

$trte()$

Nodos(x,y)

$$\begin{bmatrix} "x" \\ "y" \end{bmatrix} \begin{bmatrix} 0 & 1000 & 1000 & 0 \\ 0 & 0 & 1000 & 1000 \end{bmatrix}$$

Conectividad(xi,xm,xf)

$$\begin{bmatrix} "xi" \\ "xm" \\ "xf" \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 2 & 3 \\ 4 & 4 \end{bmatrix}$$

Datos (Area,es,E,v)

$$\begin{bmatrix} "Area" \\ "esp" \\ "E" \\ "v" \end{bmatrix} \begin{bmatrix} 500000. & 500000. \\ 1 & 1 \\ 210000 & 210000 \\ 0.3 & 0.3 \end{bmatrix}$$

MR Elemento 1

$$\begin{bmatrix} 155769. & 75000. & -115385. & -40384.6 & -40384.6 & -34615.4 \\ 75000. & 155769. & -34615.4 & -40384.6 & -40384.6 & -115385. \\ -115385. & -34615.4 & 115385. & 0. & 0. & 34615.4 \\ -40384.6 & -40384.6 & 0. & 40384.6 & 40384.6 & 0. \\ -40384.6 & -40384.6 & 0. & 40384.6 & 40384.6 & 0. \\ -34615.4 & -115385. & 34615.4 & 0. & 0. & 115385. \end{bmatrix}$$

MR Elemento 2

$$\begin{bmatrix} 40384.6 & 0. & -40384.6 & -40384.6 & 0. & 40384.6 \\ 0. & 115385. & -34615.4 & -115385. & 34615.4 & 0. \\ -40384.6 & -34615.4 & 155769. & 75000. & -115385. & -40384.6 \\ -40384.6 & -115385. & 75000. & 155769. & -34615.4 & -40384.6 \\ 0. & 34615.4 & -115385. & -34615.4 & 115385. & 0. \\ 40384.6 & 0. & -40384.6 & -40384.6 & 0. & 40384.6 \end{bmatrix}$$

MR Ensamble

$$\begin{bmatrix} 155769. & 75000. & -115385. & -40384.6 & 0 & 0 & -40384.6 & -34615.4 \\ 75000. & 155769. & -34615.4 & -40384.6 & 0 & 0 & -40384.6 & -115385. \\ -115385. & -34615.4 & 155769. & 0. & -40384.6 & -40384.6 & 0. & 75000. \\ -40384.6 & -40384.6 & 0. & 155769. & -34615.4 & -115385. & 75000. & 0. \\ 0 & 0 & -40384.6 & -34615.4 & 155769. & 75000. & -115385. & -40384.6 \\ 0 & 0 & -40384.6 & -115385. & 75000. & 155769. & -34615.4 & -40384.6 \\ -40384.6 & -40384.6 & 0. & 75000. & -115385. & -34615.4 & 155769. & 0. \\ -34615.4 & -115385. & 75000. & 0. & -40384.6 & -40384.6 & 0. & 155769. \end{bmatrix}$$

Q conocidos

$$Q \text{ GDL} [1 \ 2 \ 4 \ 7]$$

$$\text{Valor } Q [0 \ 0 \ 0 \ 0]$$

F conocidos

$$F \text{ GDL} [3 \ 5 \ 6 \ 8]$$

$$\text{Valor } F [10000 \ 10000 \ 10000 \ 10000]$$

KAA (Q con)

$$\begin{bmatrix} 155769. & -40384.6 & -40384.6 & 75000. \\ -40384.6 & 155769. & 75000. & -40384.6 \\ -40384.6 & 75000. & 155769. & -40384.6 \\ 75000. & -40384.6 & -40384.6 & 155769. \end{bmatrix}$$

KAB (Q desco)

$$\begin{bmatrix} -115385. & -34615.4 & 0. & 0. \\ 0 & 0 & -34615.4 & -115385. \\ 0 & 0 & -115385. & -34615.4 \\ -34615.4 & -115385. & 0. & 0. \end{bmatrix}$$

Q desconocidos

$$\begin{bmatrix} 0.066667 \\ 0.066667 \\ 0.066667 \\ 0.066667 \end{bmatrix}$$

Q solution

$$[0 \ 0 \ 0.066667 \ 0 \ 0.066667 \ 0.066667 \ 0 \ 0.066667]$$

Fext nodos

$$[-10000. \ -10000. \ 10000. \ -10000. \ 10000. \ 10000. \ -10000. \ 10000.]$$

u(x,y)/v(x,y) Elemento 1

(500 ,500)

$$[0.033333 \ 0.033333]$$

u(x,y)/v(x,y) Elemento 2

(500 ,500)

$$[0.033333 \ 0.033333]$$

Elemento 1

$\sigma_x/\sigma_y/\sigma_{xy}$

$$[20. \ 20. \ 0.]$$

$\epsilon_x/\epsilon_y/\epsilon_{xy}$

$$[0.000067 \ 0.000067 \ 0.]$$

Deformacion ϵ_z

-0.000057

EspesorFinal

0.999943

Elemento 2

$\sigma_x/\sigma_y/\sigma_{xy}$

$$[20. \ 20. \ -4.E-13]$$

$\epsilon_x/\epsilon_y/\epsilon_{xy}$

$$[0.000067 \ 0.000067 \ -5.E-18]$$

Deformacion ϵ_z

-0.000057

EspesorFinal

0.999943

Done



```

Define LibPub trte()=
Prgm
©Elemento Triangulo Tension Plana
©Creador: Ivan Fernandez Gracia
©Universidad de Santiago de Chile
©Ingenieria Civil Mecanica
©-----
©Sistema de Unidades SI
©-----
©L[mm]
©Modulo E[MPa]
©Inercia[mm4]
©Area[mm2]
©Torque[N·mm]
©Fuerza[N]
©-----
©Sistema de Unidades EG
©-----
©L[in]
©Modulo E[psi]
©Inercia[in4]
©Area[in2]
©Torque[lb·in]
©Fuerza[lb]
ClearAZ
©-----
©Definir variables
©-----
Local b,n,nn,desp,load,i,xn,yn
Local nii,nmm,nff,esp,eyoung,poison
Local y23,y31,y12,x32,x13,x21
Local hh,j,gdl1,gdl2
Local ii,jj,cont,cont2
Local xfijo,yfijo,n11,n22,n33
Local ez
©-----
©Entrada Datos
©-----
Request "Numero elementos",b,0
Request "Q conocidos",desp,0
Request " F conocidos",load,0
n:=b+2
nn:=2·n
©-----
©Crear memoria matriz
©-----
newMat(n,2)→nodos
newMat(b,3)→datosn
newMat(b,4)→datos
newMat(3,3)→de
newMat(3,6)→bb
newMat(6,6)→kb
newMat(nn,nn)→mrk

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```

newList(6) → gdl
newMat(desp,1) → mdesp1
newMat(desp,1) → mdesp2
newMat(load,1) → mload1
newMat(load,1) → mload2
newMat(nn-desp,nn-desp) → kprim
newMat(nn-desp,desp) → kab
newMat(nn,1) → ff
newMat(nn-desp,1) → fa
newMat(nn-desp,1) → qqprima
newMat(nn-desp,1) → ffprimagauss1
newMat(nn,1) → qq
newMat(2,1) → coordnat
newMat(2,1) → uv
newMat(2,6) → nder
newMat(6,1) → qqfijo
newMat(3,1) → tensore
newMat(3,1) → defunit
©-----
©Coordenadas Nodos
©-----
For i,1,n
Request "(x)Pos Nodo",xn,0
Request "(y)Pos Nodo",yn,0
nodos[i,1]:=xn
nodos[i,2]:=yn
EndFor
Disp "Nodos(x,y)"
Disp ["x",nodos'
      "y"]
©-----
©Matriz conectividad y Datos
©-----
For i,1,b
Request "Nodo ni/1",nii,0
Request "Nodo nm/2",nmm,0
Request "Nodo nf/3",nff,0
datosn[i,1]:=nii
datosn[i,2]:=nmm
datosn[i,3]:=nff
datos[i,1]:=0.5·det( $\begin{bmatrix} \text{nodos}[nii,1] & \text{nodos}[nii,2] & 1 \\ \text{nodos}[nmm,1] & \text{nodos}[nmm,2] & 1 \\ \text{nodos}[nff,1] & \text{nodos}[nff,2] & 1 \end{bmatrix}$ )
Request "Espesor",esp,0
datos[i,2]:=esp
Request "E",eyoung,0
datos[i,3]:=eyoung
Request "v",poison,0
datos[i,4]:=poison
EndFor
Disp "Conectividad(xi,xm,xf)"
Disp ["xi",
      "xm",
      "xf"],datosn'
Disp "Datos (Area,es,E,v)"

```

```

Disp [ "Area"
      "esp"
      "E"
      "v" ],datos'

```

```

©-----
©Creacion Matriz Db y kb
©-----

```

```

For i,1,b

```

$$\frac{\text{datos}[i,3]}{1-\text{datos}[i,4]^2} \cdot \begin{bmatrix} 1 & \text{datos}[i,4] & 0 \\ \text{datos}[i,4] & 1 & 0 \\ 0 & 0 & \frac{1-\text{datos}[i,4]}{2} \end{bmatrix} \rightarrow de$$

```

nii:=datosn[i,1]

```

```

nmm:=datosn[i,2]

```

```

nff:=datosn[i,3]

```

```

y23:=nodos[nmm,2]-nodos[nff,2]

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```

y31:=nodos[nff,2]-nodos[nii,2]

```

```

y12:=nodos[nii,2]-nodos[nmm,2]

```

```

x32:=nodos[nff,1]-nodos[nmm,1]

```

```

x13:=nodos[nii,1]-nodos[nff,1]

```

```

x21:=nodos[nmm,1]-nodos[nii,1]

```

$$\begin{bmatrix} y23 & 0 & y31 & 0 & y12 & 0 \\ 0 & x32 & 0 & x13 & 0 & x21 \\ x32 & y23 & x13 & y31 & x21 & y12 \end{bmatrix} \cdot \frac{1}{\det \begin{pmatrix} x13 & -y31 \\ -x32 & y23 \end{pmatrix}} \rightarrow bb$$

```

datos[i,2]·datos[i,1]·bb'·de·bb→kb

```

```

Disp "MR Elemento",i

```

```

Disp kb

```

```

gdl[1]:=2·nii-1

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```

gdl[2]:=2·nii

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```

gdl[3]:=2·nmm-1

```

```

gdl[4]:=2·nmm

```

```

gdl[5]:=2·nff-1

```

```

gdl[6]:=2·nff

```

```

For hh,1,6

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```

  For j,1,6

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```
    gdl1:=gdl[hh]

```

```
    gdl2:=gdl[j]

```

```
    mrk[gdl1,gdl2]:=kb[hh,j]+mrk[gdl1,gdl2]

```

```
  EndFor

```

```
EndFor

```

```
EndFor

```

```
Disp "MR Ensamble"

```

```
Disp mrk

```

```
©-----

```

```
©Cond.Desp.Q

```

```
©-----

```

```
For i,1,desp

```

```
  Request "Q GDL",mdesp1[i,1],0

```

```
  Request "Valor Q",mdesp2[i,1],0

```

```
EndFor

```

```
Disp "Q conocidos"

```

```
Disp "Q GDL",mdesp1'

```

```
Disp "Valor Q",mdesp2'

```

```
©-----

```

```
©Cond.Desp.F

```

```

©-----
For i,1,load
  Request "F GDL",mload1[i,1],0
  Request "Valor F",mload2[i,1],0
EndFor
Disp "F conocidos"
Disp "F GDL",mload1'
Disp "Valor F",mload2'
©-----
©Kaa (Q conocidos kprim)
©-----
i:=1
j:=1
ii:=1
jj:=1
While j≤nn
  cont:=0
  For h,1,desp
    If mdesp1[h,1]=i or mdesp1[h,1]=j Then
      cont:=cont+1
      If i=j Then
        cont:=cont+1
      EndIf
    EndIf
  EndFor
  If cont=0 Then
    kprim[ii,jj]:=mrk[i,j]
    jj:=jj+1
    If jj>nn-desp Then
      ii:=ii+1
      jj:=1
    EndIf
  EndIf
  j:=j+1
  If j=nn+1 Then
    j:=1
    i:=i+1
  EndIf
  If i=nn+1 Then
    j:=nn+1
  EndIf
EndWhile
Disp "KAA (Q con)"
Disp kprim
©-----
©Kab (Q desconocidos)
©-----
i:=1
j:=1
ii:=1
jj:=1
While j≤nn
  cont:=0
  For h,1,desp
    If mdesp1[h,1]=i or mdesp1[h,1]=j Then
      cont:=cont+1

```

```

If  $i=j$  Then
     $cont:=cont+1$ 
EndIf
EndIf
EndFor
 $cont2:=0$ 
For  $h,1,desp$ 
    If  $mdesp1[h,1]=i$  Then
         $cont2:=cont2+1$ 
    EndIf
EndFor
If  $cont=1$  and  $cont2=0$  Then
     $kab[ii,jj]:=mrk[i,j]$ 
     $jj:=jj+1$ 
    If  $jj>desp$  Then
         $ii:=ii+1$ 
         $jj:=1$ 
    EndIf
EndIf
 $j:=j+1$ 
If  $j=nn+1$  Then
     $j:=1$ 
     $i:=i+1$ 
EndIf
If  $i=nn+1$  Then
     $j:=nn+1$ 
EndIf
EndWhile
Disp "KAB (Q desco)"
Disp  $kab$ 
©-----
©Matriz Fext
©-----
For  $i,1,nn$ 
     $ff[i,1]:=0$ 
EndFor
For  $i,1,load$ 
     $ff[mload1[i,1],1]:=mload2[i,1]$ 
EndFor
©-----
©M Fext conocidas
©-----
For  $i,1,nn-desp$ 
     $fa[i,1]:=0$ 
EndFor
 $ii:=1$ 
For  $i,1,nn$ 
     $cont2:=0$ 
    For  $h,1,desp$ 
        If  $mdesp1[h,1]=i$  Then
             $cont2:=cont2+1$ 
        EndIf
    EndFor
    If  $cont2=0$  Then
         $fa[ii,1]:=ff[i,1]$ 
         $ii:=ii+1$ 
    EndIf
EndFor

```

```

EndIf
EndFor
©-----
©Solucionar Q desconocidos
©-----
ffprimagauss1:=kab·mdesp2
For i,1,nn-desp
ffprimagauss1[i,1]:=fa[i,1]-ffprimagauss1[i,1]
EndFor
For i,1,nn-desp
If kprim[i,i]=0 Then
kprim[i,i]:=1.E-7
EndIf
EndFor

qqprima:=kprim-1·ffprimagauss1
Disp "Q desconocidos"
Disp qqprima
©-----
©Crear M.Q.desp
©-----
For i,1,nn
qq[i,1]:=0
EndFor
For i,1,desp
qq[mdesp1[i,1],1]:=mdesp2[i,1]
EndFor
ii:=1
For i,1,nn
cont:=0
For h,1,desp
If mdesp1[h,1]=i Then
cont:=cont+1
EndIf
EndFor
If cont=0 Then
qq[i,1]:=qqprima[ii,1]
ii:=ii+1
EndIf
EndFor
Disp "Q solution"
Disp qqT
©-----
©Fuerzas nodales
©-----
Disp "Fext nodos"
Disp (mrk qq)T
©-----
©Des u(x,y)v(x,y) puntopartic
©-----
Request "Cantidad puntos",j,0
i:=1
While i≤j
Request "Elemento n°",jj,0
Request "xfijo",xfijo,0
Request "yfijo",yfijo,0
nii:=datosn[jj,1]

```

```

nmm:=datosn[jj,2]
nff:=datosn[jj,3]
y23:=nodos[nmm,2]-nodos[nff,2]
y31:=nodos[nff,2]-nodos[nii,2]
x32:=nodos[nff,1]-nodos[nmm,1]
x13:=nodos[nii,1]-nodos[nff,1]

$$\begin{bmatrix} x13 & -x32 \\ -y31 & y23 \end{bmatrix}^{-1} \cdot \begin{bmatrix} xfijo-nodos[nff,1] \\ yfijo-nodos[nff,2] \end{bmatrix} \rightarrow coornat$$

n11:=coornat[1,1]
n22:=coornat[2,1]
n33:=1-n22-n11

$$\begin{bmatrix} n11 & 0 & n22 & 0 & n33 & 0 \\ 0 & n11 & 0 & n22 & 0 & n33 \end{bmatrix} \rightarrow nder$$

gdl[1]:=2·nii-1
gdl[2]:=2·nii
gdl[3]:=2·nmm-1
gdl[4]:=2·nmm
gdl[5]:=2·nff-1
gdl[6]:=2·nff

$$\begin{bmatrix} qq[gdl[1],1] \\ qq[gdl[2],1] \\ qq[gdl[3],1] \\ qq[gdl[4],1] \\ qq[gdl[5],1] \\ qq[gdl[6],1] \end{bmatrix} \rightarrow qqfijo$$

nder·qqfijo→uv
Disp "u(x,y)/v(x,y)", "Elemento", jj
Disp "(", xfijo, ", ", yfijo, ")"
Disp uv
i:=i+1
EndWhile
©-----
©Tensor por elemento
©-----
For i,1,b

$$\frac{datos[i,3]}{1-datos[i,4]^2} \cdot \begin{bmatrix} 1 & datos[i,4] & 0 \\ datos[i,4] & 1 & 0 \\ 0 & 0 & \frac{1-datos[i,4]}{2} \end{bmatrix} \rightarrow de$$

nii:=datosn[i,1]
nmm:=datosn[i,2]
nff:=datosn[i,3]
y23:=nodos[nmm,2]-nodos[nff,2]
y31:=nodos[nff,2]-nodos[nii,2]
y12:=nodos[nii,2]-nodos[nmm,2]
x32:=nodos[nff,1]-nodos[nmm,1]
x13:=nodos[nii,1]-nodos[nff,1]
x21:=nodos[nmm,1]-nodos[nii,1]

$$\begin{bmatrix} y23 & 0 & y31 & 0 & y12 & 0 \\ 0 & x32 & 0 & x13 & 0 & x21 \\ x32 & y23 & x13 & y31 & x21 & y12 \end{bmatrix} \cdot \frac{1}{\det \begin{pmatrix} x13 & -y31 \\ -x32 & y23 \end{pmatrix}} \rightarrow bb$$

gdl[1]:=2·nii-1
gdl[2]:=2·nii
gdl[3]:=2·nmm-1

```

```

gdl[4]:=2· nmm
gdl[5]:=2· nff-1
gdl[6]:=2· nff

$$\begin{bmatrix} qq[gdl[1],1] \\ qq[gdl[2],1] \\ qq[gdl[3],1] \\ qq[gdl[4],1] \\ qq[gdl[5],1] \\ qq[gdl[6],1] \end{bmatrix} \rightarrow qqfijo$$

de· bb· qqfijo → tensore
Disp "Elemento",i
Disp "σx/σy/σxy"
Disp tensoret
bb· qqfijo → defunit
Disp "εx/εy/εxy"
Disp defunitt

$$\frac{\frac{-datos[i,3] \cdot datos[i,4]}{(1+datos[i,4]) \cdot (1-2 \cdot datos[i,4])}}{\frac{datos[i,3] \cdot datos[i,4]}{(1+datos[i,4]) \cdot (1-2 \cdot datos[i,4])} + 2 \cdot \frac{datos[i,3]}{2 \cdot (1+datos[i,4])}} \cdot (defunit[1,1] + defunit[2,1]) \rightarrow ez$$

Disp "Deformacion εz"
Disp ez
Disp "EspesorFinal"
Disp ez· datos[i,2]+datos[i,2]
EndFor
EndPrgm

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