

Advanced Finite Elements

ME EN 7540

Static Hertz Contact Problem

Spring 2006

This is an example taken from ANSYS Verification Manual VM 63. A sphere of radius r is pressed against a rigid flat plane. Determine the contact radius, a , for a given load F .

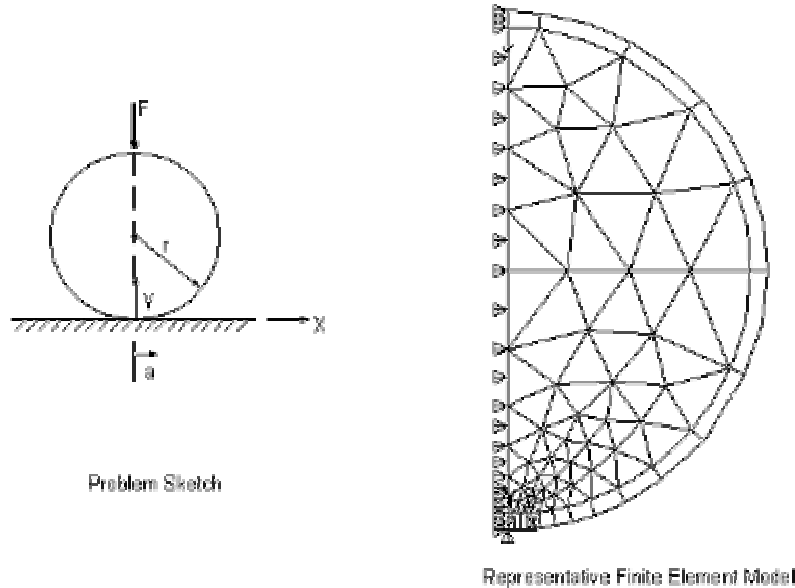


Figure 1. Static Hertz Problem

Table 1 Material, geometric, and loading properties

Material Properties	Geometric Properties	Loading
$E = 1000 \text{ N/mm}^2, \nu = 0.3$	$r = 8 \text{ mm}$	$F = (30 \times 2\pi) \text{ N}$

Analysis Assumptions and Modeling Notes

An axisymmetric model is used. A node is placed near the expected radius of contact. Midside nodes are removed along the surface where contact is likely to occur. The model is comprised of both PLANE82 and PLANE2 for verification purposes, but could be solved using either element type alone. The model is solved using 3-D node to node contact elements (CONTA178).

Input Listing

```
/PREP7
ET,1,PLANE82,,,1      ! AXISYMMETRIC ELEMENTS
ET,2,PLANE2,,,1
ET,3,178              ! NODAL CONTACT
R,1
RMOD,1,7,1           !CONTACT NORMAL ALONG UY
MP,EX,1,1E3
MP,NUXY,1,,3
LOCAL,11,1,0,8,0    ! LOCAL CYLINDRICAL C.S. AT CENTERLINE
K,1,8,-90            ! DEFINE KEYPOINTS
K,2,8
K,3,7.5,-90
K,4,7.5
K,5
K,6,8,-82.65        ! PLACE KEYPOINT AND NODE AT EXPECTED CONTACT RADIUS
K,7,7.5,-82.65
L,1,3                ! DEFINE LINES
L,2,4
L,6,7
LESIZE,ALL,,,1     ! DEFINE ELEMENT DIVISIONS ON ALL EXISTING LINES
A,1,6,7,3           ! DEFINE AREAS
A,6,2,4,7
A,3,7,4,5
LOCAL,12,0,0,8,0    ! CREATE HALF-SYMMETRY MODEL
ARSYM,Y,1,3,1
NUMMRG,KPOI
ESIZE,,4            ! DEFINE ELEMENT DIVISIONS ON REMAINING LINES
LESIZE,4,,,5
*REPEAT,2,1
LESIZE,6,,,8,8
LESIZE,7,,,8,(1/8)
LESIZE,10,,,1
*REPEAT,2,2
LESIZE,9,,,6,.2
TYPE,1              ! CREATE NODES AND ELEMENTS
AMESH,1,2,1
AMESH,4,5,1
TYPE,2
AMESH,3,6,3
CSYS,0
N,1001,-1,1E-8      !NODE 1001 IS THE GROUND
D,1001,ALL          !X POSITION DOES NOT MATTER IN THIS CASE BECAUSE
                   !THE CONTACT NORMAL IS ONLY ALONG UY

TYPE,3
REAL,1
EN,205,1001,2
EN,201,1001,4
EN,202,1001,6
EN,203,1001,8
EN,204,1001,10
EN,206,1001,31

MODMSH,NOCHECK
TYPE,1              ! REMOVE MIDSIDE NODES ALONG CONTACT SURFACE
EMODIF,7,7,0
*REPEAT,6,1
MODMSH,CHECK
FINISH

/SOLU
NSEL,S,LOC,X,-.01,.01 ! BOUNDARY CONDITIONS AND LOADING
D,ALL,UX,0
NSEL,R,LOC,Y,0
D,ALL,UY,0
NSEL,,ALL
LOAD=0
*CREATE,LOADSTEP    ! MACRO TO INCREMENTALLY APPLY LOAD
```

```

FK,8,FY,ARG1
SOLVE
*END
*DO,1,1,3
LOAD=LOAD-10
*USE,LOADSTEP,LOAD*6.2831853
*ENDDO
FINISH

/POST1                ! POSTPROCESS
SET,3
ESEL,,TYPE,,3
ETABLE,RFOR,SMISC,1
NSLE
NLIST                ! LIST COORDINATES OF NODES OF CONTACT SURFACE
PRNSOL,U,COMP        ! LIST DISPLACEMENTS OF NODES
*GET,EMAX,ELEM,,NUM,MAX
*DO,ENUM,201,EMAX    ! START SEARCH FROM ELEM 201
*GET,GRFR,ELEM,ENUM,ETAB,RFOR    ! FIND LAST ELEMENT IN CONTACT
*IF,GRFR,EQ,0.0,EXIT
*ENDDO
ESEL,,ELEM,,(ENUM-1) ! SELECT LAST CONTACTING ELEMENT
NSLE                ! SELECT NODES ATTACHED TO SELECTED ELEMENTS
*GET,NMIN,NODE,0,NUM,MIN
NODX=NX(NMIN)
NUX =UX(NMIN)
AACT=NODX+NUX      ! A - ACTUAL
*DIM,LABEL,CHAR,1,2
*DIM,VALUE,,1,1
LABEL(1,1) = 'A = '
LABEL(1,2) = ' mm'
*VFILL,VALUE(1,1),DATA,AACT
/COM
/OUTPUT,contact.txt
*VWRITE,LABEL(1,1),VALUE(1,1),LABEL(1,2)
(1X,A4,F10.3,A3)
/OUTPUT,,
FINISH

```