Contact analysis in Nastran SOL101

Using linear-gap elements

by

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contact analysis by linear-gap

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objectives

Gap constraints in SOL101
from version 70.5

Gap Elements in SOL106
and SOL126

Overview, Comparison
methodology and tools

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Gap constraints in SOL101
from version 70.5

Do not require gap stiffness ◇

No friction considered ◇

Only opening or closing of gaps ◇

Constrain for single d.o.f ◇

Solution by iteration ◇

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Gap constraints in SOL101

characteristics

The displacement cannot be negative
– to Avoid Penetration ◇

the the chosen d.o.f must be
perpendicular to contact surface ◇

Chosen d.o.f must be positive
in the opening direction ◇

Chosen d.o.f must be positive
in the opening direction ◇

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Gap constraints in SOL101

solution

Constraints are solved by the
iterative technique ◇

The iteration starts with the random
vector of initial state – closed/open ◇

Solution obtained when – No
Penetration/ Tension Forces ◇

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Gap constraints in SOL101

Advantages

Alternative method to solution
using Gap in SOL 106 ◇

No Need for Gap Stiffness
calculations ◇

No know-how needed to control
nonlinear parameter as in SOL 106 ◇

SOl106 may not converge on some
cases and some Initial gap values ◇

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Gap constraints in SOL101

Advantages

No need of manual control and input
file parsing on every iteration ◇

Achieved full convergence ◇

The time/effort required is
negligible ◇

Fast turnaround time ◇

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Gap constraints in SOL101

Limitations

Only constraint displacement
non-linearity ◇

No Gap stiffness and no sliding
friction ◇

Free-Bodies cannot be analyzed ◇

No constraints changes allowed
between sub cases ◇

Solution may not converge ◇

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methodology

P = 30.

L = 60.
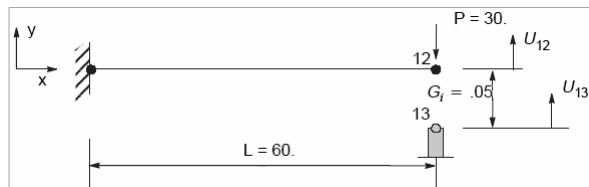
Penetrating Node 13   *Np*

Opening Node 12   *No*

Initial gap opening   *Gi*

Displacement of penetrating Node U_{13} *Up*

Displacement of opening Node U_{12} *Uo*

Actual gap displacement   *Ug*

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methodology

MPC Modeling

P = 30.

L = 60.
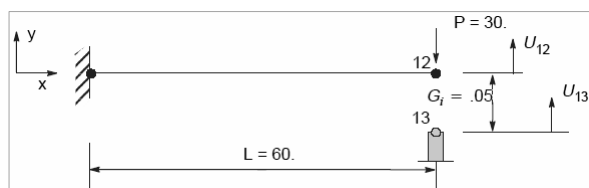
Actual Gap (Ug) = difference in displacement of (U_{13}) and (U_{12}) + initial gap(G_i)

$$Ug = U_{12} - U_{13} + G_i$$

or

$$Ug - U_{12} + U_{13} - G_i = 0$$

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MPC Modeling

$$U_g - U_{12} + U_{13} - G_i = 0$$

Since Ug cannot be dependent and U_{13} is constrained already

$$- U_{12} + U_g - G_i = 0$$

Assign SPOINT 51 for Ug and SPOINT 101 for G_i ◇

Assign SUPORT for Ug ◇

Apply initial gap displacement to G_i ◇

Create MPC using the Relation ◇

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Case and bulk cards

Max. No. of Iteration ◇
PARAM,CDITER, <integer>

Print Iteration History ◇
PARAM,CDPRT, <yes/no>

Punch Final Contact Status ◇
PARAM,CDSHUT, <yes/no>

Input Vector of Initial status
DMIG,CDSHUT ◇

Default – All closed

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Example1

Proj: Example Model-Basic

FORCE = 1.00e+04

CBAR

CBAR

2 Bolts As
CBAR12ϕ

6 points
u,v,w=0
$\theta x, \theta y, \theta z = 0$
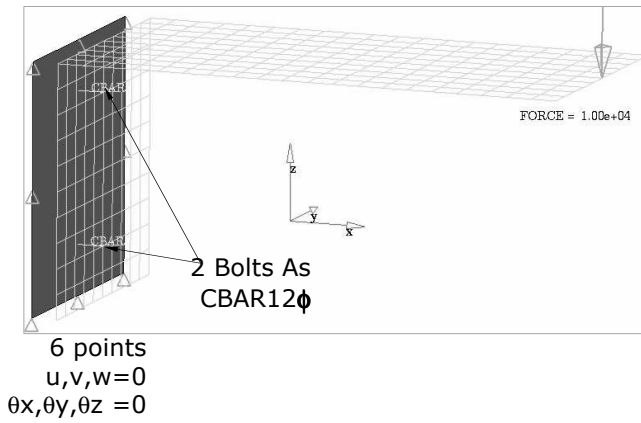
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Example1

Analyzed Models

Model Without
Contact

Model With
Contact
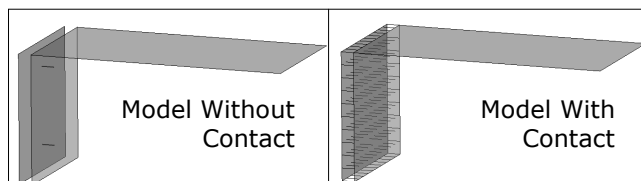
Methods used for contact

TempRod CBAR –

Cgap SOL106 –

Lingap SOL101 –

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Bulk Cards

```
ID TEST,p1
SOL 101
TIME 60.0
CEND
$$--------------------- Case Control Cards-------------
ECHO = NONE
TITLE        2 bolts with Lingap for contact
$$----------------------------------------------------
SET 1 = 1277,1278
$HMSET       1       2 "BOLTS"
$$----------------------------------------------------
SET 3 = 1065 THRU 1115,1117 THRU 1150,
        1152 THRU 1236,1238 THRU 1271,
        1273 THRU 1306,1332
$HMSET       2       1 "MPCforces"
$$----------------------------------------------------
DISPLACEMENT(PLOT)        = ALL
ELSTRESS(PLOT)            = ALL
ELFORCE(PRINT) = 1
MPCFORCES(SORT1,REAL)=ALL
SPCFORCES(SORT1,REAL)=ALL
GPFORCE (PLOT) = 2
$$----------------------------------------------------
MPC = 101
$$----------------------------------------------------
$HMNAME LOADSTEP               1"LOADSTEP1"
SUBCASE       1
   SPC   =       2
   LOAD  =       1
```

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Bulk Cards

```
$$------------------------------------------------------
$$                    Bulk Data Cards
$$------------------------------------------------------
BEGIN BULK
PARAM,   START,      1
PARAM,   SEQOUT,     0
PARAM,   OESX,      NO
PARAM,   OEFX,      NO
PARAM,AUTOSPC,YES
PARAM,BAILOUT,-1
PARAM,K6ROT,1.0
PARAM,NEWSEQ,3
PARAM,POST,-2
PARAM,PRGPST,NO
PARAM   CDITER  100
PARAM   CDPCH   YES
PARAM   CDPRT   YES
$$
$$  GRID Data
$$
GRID       1065     0.0    0.0    100.0
```

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Input for lingap

Bulk Cards

```
$   PLOTEL Elements
$
$
SPOINT,300001,300002
SUPORT,300001,0
SPC,101,300002,0,0
MPC,101,1074,1,1.0,1187,1,-1.0,,+MP1
+MP1,,300001,0,1.0,300002,0,-1.0
$
$
SPOINT,300003,300004
SUPORT,300003,0
SPC,101,300004,0,0
MPC,101,1073,1,1.0,1188,1,-1.0,,+MP2
+MP2,,300003,0,1.0,300004,0,-1.0
$
$
SPOINT,300005,300006
SUPORT,300005,0
SPC,101,300006,0,0
MPC,101,1072,1,1.0,1189,1,-1.0,,+MP3
+MP3,,300005,0,1.0,300006,0,-1.0
$
```

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Input for lingap

Bulk Cards

```
DMIG    CDSHUT  0       9       1       0                       1
DMIG    CDSHUT  1       0               300001  0       0.
        300003  0       0.              300005  0       0.
        300007  0       0.              300009  0       0.
        300011  0       0.              300013  0       0.
        300015  0       0.              300017  0       0.
        300019  0       0.              300021  0       0.
        300023  0       0.              300025  0       0.
        300027  0       0.              300029  0       0.
        300031  0       0.              300033  0       0.
$$  ........................................................
FORCE           1       1332            01.0000000.0000000.000000-10000.0
$$
$$   SPC Data
$$
SPC             1       1075   1234560.000000
SPC             1       1090   1234560.000000
SPC             1       1095   1234560.000000
SPC             1       1065   1234560.000000
SPC             1       1100   1234560.000000
SPC             1       1080   1234560.000000
SPC             1       1070   1234560.000000
SPC             1       1085   1234560.000000
SPCADD  2       1       101
$$
$$   SPCD Data
$$
ENDDATA
```
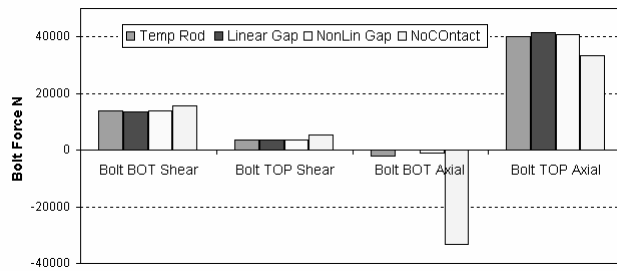
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Results and Discussion

Bolt Forces

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References

References

MSC/NASTRAN manuals from 70.5 ◇

Local Analysis of Fastener Holes using the
linear Gap Technology of MSC/NASTRAN
John McCullough and Lance Proctor ◇
Somewhere from the web

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