mo / (Abs(Ec) + Ro)
        vP = Fy
        Stp = Abs(mP - vP) <= 0.0001
        FACTOR = J / (Rv * Rh * Mo)
        Ro = Ro + Abs(mP - vP) * FACTOR / 2
        DoEvents
    Loop
    BoltCoefficient = (mP + vP) / 2

    Exit Function
ForcedExit:
    BoltCoefficient = Rv * Rh
End Function
```