

Annexe A

Exemple d'un fichier de donnée

Plaque triangulaire droite E-L-L (cas flexionnel)

6	14	31	12	12	8	6	0.2	0.3
10	17	6	2					
1		0.0		0.0				
2		0.3535		0.0				
3		0.7071		0.0				
4		0.3535		0.3535				
5		0.0		0.7071				
6		0.0		0.3535				
7		0.2357		0.2357				
8		0.0		0.0				
9		0.3535		0.0				
10		0.7071		0.0				
11		0.3535		0.3535				
12		0.0		0.7071				
13		0.0		0.3535				
14		0.2357		0.2357				
1	1 2 7 8	9 14 1 8	7 13 20 19	25 26 31 1 7	1 8 7 1			
2	2 3 7 9	10 14 2 9	8 14 21 20	26 27 31 2 8	2 9 8 2			
3	3 4 7 10	11 14 3 10	9 15 22 21	27 28 31 3 9	3 10 9 3			
4	4 5 7 11	12 14 4 11	10 16 23 22	28 29 31 4 10	4 11 10 4			
5	5 6 7 12	13 14 5 12	11 17 24 23	29 30 31 5 11	5 12 11 5			
6	6 1 7 13	8 14 6 7	12 18 19 24	30 25 31 6 12	6 7 12 6			
1	1	1	0					
2	1	1	0					
3	1	1	1					
4	1	1	1					
5	1	1	1					
6	1	1	0					
7	1	1	0					
10	1	1	1					
11	1	1	1					
12	1	1	1					
1	1	1	0					
2	1	1	0					
3	1	1	1					
4	1	1	1					
5	1	1	0					
6	1	1	0					
7	1	1	0					
8	1	1	0					
9	1	1	0					
10	1	1	0					
11	1	1	0					

12	1	1	0
15	1	1	1
16	1	1	1
27	1	1	1
28	1	1	1
29	1	1	1
1	1	1	0
2	1	1	0
3	1	1	0
4	1	1	0
5	1	1	0
6	1	1	0
3	1	1	1
4	1	1	1

Exemple d'un fichier de sortie

Plaque triangulaire droite E-L-L (cas flexionnel)

NTE = 6
 NTN = 14
 NTC = 31
 NTFT = 12
 NTFR = 12
 NNR = 10
 NCR = 17
 NFTR = 6
 NFRR = 2
 NP = 8
 NMODE = 6
 H = 2.000E-001
 XNU = 3.000E-001

NOEUD	X	Y
1	.00000000	.00000000
2	.35350000	.00000000
3	.70710000	.00000000
4	.35350000	.35350000
5	.00000000	.70710000
6	.00000000	.35350000
7	.23570000	.23570000
8	.00000000	.00000000
9	.35350000	.00000000
10	.70710000	.00000000
11	.35350000	.35350000
12	.00000000	.70710000
13	.00000000	.35350000
14	.23570000	.23570000

Elem N1 N2 N3 N4 N5 N6 C1 C2 C3 C4 C5 C6 C7 C8 C9 FT1 FT2 FR1 FR2 FR3 Inter

1	1	2	7	8	9	14	1	8	7	13	20	19	25	26	31	1	7	1	8	7	1
2	2	3	7	9	10	14	2	9	8	14	21	20	26	27	31	2	8	2	9	8	2
3	3	4	7	10	11	14	3	10	9	15	22	21	27	28	31	3	9	3	10	9	3
4	4	5	7	11	12	14	4	11	10	16	23	22	28	29	31	4	10	4	11	10	4
5	5	6	7	12	13	14	5	12	11	17	24	23	29	30	31	5	11	5	12	11	5
6	6	1	7	13	8	14	6	7	12	18	19	24	30	25	31	6	12	6	7	12	6

NOEUD	REST	R1	R2	R3
1		1	1	0
2		1	1	0
3		1	1	1
4		1	1	1
5		1	1	1
6		1	1	0

7	1	1	0
10	1	1	1
11	1	1	1
12	1	1	1
COTE REST			
	R1	R2	R3
1	1	1	0
2	1	1	0
3	1	1	1
4	1	1	1
5	1	1	0
6	1	1	0
7	1	1	0
8	1	1	0
9	1	1	0
10	1	1	0
11	1	1	0
12	1	1	0
15	1	1	1
16	1	1	1
27	1	1	1
28	1	1	1
29	1	1	1

FACE TRI RES			
	R1	R2	R3
1	1	1	0
2	1	1	0
3	1	1	0
4	1	1	0
5	1	1	0
6	1	1	0

FACE REC RES			
	R1	R2	R3
3	1	1	1
4	1	1	1

NEQ= 1694

PARAMETRES DE FREQUENCES:

1	.2024902D+01
2	.4507761D+01
3	.5977488D+01
4	.8526194D+01
5	.9237120D+01
6	.1116053D+02

Annexe B

Programme en Matlab pour le calcul des fonctions de forme et les intégrales

```
% programme pour calculer les fonctions de forme.
syms z x1 x2 x3 x px2 px3 pz gz
x1=1-x2-x3;
px2(1)=1;
px2(2)=2*x2-1;
for i = 2:12
px2(i+1)=(((4*(i-1)+2)*x2-2*(i-1)-1)*px2(i)-(i-1)*px2(i-1))/((i-1)+1);
end;
px3(1)=1;
px3(2)=2*x3-1;
for i = 2:12
px3(i+1)=(((4*(i-1)+2)*x3-2*(i-1)-1)*px3(i)-(i-1)*px3(i-1))/((i-1)+1);
end;
pz(1)=1;
pz(2)=2*z-1;
for i = 2:12
pz(i+1)=(((4*(i-1)+2)*z-2*(i-1)-1)*pz(i)-(i-1)*pz(i-1))/((i-1)+1);
end;
gz(1)=1-z;
gz(2)=z;
for i = 2:10
gz(i+1)= int(pz(i));
end;
F(1)=(1-z)*x1;
F(2)=(1-z)*x2;
F(3)=(1-z)*x3;
F(4)=z*x1;
F(5)=z*x2;
F(6)=z*x3;
F(7)=(1-z)*x1*x2*px2(1);
F(8)=(1-z)*x2*x3*px3(1);
F(9)=(1-z)*x1*x3*px3(1);
F(10)=z*x1*x2*px2(1);
F(11)=z*x2*x3*px3(1);
F(12)=z*x1*x3*px3(1);
F(13)=x1*gz(3);
F(14)=x2*gz(3);
F(15)=x3*gz(3);
F(16)=(1-z)*x1*x2*px2(2);
F(17)=(1-z)*x3*x2*px3(2);
F(18)=(1-z)*x1*x3*px3(2);
F(19)=z*x1*x2*px2(2);
F(20)=z*x3*x2*px3(2);
F(21)=z*x1*x3*px3(2);
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$F(22)=x1*gz(4);$
 $F(23)=x2*gz(4);$
 $F(24)=x3*gz(4);$
 $F(25)=(1-z)*x1*x2*x3*px2(1)*px3(1);$
 $F(26)=z*x1*x2*x3*px2(1)*px3(1);$
 $F(27)=(1-z)*x1*x2*px2(3);$
 $F(28)=(1-z)*x3*x2*px3(3);$
 $F(29)=(1-z)*x1*x3*px3(3);$
 $F(30)=z*x1*x2*px2(3);$
 $F(31)=z*x3*x2*px3(3);$
 $F(32)=z*x1*x3*px3(3);$
 $F(33)=x1*gz(5);$
 $F(34)=x2*gz(5);$
 $F(35)=x3*gz(5);$
 $F(36)=(1-z)*x1*x2*x3*px2(2)*px3(1);$
 $F(37)=(1-z)*x1*x2*x3*px2(1)*px3(2);$
 $F(38)=z*x1*x2*x3*px2(2)*px3(1);$
 $F(39)=z*x1*x2*x3*px2(1)*px3(2);$
 $F(40)=x1*x2*gz(3);$
 $F(41)=x2*x3*gz(3);$
 $F(42)=x1*x3*gz(3);$
 $F(43)=(1-z)*x1*x2*px2(4);$
 $F(44)=(1-z)*x3*x2*px3(4);$
 $F(45)=(1-z)*x1*x3*px3(4);$
 $F(46)=z*x1*x2*px2(4);$
 $F(47)=z*x3*x2*px3(4);$
 $F(48)=z*x1*x3*px3(4);$
 $F(49)=x1*gz(6);$
 $F(50)=x2*gz(6);$
 $F(51)=x3*gz(6);$
 $F(52)=(1-z)*x1*x2*x3*px2(3)*px3(1);$
 $F(53)=(1-z)*x1*x2*x3*px2(2)*px3(2);$
 $F(54)=(1-z)*x1*x2*x3*px2(1)*px3(3);$
 $F(55)=z*x1*x2*x3*px2(3)*px3(1);$
 $F(56)=z*x1*x2*x3*px2(2)*px3(2);$
 $F(57)=z*x1*x2*x3*px2(1)*px3(3);$
 $F(58)=x1*x2*px2(2)*gz(3);$
 $F(59)=x2*x3*px3(2)*gz(3);$
 $F(60)=x1*x3*px3(2)*gz(3);$
 $F(61)=x1*x2*gz(4);$
 $F(62)=x2*x3*gz(4);$
 $F(63)=x1*x3*gz(4);$
 $F(64)=x1*x2*x3*gz(3);$
 $F(65)=(1-z)*x1*x2*px2(5);$
 $F(66)=(1-z)*x3*x2*px3(5);$
 $F(67)=(1-z)*x1*x3*px3(5);$
 $F(68)=z*x1*x2*px2(5);$

$F(69)=z*x^3*x^2*px^3(5);$
 $F(70)=z*x^1*x^3*px^3(5);$
 $F(71)=x^1*gz(7);$
 $F(72)=x^2*gz(7);$
 $F(73)=x^3*gz(7);$
 $F(74)=(1-z)*x^1*x^2*x^3*px^2(1)*px^3(4);$
 $F(75)=(1-z)*x^1*x^2*x^3*px^2(2)*px^3(3);$
 $F(76)=(1-z)*x^1*x^2*x^3*px^2(3)*px^3(2);$
 $F(77)=(1-z)*x^1*x^2*x^3*px^2(4)*px^3(1);$
 $F(78)=z*x^1*x^2*x^3*px^2(1)*px^3(4);$
 $F(79)=z*x^1*x^2*x^3*px^2(2)*px^3(3);$
 $F(80)=z*x^1*x^2*x^3*px^2(3)*px^3(2);$
 $F(81)=z*x^1*x^2*x^3*px^2(4)*px^3(1);$
 $F(82)=x^1*x^2*px^2(2)*gz(4);$
 $F(83)=x^2*x^3*px^3(2)*gz(4);$
 $F(84)=x^1*x^3*px^3(2)*gz(4);$
 $F(85)=x^1*x^2*px^2(3)*gz(3);$
 $F(86)=x^2*x^3*px^3(3)*gz(3);$
 $F(87)=x^1*x^3*px^3(3)*gz(3);$
 $F(88)=x^1*x^2*gz(5);$
 $F(89)=x^2*x^3*gz(5);$
 $F(90)=x^1*x^3*gz(5);$
 $F(91)=x^1*x^2*x^3*px^2(1)*px^3(2)*gz(3);$
 $F(92)=x^1*x^2*x^3*px^2(2)*px^3(1)*gz(3);$
 $F(93)=x^1*x^2*x^3*gz(4);$
 $F(94)=(1-z)*x^1*x^2*px^2(6);$
 $F(95)=(1-z)*x^3*x^2*px^3(6);$
 $F(96)=(1-z)*x^1*x^3*px^3(6);$
 $F(97)=z*x^1*x^2*px^2(6);$
 $F(98)=z*x^3*x^2*px^3(6);$
 $F(99)=z*x^1*x^3*px^3(6);$
 $F(100)=x^1*gz(8);$
 $F(101)=x^2*gz(8);$
 $F(102)=x^3*gz(8);$
 $F(103)=(1-z)*x^1*x^2*x^3*px^2(1)*px^3(5);$
 $F(104)=(1-z)*x^1*x^2*x^3*px^2(2)*px^3(4);$
 $F(105)=(1-z)*x^1*x^2*x^3*px^2(3)*px^3(3);$
 $F(106)=(1-z)*x^1*x^2*x^3*px^2(4)*px^3(2);$
 $F(107)=(1-z)*x^1*x^2*x^3*px^2(5)*px^3(1);$
 $F(108)=z*x^1*x^2*x^3*px^2(1)*px^3(5);$
 $F(109)=z*x^1*x^2*x^3*px^2(2)*px^3(4);$
 $F(110)=z*x^1*x^2*x^3*px^2(3)*px^3(3);$
 $F(111)=z*x^1*x^2*x^3*px^2(4)*px^3(2);$
 $F(112)=z*x^1*x^2*x^3*px^2(5)*px^3(1);$
 $F(113)=x^1*x^2*gz(6);$
 $F(114)=x^2*x^3*gz(6);$
 $F(115)=x^1*x^3*gz(6);$
 $F(116)=x^1*x^2*px^2(2)*gz(5);$
 $F(117)=x^2*x^3*px^3(2)*gz(5);$

$F(118)=x_1*x_3*px_3(2)*gz(5);$
 $F(119)=x_1*x_2*px_2(3)*gz(4);$
 $F(120)=x_2*x_3*px_3(3)*gz(4);$
 $F(121)=x_1*x_3*px_3(3)*gz(4);$
 $F(122)=x_1*x_2*px_2(4)*gz(3);$
 $F(123)=x_2*x_3*px_3(4)*gz(3);$
 $F(124)=x_1*x_3*px_3(4)*gz(3);$
 $F(125)=x_1*x_2*x_3*px_2(1)*px_3(3)*gz(3);$
 $F(126)=x_1*x_2*x_3*px_2(2)*px_3(2)*gz(3);$
 $F(127)=x_1*x_2*x_3*px_2(3)*px_3(1)*gz(3);$
 $F(128)=x_1*x_2*x_3*px_2(1)*px_3(2)*gz(4);$
 $F(129)=x_1*x_2*x_3*px_2(2)*px_3(1)*gz(4);$
 $F(130)=x_1*x_2*x_3*gz(5);$
 $F(131)=(1-z)*x_1*x_2*px_2(7);$
 $F(132)=(1-z)*x_3*x_2*px_3(7);$
 $F(133)=(1-z)*x_1*x_3*px_3(7);$
 $F(134)=z*x_1*x_2*px_2(7);$
 $F(135)=z*x_3*x_2*px_3(7);$
 $F(136)=z*x_1*x_3*px_3(7);$
 $F(137)=x_1*gz(9);$
 $F(138)=x_2*gz(9);$
 $F(139)=x_3*gz(9);$
 $F(140)=(1-z)*x_1*x_2*x_3*px_2(1)*px_3(6);$
 $F(141)=(1-z)*x_1*x_2*x_3*px_2(2)*px_3(5);$
 $F(142)=(1-z)*x_1*x_2*x_3*px_2(3)*px_3(4);$
 $F(143)=(1-z)*x_1*x_2*x_3*px_2(4)*px_3(3);$
 $F(144)=(1-z)*x_1*x_2*x_3*px_2(5)*px_3(2);$
 $F(145)=(1-z)*x_1*x_2*x_3*px_2(6)*px_3(1);$
 $F(146)=z*x_1*x_2*x_3*px_2(1)*px_3(6);$
 $F(147)=z*x_1*x_2*x_3*px_2(2)*px_3(5);$
 $F(148)=z*x_1*x_2*x_3*px_2(3)*px_3(4);$
 $F(149)=z*x_1*x_2*x_3*px_2(4)*px_3(3);$
 $F(150)=z*x_1*x_2*x_3*px_2(5)*px_3(2);$
 $F(151)=z*x_1*x_2*x_3*px_2(6)*px_3(1);$
 $F(152)=x_1*x_2*gz(7);$
 $F(153)=x_2*x_3*gz(7);$
 $F(154)=x_1*x_3*gz(7);$
 $F(155)=x_1*x_2*px_2(2)*gz(6);$
 $F(156)=x_2*x_3*px_3(2)*gz(6);$
 $F(157)=x_1*x_3*px_3(2)*gz(6);$
 $F(158)=x_1*x_2*px_2(3)*gz(5);$
 $F(159)=x_2*x_3*px_3(3)*gz(5);$
 $F(160)=x_1*x_3*px_3(3)*gz(5);$
 $F(161)=x_1*x_2*px_2(4)*gz(4);$
 $F(162)=x_2*x_3*px_3(4)*gz(4);$
 $F(163)=x_1*x_3*px_3(4)*gz(4);$
 $F(164)=x_1*x_2*px_2(5)*gz(3);$
 $F(165)=x_2*x_3*px_3(5)*gz(3);$
 $F(166)=x_1*x_3*px_3(5)*gz(3);$


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F(167)=x1*x2*x3*px2(1)*px3(4)*gz(3);
F(168)=x1*x2*x3*px2(2)*px3(3)*gz(3);
F(169)=x1*x2*x3*px2(3)*px3(2)*gz(3);
F(170)=x1*x2*x3*px2(4)*px3(1)*gz(3);
F(171)=x1*x2*x3*px2(1)*px3(3)*gz(4);
F(172)=x1*x2*x3*px2(2)*px3(2)*gz(4);
F(173)=x1*x2*x3*px2(3)*px3(1)*gz(4);
F(174)=x1*x2*x3*px2(2)*gz(5);
F(175)=x1*x2*x3*px3(2)*gz(5);
F(176)=x1*x2*x3*gz(6);
dx(1,i)=diff(F(i),x1);
dx(2,i)=diff(F(i),x2);
dx(3,i)=diff(F(i),x3);
dz(i)=diff(F(i),z);
m=1;
for k=1:3;
    for l=1:3;
        for i=1:176;
            for j=1:i;
                A(i,j)=dx(k,i)*dx(l,j);
                A(i,j)=int(A(i,j),z,0,1);
                A(i,j)=int(A(i,j),x2,0,1-x3);
                A(i,j)=int(A(i,j),x3,0,1);
                A(i,j)=vpa(A(i,j));
                V(m)=A(i,j);
                m=m+1;
            end;
        end;
    end;
end;
VA=VA';
for k=1:3;
    for i=1:176;
        for j=1:i;
            B(i,j)=dx(k,i)*dz(j);
            B(i,j)=int(B(i,j),z,0,1);
            B(i,j)=int(B(i,j),x2,0,1-x3);
            B(i,j)=int(B(i,j),x3,0,1);
            B(i,j)=vpa(B(i,j));
            VB(m)=B(i,j);
            m=m+1;
        end;
    end;
end;
VB=VB';
for k=1:3;
    for i=1:176;
        for j=1:i;

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C(i,j)=dz(i)*dx(k,j);
C(i,j)=int(C(i,j),z,0,1);
C(i,j)=int(C(i,j),x2,0,1-x3);
C(i,j)=int(C(i,j),x3,0,1);
C(i,j)=vpa(C(i,j));
vVC(m)=C(i,j);
m=m+1
end;
end;
end;
VC=VC';
for i=1:176;
for j=1:i;
d(i,j)=dz(i)*dz(j);
d(i,j)=int(d(i,j),z,0,1);
d(i,j)=int(d(i,j),x2,0,1-x3);
d(i,j)=int(d(i,j),x3,0,1);
d(i,j)=vpa(d(i,j));
Vd(m)=d(i,j);
m=m+1
end;
end;
Vd=Vd';
for i=1:176;
for j=1:i;
M(i,j)=F(i)*F(j);
M(i,j)=int(M(i,j),z,0,1);
M(i,j)=int(M(i,j),x2,0,1-x3);
M(i,j)=int(M(i,j),x3,0,1);
M(i,j)=vpa(M(i,j));
VM(m)=M(i,j);
m=m+1
end;
end;
VM=VM';

```