รายการอ้างอิง

ภาษาไทย

วีระเดช พะเยาศิริพงศ์, **รวมกฎหมายก่อสร้าง**, สำนักพิมพ์พัฒนาศึกษา, 2001

อรรถวุฒิ อุบลจินดา, **การทนไฟขององค์อาคารเหล็กโครงสร้างรูปพรรณที่มีการป้องกันและมีค่าองค์ประกอบหน้าตัดสูง**, วิทยานิพนธ์ปริญญามหาบัณฑิต, ภาควิชาวิศวกรรมโยธา, คณะวิศวกรรมศาสตร์, จุฬาลงกรณ์มหาวิทยาลัย, 2545

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ภาคผนวก

ภาคผนวก ก.

ตัวอย่างแฟ้มข้อมูลที่ถูกสร้างขึ้นสำหรับประมาณค่าความหนาที่เหมาะสมของวัสดุเคลือบผิวป้องกันไฟกรณีเหล็กไวด์แฟลนจ์ W 125 × 23.8

```
!=========================================================================
!              H 125 x 125 x 6.5 x 9 mm. with 10 mm. & 30 mm. thk. Coating
!=========================================================================

!Set Thermal Analysis with H-Method
!==================================
/NOPR
/PMETH,OFF,0
KEYW , PR_SET, 1
KEYW , PR_STRUC, 0
KEYW , PR_THERM, 1
KEYW , PR_FLUID, 0
KEYW , PR_MULTI, 0
/GO
!
/PREP7                ! Enters The Model Creation Preprocessor
!
/UNITS,USER           ! Set Unit to User Defined Unit as Shown
                      ! Length         :   mm
                      ! Mass           :   kg
                      ! Time           :   sec.
                      ! Temperature    :   C , Centigrade degree
                      ! K              :   kg.mm/s^3.C    [from W/m.C]
                      ! C              :   mm^2/s^2.C     [from J/kg.C]
                      ! Dens           :   kg/mm^3        [from kg/m^3]
                      ! a = K/Dens.C   :   mm^2/s         [from m^2/s]
                      ! hc             :   kg/s^3.C       [from W/m^2.C]
                      ! Stefan Cons.   :   kg/s^3.C^4     [from W/m^2.C^4]
!
TOFFST,273            ! Set Temperature Offset to 273 for Centigrade Deg
!
ET,1,PLANE55          ! Set Element Type to PLANE55
!
!Set Material Properties
!=======================
!## Set K of Mate.Prop.1 (Steel)
MPTEMP,,,,,,,,        ! Clear Previous Mate.Prop.Temp.
MPTEMP,1,0
MPTEMP,2,100
MPTEMP,3,200
MPTEMP,4,300
MPTEMP,5,400
MPTEMP,6,500
MPTEMP,7,600
MPTEMP,8,700
MPTEMP,9,800
MPDATA,KXX,1,,5.400E+04
MPDATA,KXX,1,,5.067E+04
MPDATA,KXX,1,,4.734E+04
MPDATA,KXX,1,,4.401E+04
MPDATA,KXX,1,,4.068E+04
MPDATA,KXX,1,,3.735E+04
MPDATA,KXX,1,,3.402E+04
MPDATA,KXX,1,,3.069E+04
MPDATA,KXX,1,,2.730E+04
!
!## Set C of Mate.Prop.1 (Steel)
MPTEMP,,,,,,,,        ! Clear Previous Mate.Prop.Temp.
MPTEMP,1,0
```

```
MPTEMP,2,100
MPTEMP,3,200
MPTEMP,4,300
MPTEMP,5,400
MPTEMP,6,500
MPTEMP,7,600
MPTEMP,8,700
MPTEMP,9,800
MPDATA,C,1,,4.750E+08
MPDATA,C,1,,4.905E+08
MPDATA,C,1,,5.180E+08
MPDATA,C,1,,5.575E+08
MPDATA,C,1,,6.090E+08
MPDATA,C,1,,6.726E+08
MPDATA,C,1,,7.481E+08
MPDATA,C,1,,8.357E+08
MPDATA,C,1,,9.353E+08
!
!## Set Density of Mate.Prop.1 (Steel)
MPTEMP,,,,,,,,          ! Clear Previous Mate.Prop.Temp.
MPTEMP,1,0
MPTEMP,2,100
MPTEMP,3,200
MPTEMP,4,300
MPTEMP,5,400
MPTEMP,6,500
MPTEMP,7,600
MPTEMP,8,700
MPTEMP,9,800
MPDATA,DENS,1,,7.850E-06
MPDATA,DENS,1,,7.850E-06
MPDATA,DENS,1,,7.850E-06
MPDATA,DENS,1,,7.850E-06
MPDATA,DENS,1,,7.850E-06
MPDATA,DENS,1,,7.850E-06
MPDATA,DENS,1,,7.850E-06
MPDATA,DENS,1,,7.850E-06
MPDATA,DENS,1,,7.850E-06
!
!## Set K of Mate.Prop.2 (Fire Proofing Mate.)
MPTEMP,,,,,,,,          ! Clear Previous Mate.Prop.Temp.
MPTEMP,1,0
MPTEMP,2,100
MPTEMP,3,200
MPTEMP,4,300
MPTEMP,5,400
MPTEMP,6,500
MPTEMP,7,600
MPTEMP,8,700
MPTEMP,9,800
MPTEMP,10,900
MPTEMP,11,1200
MPDATA,KXX,2,,9.350E+01
MPDATA,KXX,2,,1.042E+02
MPDATA,KXX,2,,1.148E+02
MPDATA,KXX,2,,1.255E+02
MPDATA,KXX,2,,1.361E+02
MPDATA,KXX,2,,1.468E+02
MPDATA,KXX,2,,1.574E+02
MPDATA,KXX,2,,1.681E+02
MPDATA,KXX,2,,1.787E+02
MPDATA,KXX,2,,1.894E+02
MPDATA,KXX,2,,2.210E+02
!
!## Set C of Mate.Prop.2 (Fire Proofing Mate.)
MPTEMP,,,,,,,,          ! Clear Previous Mate.Prop.Temp.
MPTEMP,1,0
MPTEMP,2,100
MPTEMP,3,200
MPTEMP,4,300
MPTEMP,5,400
MPTEMP,6,500
MPTEMP,7,600
MPTEMP,8,700
MPTEMP,9,800
MPTEMP,10,900
MPTEMP,11,1200
```

```
MPDATA,C,2,,9.700E+08
MPDATA,C,2,,9.700E+08
MPDATA,C,2,,9.700E+08
MPDATA,C,2,,9.700E+08
MPDATA,C,2,,9.700E+08
MPDATA,C,2,,9.700E+08
MPDATA,C,2,,9.700E+08
MPDATA,C,2,,9.700E+08
MPDATA,C,2,,9.700E+08
MPDATA,C,2,,9.700E+08
MPDATA,C,2,,9.700E+08
!
!## Set Density of Mate.Prop.2 (Fire Proofing Mate.)
MPTEMP,,,,,,,,          ! Clear Previous Mate.Prop.Temp.
MPTEMP,1,0
MPTEMP,2,100
MPTEMP,3,200
MPTEMP,4,300
MPTEMP,5,400
MPTEMP,6,500
MPTEMP,7,600
MPTEMP,8,700
MPTEMP,9,800
MPTEMP,10,900
MPTEMP,11,1200
MPDATA,DENS,2,,8.900E-07
MPDATA,DENS,2,,8.900E-07
MPDATA,DENS,2,,8.900E-07
MPDATA,DENS,2,,8.900E-07
MPDATA,DENS,2,,8.900E-07
MPDATA,DENS,2,,8.900E-07
MPDATA,DENS,2,,8.900E-07
MPDATA,DENS,2,,8.900E-07
MPDATA,DENS,2,,8.900E-07
MPDATA,DENS,2,,8.900E-07
MPDATA,DENS,2,,8.900E-07
!
*DIM,TF,TABLE,37,1,1,TIME, ,       ! Create Array for Storing the Temperature of
Furnace
TF(1, 0, 1) = 0
TF(1, 1, 1) = 30
TF(2, 0, 1) = 300
TF(2, 1, 1) = 586.410430568309
TF(3, 0, 1) = 600
TF(3, 1, 1) = 688.427331513134
TF(4, 0, 1) = 900
TF(4, 1, 1) = 748.560952759175
TF(5, 0, 1) = 1200
TF(5, 1, 1) = 791.354927230988
TF(6, 0, 1) = 1500
TF(6, 1, 1) = 824.602639810069
TF(7, 0, 1) = 1800
TF(7, 1, 1) = 851.79587968833
TF(8, 0, 1) = 2100
TF(8, 1, 1) = 874.803680367253
TF(9, 0, 1) = 2400
TF(9, 1, 1) = 894.744236179681
TF(10, 0, 1) = 2700
TF(10, 1, 1) = 912.339984657452
TF(11, 0, 1) = 3000
TF(11, 1, 1) = 928.084808553963
TF(12, 0, 1) = 3300
TF(12, 1, 1) = 942.331313366404
TF(13, 0, 1) = 3600
TF(13, 1, 1) = 955.340051348972
TF(14, 0, 1) = 3900
TF(14, 1, 1) = 967.309014538336
TF(15, 0, 1) = 4200
TF(15, 1, 1) = 978.392187133376
TF(16, 0, 1) = 4500
TF(16, 1, 1) = 988.711692840945
TF(17, 0, 1) = 4800
TF(17, 1, 1) = 998.366020183992
TF(18, 0, 1) = 5100
TF(18, 1, 1) = 1007.43575360991
TF(19, 0, 1) = 5400
TF(19, 1, 1) = 1015.9876663282
```

```
TF(20, 0, 1) = 5700
TF(20, 1, 1) = 1024.07770658585
TF(21, 0, 1) = 6000
TF(21, 1, 1) = 1031.75321804906
TF(22, 0, 1) = 6300
TF(22, 1, 1) = 1039.05461855028
TF(23, 0, 1) = 6600
TF(23, 1, 1) = 1046.01668840216
TF(24, 0, 1) = 6900
TF(24, 1, 1) = 1052.66957241791
TF(25, 0, 1) = 7200
TF(25, 1, 1) = 1059.03956874565
TF(26, 0, 1) = 7800
TF(26, 1, 1) = 1071.02050168113
TF(27, 0, 1) = 8400
TF(27, 1, 1) = 1082.11393634527
TF(28, 0, 1) = 9000
TF(28, 1, 1) = 1092.442337554
TF(29, 0, 1) = 9600
TF(29, 1, 1) = 1102.10444976192
TF(30, 0, 1) = 10200
TF(30, 1, 1) = 1111.18105319515
TF(31, 0, 1) = 10800
TF(31, 1, 1) = 1119.73907338083
TF(32, 0, 1) = 11400
TF(32, 1, 1) = 1127.83457884828
TF(33, 0, 1) = 12000
TF(33, 1, 1) = 1135.51500951216
TF(34, 0, 1) = 12600
TF(34, 1, 1) = 1142.82086113662
TF(35, 0, 1) = 13200
TF(35, 1, 1) = 1149.78697780871
TF(36, 0, 1) = 13800
TF(36, 1, 1) = 1156.44355703389
TF(37, 0, 1) = 14400
TF(37, 1, 1) = 1162.81694087728
!
!Store the Dimension of Steel Area
!==================================
w = 59.25
x = 9
y = 62.5
z = 62.5
Dp1 = 10
!
!Create Macro SHOW
!=================
*CREATE,SHOW
!Set Coordinate and Create Areas
!================================

/PREP7
!
a = ARG1 + w
b = ARG1 + x
c = ARG1
d = ARG1 + y
e = ARG1 + z
f = w
g = ARG1 + ARG1 + x
GridMin = 0
*IF,d,GT,e,THEN
GridMax = d
*ELSE
GridMax = e
*ENDIF
GridSpc = GridMax/10
WPSTYL,,GridSpc,GridMin,GridMax,0.003,0,0,0  !Plot Controling
K,2,a,b
K,3,c,b
K,4,c,c
K,5,d,c
K,6,d,e
K,1,a,e
K,7,f,e
K,8,f,g
K,9,0,g
```

```
K,10,0,0
K,11,d,0
!
A,1,2,3,4,5,6
A,5,6,1,7,8,9,10,11
AOVLAP,ALL
!
!Set Mate.Prop.to Each Area
!==========================
ASEL,S,AREA,,1          ! Select Area No.1 (Steel)
AATT,1,,1,0             ! Set Mate.Prop.No.1 to Area No.1
ASEL,S,AREA,,3          ! Select Area No.3 (Fire Proofing Mate.)
AATT,2,,1,0             ! Set Mate.Prop.No.2 to Area No.3
ALLSEL,ALL              ! Select All Area
!
!Set Meshing Size and Mesh
!=========================
MSHKEY,0                ! Set Meshing Type to Free Meshing
ESIZE,1.08,0            ! Set Element Size
AMESH,1                 ! Mesh Area No.1 (Steel)
ElmSize = ARG1/8        ! Store Element Size
ESIZE,ElmSize,0         ! Set Element Size
AMESH,3                 ! Mesh Area No.3 (Fire Proofing Mate.)
!
/PNUM,MAT,1
EPLOT
/AUTO
/REPLOT
!
!Set Loads,Boundary Conditions and Analysis Options
!=================================================
/SOLU                   ! Enter The Solution Processor
!
TUNIF,30                ! Set Uniform Temp.as Initial Temp.Condition
!
SFL,8,CONV,25, , %TF%
SFL,9,CONV,25, , %TF%
SFL,10,CONV,25, , %TF%
SFL,11,CONV,25, , %TF%
!
ANTYPE,4                ! Set Analysis Type to Transient Analysis
TRNOPT,FULL             ! Set Transient Analysis Option to Full
OUTRES,NSOL,ALL,        ! Set Solution Control to Nodal DOF Solution
!
TIME,3600               ! Set for Analysis Time
AUTOTS,-1               ! Set Automatic Time Stepping to Program Option
DELTIM,60,60,60,1       ! Set Time Step Sizes [DTIME,DTMIN,DTMAX,Carry]
KBC,1                   ! Specifie Stepped or Ramped Loading to Stepped Loading
!
/STATUS,SOLU            ! Provide a solution status summary
SOLVE                   ! Start a solution
!
/POST1                  ! Enter the database results postprocessor
LSEL,S,,,1,4,1
NSLL,S,1
TMP1=0
J=0
*DO,I,1,400,1
*GET,TMP,TEMP,I
*IF,TMP,EQ,TMP0,THEN
*EXIT
*ENDIF
TMP1=TMP+TMP1
TMP0=TMP
J=J+1
*ENDDO
TAVG = TMP1/J           ! Get the Average Temperature on the Surface of Steel
!
/POST1                  ! Enter the database results postprocessor
PLNSOL,TEMP, ,0,        ! Display results as continuous contours
Optimal_Thickness = Dp3  ! Display the Optimal Thickness
Critical_Temp = 538      ! Display the Critical Temperature
*END
!
!Create Macro THICK
!==================
*CREATE,THICK
```

```
!Set Coordinate and Create Areas
!================================
/PREP7
!
a = ARG1 + w
b = ARG1 + x
c = ARG1
d = ARG1 + y
e = ARG1 + z
f = w
g = ARG1 + ARG1 +x
GridMin = 0
*IF,d,GT,e,THEN
GridMax = d
*ELSE
GridMax = e
*ENDIF
GridSpc = GridMax/10
WPSTYL,,GridSpc,GridMin,GridMax,0.003,0,0,0  !Plot Controling
K,2,a,b
K,3,c,b
K,4,c,c
K,5,d,c
K,6,d,e
K,1,a,e
K,7,f,e
K,8,f,g
K,9,0,g
K,10,0,0
K,11,d,0
!
A,1,2,3,4,5,6
A,5,6,1,7,8,9,10,11
AOVLAP,ALL
!
!Set Mate.Prop.to Each Area
!==========================
ASEL,S,AREA,,1          ! Select Area No.1 (Steel)
AATT,1,,1,0             ! Set Mate.Prop.No.1 to Area No.1
ASEL,S,AREA,,3          ! Select Area No.3 (Fire Proofing Mate.)
AATT,2,,1,0             ! Set Mate.Prop.No.2 to Area No.3
ALLSEL,ALL              ! Select All Area
!
!Set Meshing Size and Mesh
!=========================
MSHKEY,0                ! Set Meshing Type to Free Meshing
ESIZE,1.08,0            ! Set Element Size
AMESH,1                 ! Mesh Area No.1 (Steel)
ElmSize = ARG1/8        ! Store Element Size
ESIZE,ElmSize, 0        ! Set Element Size
AMESH,3                 ! Mesh Area No.3 (Fire Proofing Mate.)
!
/PNUM,MAT,1
EPLOT
/AUTO
/REPLOT
!
!Set Loads,Boundary Conditions and Analysis Options
!=================================================
/SOLU                   ! Enter The Solution Processor
!
TUNIF,30                ! Set Uniform Temp.as Initial Temp.Condition
!
SFL,8,CONV,25, , %TF%
SFL,9,CONV,25, , %TF%
SFL,10,CONV,25, , %TF%
SFL,11,CONV,25, , %TF%
!
ANTYPE,4                ! Set Analysis Type to Transient Analysis
TRNOPT,FULL             ! Set Transient Analysis Option to Full
OUTRES,NSOL,ALL,        ! Set Solution Control to Nodal DOF Solution
!
TIME,3600               ! Set for Analysis Time
AUTOTS,-1               ! Set Automatic Time Stepping to Program Option
DELTIM,60,60,60,1       ! Set Time Step Sizes [DTIME,DTMIN,DTMAX,Carry]
KBC,1                   ! Specifie Stepped or Ramped Loading to Stepped Loading
!
```

ประวัติผู้เขียนวิทยานิพนธ์

นาย วงศ์รวี คงมาก เกิดวันที่ 12 พฤษภาคม พ.ศ. 2522 ที่จังหวัดตรัง สำเร็จการศึกษาระดับระดับมัธยมศึกษาจากโรงเรียนสาธิตมหาวิทยาลัยสงขลานครินทร์ วิทยาเขตปัตตานี สำเร็จการศึกษาระดับปริญญาวิศวกรรมศาสตรบัณฑิต สาขาวิศวกรรมโยธา ภาควิชาวิศวกรรมโยธา คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ในปีการศึกษา 2542 และเข้าศึกษาต่อในหลักสูตรวิศวกรรมศาสตรมหาบัณฑิตที่จุฬาลงกรณ์มหาวิทยาลัย เมื่อ พ.ศ. 2544