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RESEARCH ARTICLE

DESIGN AND ANALYSIS OF DRY CYLINDER LINERS OF COATED AND NONCOATED MATERIALS USED IN DIESEL ENGINES

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ABSTRACT

A Cylinder liner is a cylindrical part to be fixed in to an engine block to form a cylinder. It is one of the most significant efficient parts to make up the interior of an engine. Aim of the thesis is to design and analysis of a dry liner for diesel engines. The first step is to model the dry liner part by using Pro/Engineer. The dimension of the liner are taken from "Kusalava Industries", Vijayawada for the engine of Hino – X Ashok Leyland model. In the next step, the amount of heat generated, heat transfer rate of the component, temperature produced inside the cylinder are to be calculated. usually cylinder liners are ended of Cast Iron, Cast steel, Nickel CI, Nickel chrome CI. The surface of the liner is heat treated to obtain hard surface. The foremost aim of the document is to learn the heat transfer rate, heat flux, temperature distribution, thermal stresses, thermal strain, and thermal gradient of the liner by apply boundary circumstances as a temperature produced inside of the cylinder. And also by applying the surface coatings like ceramic, aluminum alloys and Nickel chrome alloy steel. Also we are conducting fatigue analysis on the liners. Fatigue analysis is used for finding the life time of the component means we can find out numeral of cycles it can with stand for the applied loads. By compa re the above results, the desirable type of liner in a diesel engine can be validated. Modeling is ended in Pro/Engineer and analysis is done in ANSYS.

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INTRODUCTION

Cylinder liners

Less hazard of defects. The more complex the casting, the more tricky to create a homogenous casting with low residual stresses. Cylinder liners from older lower powered engines had a consistent wall thickness and the cooling was achieve by circulating cooling water during a space formed between liner and jacket.

Types of cylinder liner

- Dry Cylinder Liners
- Wet Cylinder Liner

Functions of dry cylinder liners

Formation of sliding surface

- High anti-galling properties
- Less wear on the cylinder liner itself
- Less wear on the partner piston ring
- Less consumption of lubricant

Qualities of a good dry cylinder liner

A good liner must possess the following qualities

- Strength to resist the gas pressure
- Sufficiently hard to resist wear
- Strength to resist the thermal stresses owing to the heat flow through the liner wall.
- Corrosion resisting.
- Capable of taking a good bearing surface.
- It should by symmetrical in shape to avoid unequal deflection due to gas load and unequal expansion due to thermal load.
- No distortion of the inner surface due to restrictive fixings.

Dry cylinder liner materials

- Matrix - Pearlite
- Graphite – A & B Type

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- Free Ferrite – Max. 5%
- Free Carbide – Max. 5%

Dimensions

	Full Finish	Semi Finish	
	Dry & Wet Type	Wet Type	Dry Type
Inner Diameter	40 - 250 mm	40 - 250 mm	40 - 325 mm
Outer Diameter	45 - 350 mm	45 - 350 mm	45 - 350 mm
Length	Up to 375 mm	Up to 550 mm	Up to 700 mm

Geometrical Parameters

○	Ovality / Roundness (Circularity) - Within 1 thou
⊥	Perpendicularity - Within 1 thou
I	Taper - Within 1 thou
∠	Angularity - Within 1 thou
⌭	Cylindricity - Within 1 thou
◎	Concentricity - Within 1 thou

Finishing

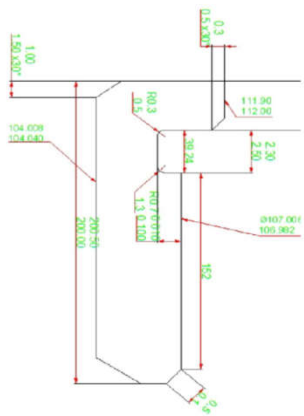
- Phosphating / Blackening
- Chrome Plating (Inner and Outer diameter)

Cylinder Liners for Aluminum Blocks

The main aim of the project is to analyze the strength of dry cylinder liner without taking coating material and by taking coating materials using coupled filed analysis. And also to characterize the capability of a material to survive the many cycles a component may experience during its lifetime using fatigue analysis.

Dry liners coating materials

A dissipation of a smaller amount heat from the cylinder liners necessitate the safety of their inside surfaces adjacent to overheating.



CHAPTER –II

Cylinder liner specifications

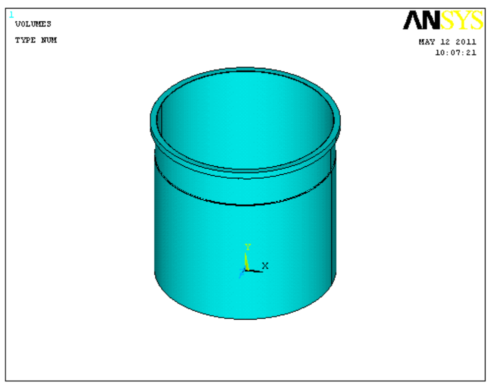
A variety of coating materials have been recommended which are supposed to be capable of making the cylinder liner surfaces resistant to fit and abrasion. Such optional materials include chromium carbide, titanium carbonate and oxide, chromium oxide, and alumina titanium.

Specifications of Hino-x 145
Bore = 104.04mm
Stroke = 4.72inch = 119.888mm
Maximum power = 175 hp @ 2500rpm
Maximum torque = 376 lbft @ 1600rpm
Displacement = 4730 cu cm = 4730000 cu mm =0.0011825 cum
No of cylinders = 4 cylinders
Outer diameter = 106.9940
Collar diameter = 112mm
Collar width = 8.09mm
Total length = 201.2mm
Capacity per cylinder = 1182500 cu mm
Density of diesel = 820 to 950 kg/cu m at 15^0c
= $0.00095 kg/cm^3$

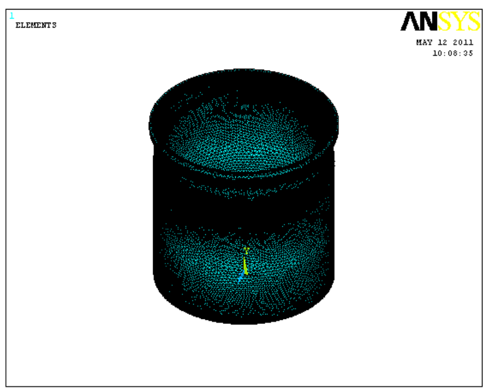
Density = $0.00000095 kg/mm^3$
Diesel $C_{10}H_{22}$ to $C_{15}H_{28}$
Molecular weight of $C_{15}H_{28}$ = 208 g/mole
Mass = density × volume
= 0.00000095× 1182500
m = 1.12kg
R = 8.314 j/mol k
Pv = mRT
$P = \frac{MRT}{V}$
$P = \frac{1.2\times8.314\times288}{0.208\times0.0011825}$
P = 10903645.34 J/m3
P = 10.9 N

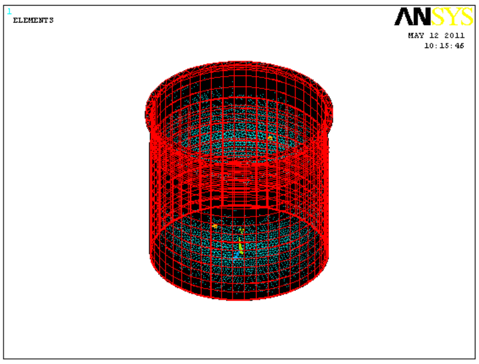
Uncoated cylinder liner

Model of Cylinder Liner



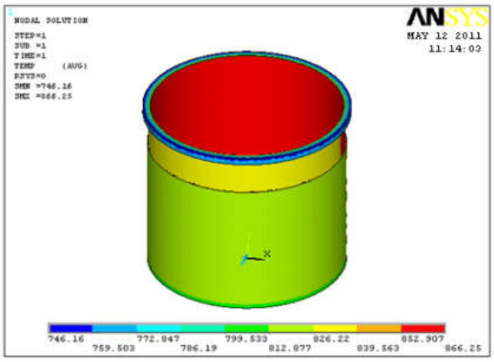
Meshed Surface of Cylinder Liner and Temperature Loads

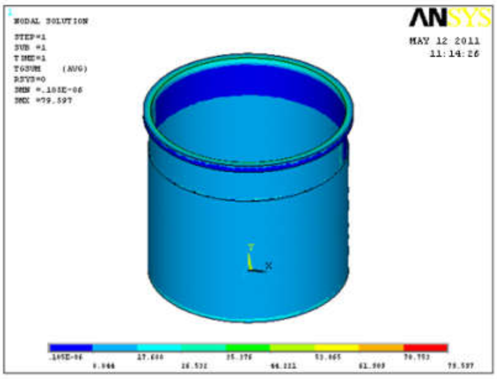


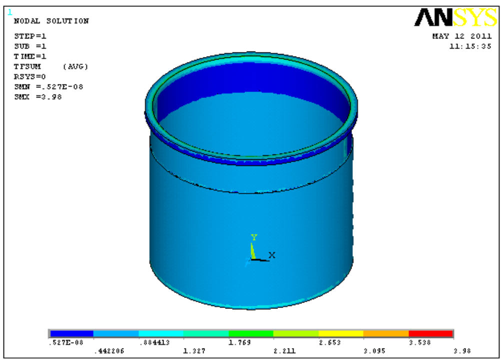


General Post Processor – Plot Results – Contour Plot – Nodal Solution – Stress – Nodal Temperature Nodal Temperature,

Nodal Temperature, Thermal gradient& Thermal flux







New analysis

For Cylinder Liner – Cast Iron
Structural Properties
Element Type: Solid 20 node 95
Material Properties: Density - 0.00000719kg/mm^3
Young's Modulus – 157000Mpa
Poisson's ratio -0.283

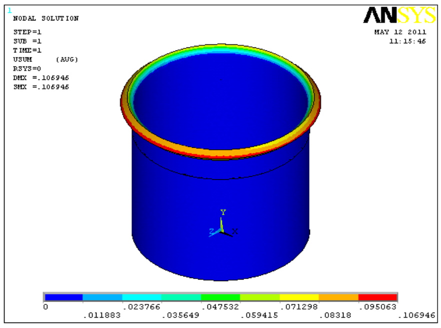
For Fin – Aluminum Alloy 6101
Element Type: Solid 20 node 95
Material Properties: Density - 0.0000027kg/mm^3
Young's Modulus – 69000Mpa
Poisson's ratio -0.32
Pressure – 10.9N/mm^2

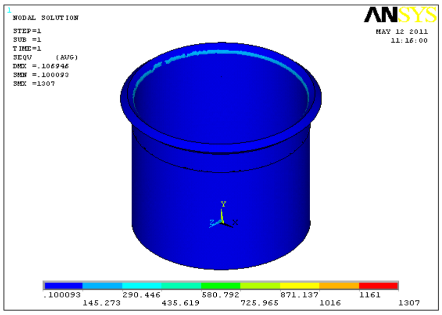
Loads – define Loads – Apply – Thermal – Convection – on areas
Bulk Temperature – 470K
Film Coefficient – 0.00234606W/mm^{2}K

Post Processor

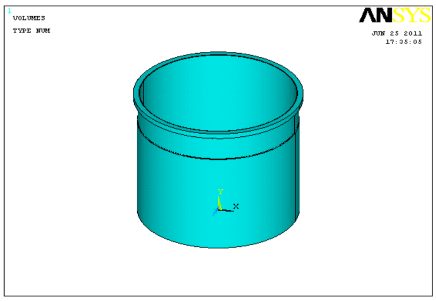
General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Sum

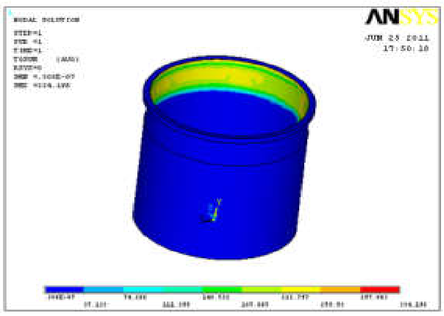
Displacement, Von Mises Stress





Cylinder liner coated with ceramic (PSZ)





Element Type: Solid 20 node 90

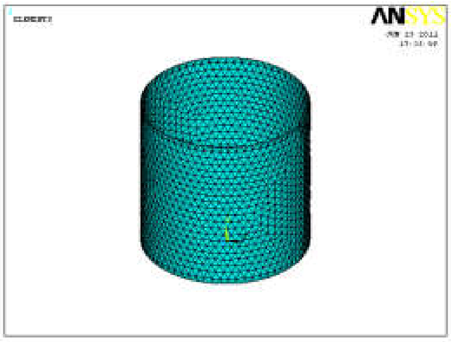
Material Properties: Thermal Conductivity – 25.2W/mk
Specific Heat – 506 J/kg k
Density - 0.00000719kg/mm^3
For Fin – Aluminum Alloy 6101

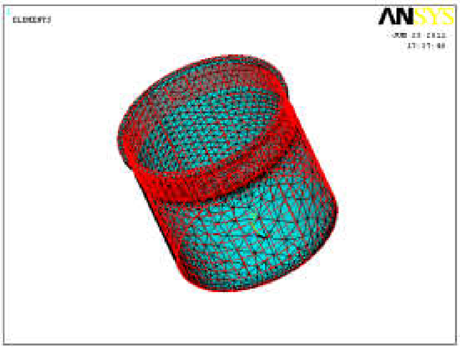
Element Type: Solid 20 node 90
Material Properties: Thermal Conductivity – 220W/mk
Specific Heat – 895 J/kg k
Density - 0.0000027kg/mm^3

For liner coating – Ceramic (PSZ)

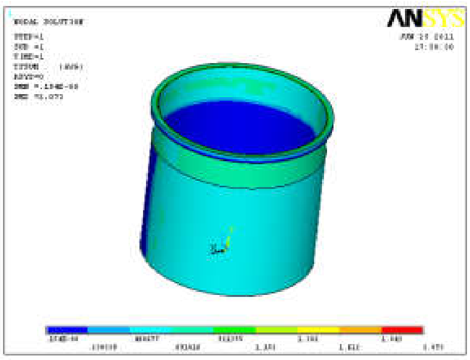
Element Type: Solid 20 node 90

Material Properties: Thermal Conductivity – 3W/mk
Specific Heat – 418.68 J/kg k
Density - 0.00000575kg/mm^3
Meshed Surface of Cylinder Liner, Temperature Loads& Thermal gradient





Thermal flux



For Cylinder Liner – Cast Iron

Structural Properties

Element Type: Solid 20 node 95

Material Properties: Density - 0.00000719kg/mm^3
Young's Modulus – 157000Mpa
Poisson's ratio -0.283
For Fin – Aluminum Alloy 6101

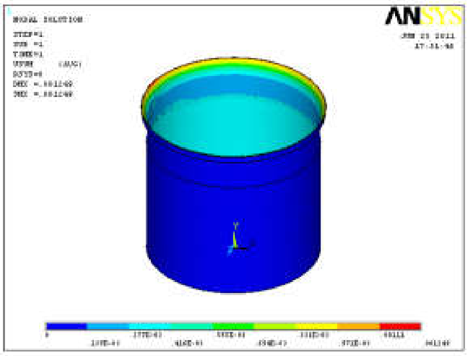
Element Type: Solid 20 node 95
Material Properties: Density - 0.0000027kg/mm^3
Young's Modulus – 69000Mpa
Poisson's ratio - 0.32
For liner coating – Ceramic (PSZ)

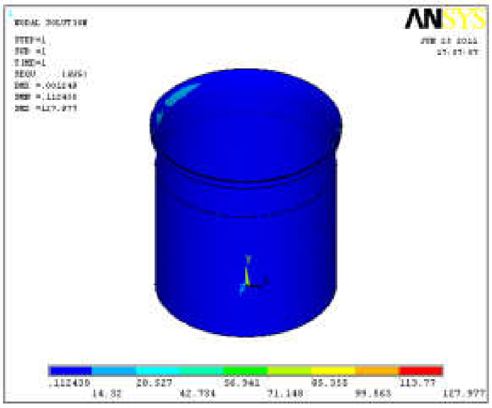
Element Type: Solid 20 node 95

Material Properties: Density - 0.00000719kg/mm^3
Young's Modulus – 157000Mpa
Poisson's ratio - 0.31
Pressure – 4.5N/mm^2
Loads – define Loads – Apply – Thermal – Convection – on areas
Bulk Temperature – 470K
Film Coefficient – 0.00234606W/mm^{2}K

Post Processor

General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Sum





Displacement, Von Mises Stress

Cylinder liner coated with aluminium oxide (Al_2O_3)

Material propertie

For Cylinder Liner – Cast Iron

Element Type: Solid 20 node 90

Material Properties: Thermal Conductivity – 25.2W/mk
Specific Heat – 506 J/kg k

Density - 0.00000719kg/mm^3

For Fin – Aluminum Alloy 6101

Element Type: Solid 20 node 90

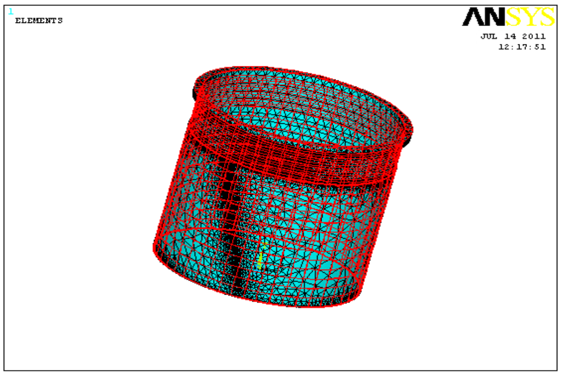
Material Properties: Thermal Conductivity – 220W/mk
Specific Heat – 895 J/kg k

Density - 0.0000027kg/mm^3
For liner coating – Al_2O_3
Element Type: Solid 20 node 90

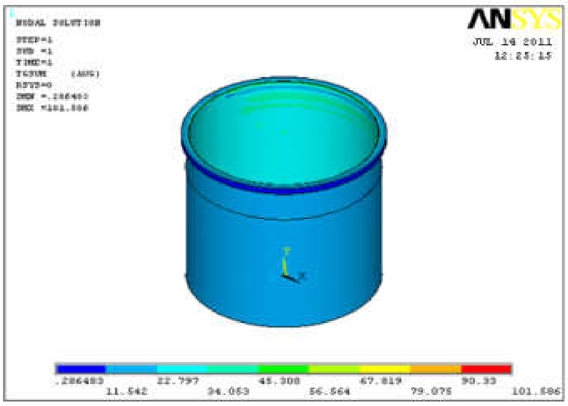
Material Properties: Thermal Conductivity – 25W/mk
Specific Heat – 880 J/kg k

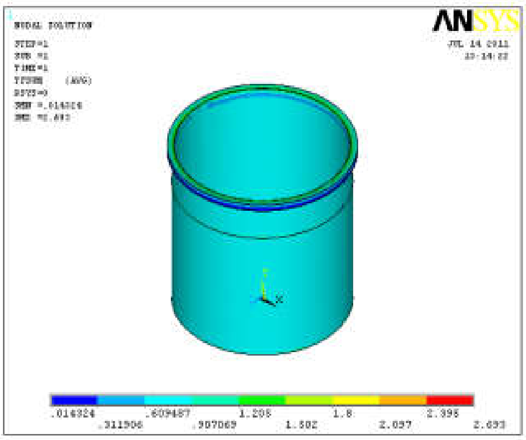
Density - 0.0000039kg/mm^3
LOADS
Temperature Loads
Temperature – 831K

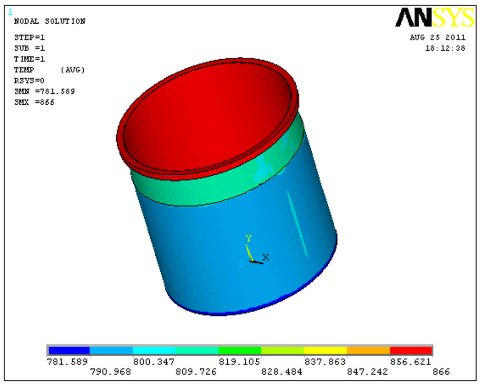
Temperature, Loads, solution



Temperature, Loads, solution







New analysis

For Cylinder Liner – Cast Iron
Structural Properties

Element Type: Solid 20 node 95

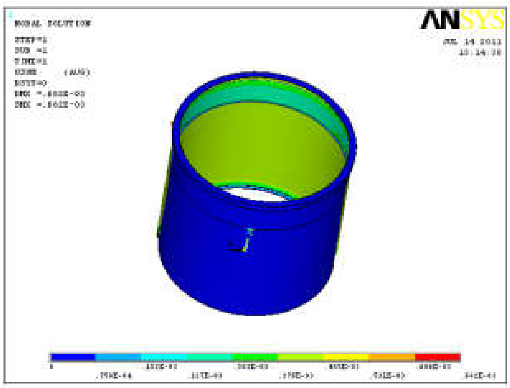
Material Properties: Density - 0.00000719kg/mm^3
Young's Modulus – 157000Mpa
Poisson's ratio -0.283
For Fin – Aluminum Alloy 6101
Element Type: Solid 20 node 95

Material Properties: Density - 0.0000027kg/mm^3
Young's Modulus – 69000Mpa
Poisson's ratio - 0.32
For liner coating – Al_2O_3

Element Type: Solid 20 node 95
Material Properties: Density - 0.0000039kg/mm^3
Young's Modulus – 353000Mpa
Poisson's ratio - 0.22
Pressure – 10.9N/mm^2
Loads – define Loads – Apply – Thermal – Convection – on areas
Bulk Temperature – 470K
Film Coefficient – 0.00234606W/mm^{2}K

Post Processor

General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Sum Displacement, Von Mises Stress



Cylinder liner coated with Nickel chrome alloy steel

Material properties

For Cylinder Liner – Cast Iron

Element Type: Solid 20 node 90

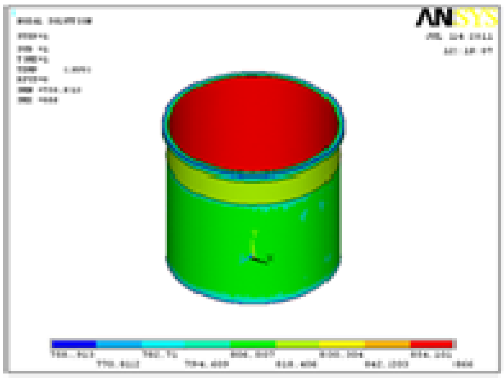
Material Properties: Thermal Conductivity – 25.2W/mk
Specific Heat – 506 J/kg k
Density - 0.00000719kg/mm^3
For Fin – Aluminum Alloy 6101

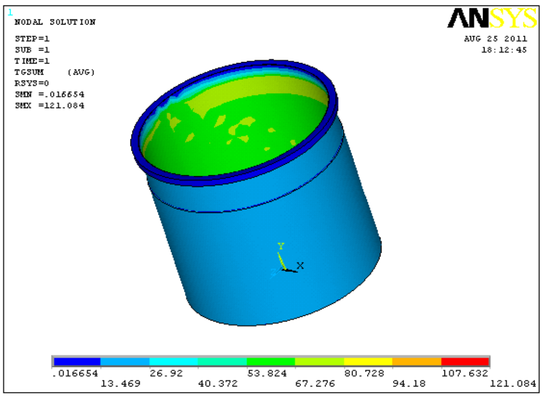
Element Type: Solid 20 node 90
Material Properties: Thermal Conductivity – 220W/mk
Specific Heat – 895 J/kg k
Density - 0.0000027kg/mm^3
For liner coating – Nickelchrome Alloy Steel

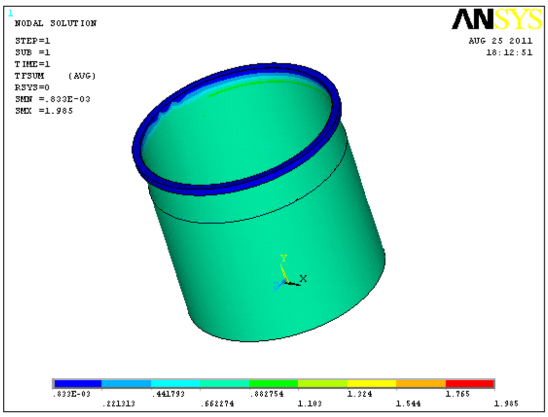
Element Type: Solid 20 node 90

Material Properties: Thermal Conductivity – 12W/mk
Specific Heat – 500 J/kg k
Density - 0.00000745kg/mm^3

Nodal Temperature, Thermal gradient, Thermal flux







For Cylinder Liner – Cast Iron

Structural Properties

Element Type: Solid 20 node 95

Material Properties: Density - 0.00000719kg/mm^3
Young's Modulus – 157000Mpa
Poisson's ratio -0.28
For Fin – Aluminum Alloy 6101

Element Type: Solid 20 node 95

Material Properties: Density - 0.0000027kg/mm^3
Young's Modulus – 69000Mpa
Poisson's ratio - 0.32
For liner coating – NickelChrome Alloy Steel

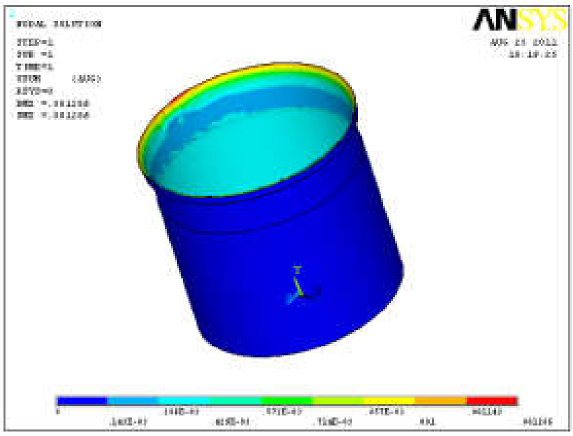
Element Type: Solid 20 node 95

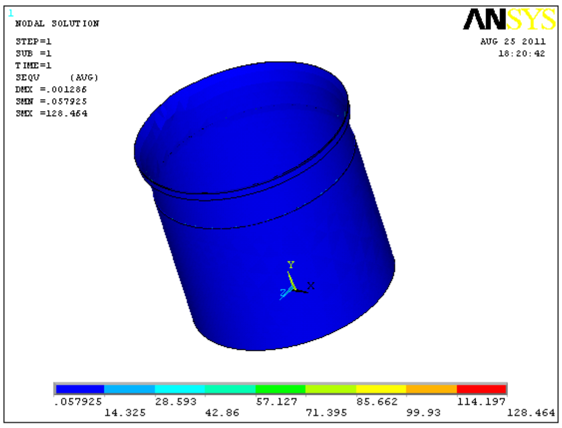
Material Properties: Density - 0.00000745kg/mm^3
Young's Modulus – 115000Mpa
Poisson's ratio - 0.32
Pressure – 10.9N/mm^2
Loads – define Loads – Apply – Thermal – Convection – on areas
Bulk Temperature – 470K
Film Coefficient – 0.00234606W/mm^{2}K

Post Processor

General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Sum

Displacement, Von Mises Stress





Material	Displacement (mm)	Von Mises Stress (N/mm^2)	Nodal Temperature (K)	Thermal Gradient (K/mm)	Thermal Flux (W/mm^2)
Without Coating	0.106946	1307	866.25	79.597	3.98
PSZ Coating	0.01249	127.977	866	334.196	2.073
Al_2O_3	0.000682	60.681	866	101.586	2.693
Nickel Chrome Coating	0.001286	128.464	866	121.084	1.985

RESULTS

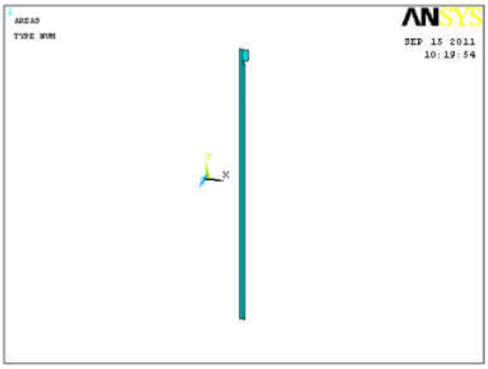
Fatigue analysis

Fatigue is the progressive and localized structural damage that occurs when a material is subjected to cyclic loading. The nominal maximum stress values are less than the ultimate tensile stress limit, and may be below the yield stress limit of the material.

Fatigue analysis

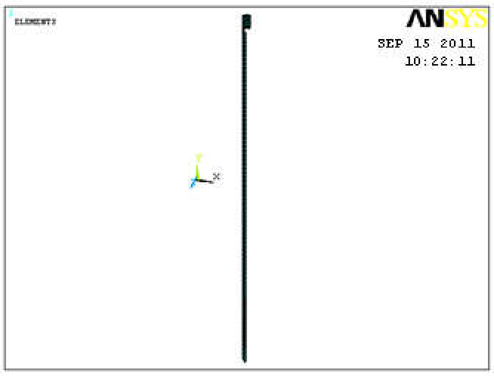
Uncoated

Surafce of liner



For Cylinder Liner – Cast Iron
Element Type – Solid 20 Node 95
Material Properties
Young's modules - 12.9e^6
Poisson ratio - 0.29
Density - 6800kg/m^3

Meshed Model



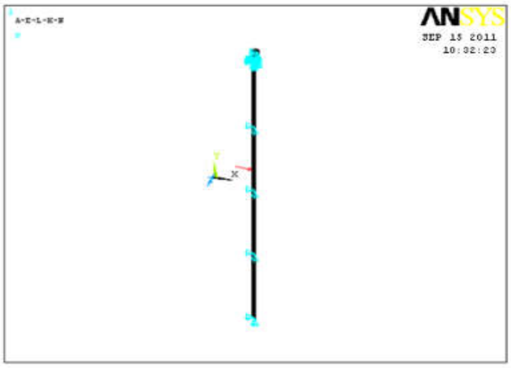
Solution

Analysis type
New analysis
Transient
Ok
Ok

Four load cases are applied

- 10.9 N. The time at the end of the load step is 10 seconds.
- -10.9 N. The time at the end of the load step is 20 seconds.
- 15 N. The time at the end of the load step is 30 seconds.
- -15 N. The time at the end of the load step is 40 seconds.

D.O.F Constraining



Stress Locations

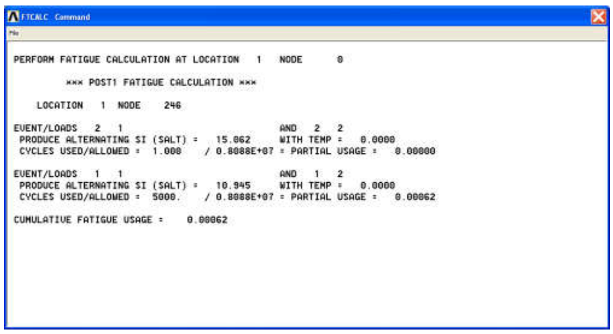
- NLOC = 1
- NODE = 246(node at the constrained area)
- NLOC = 2
- NODE = 25(node at the pressure area)
- NLOC = 3
- NODE = 275(node at the open area)

General Postproc

Fatigue
Property Table
S-N Table

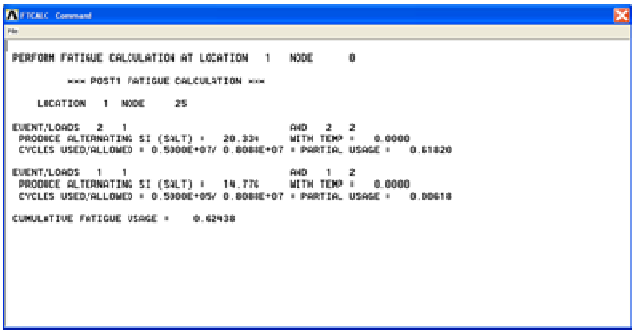
RESULTS

Node at constrained area



Node 246 at the constrained area. The Cumulative Fatigue Usage value is 0.00062, is the sum of the partial usage factors (Miner's rule).

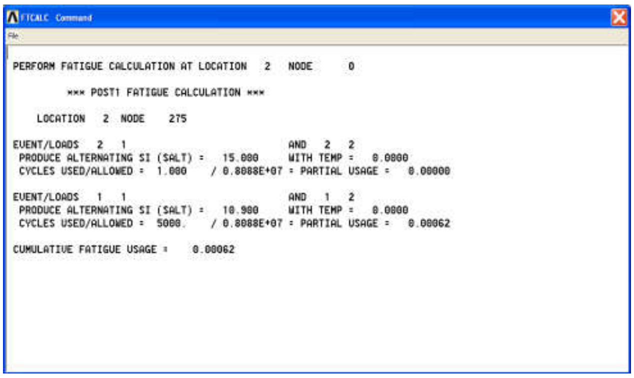
Node at pressure area



Node 25 at the pressure area:

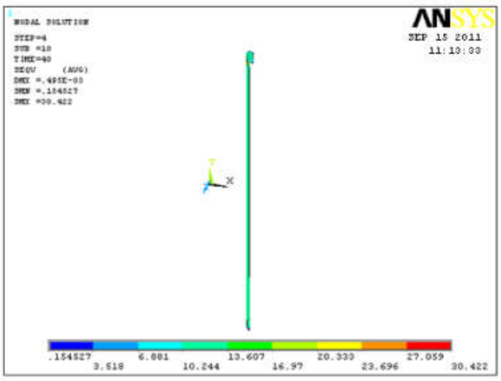
The Cumulative Fatigue Usage value is 0.62438, is the sum of the partial usage factors (Miner's rule).

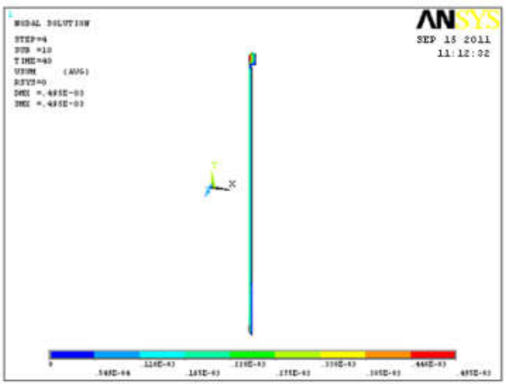
Node at open area



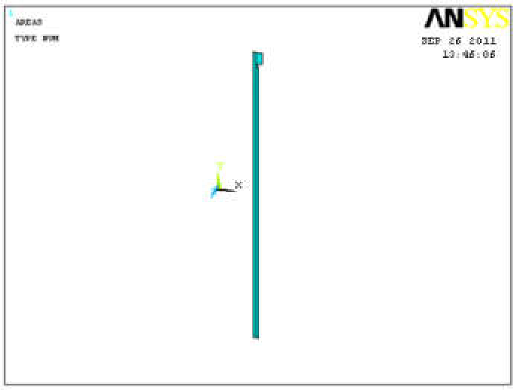
Node 275 at the open area. The Cumulative Fatigue Usage value is 0.00062, is the sum of the partial usage factors (Miner's rule).

Displacement, stress





Nickel chrome alloy



Surafce of Liner

For Cylinder Liner – Cast Iron
Structural Properties

Element Type: Solid 20 node 95

Material Properties: Density - 0.00000719kg/mm^3
Young's Modulus – 157000Mpa
Poisson's ratio -0.283
For Fin – Aluminum Alloy 6101

Element Type: Solid 20 node 95

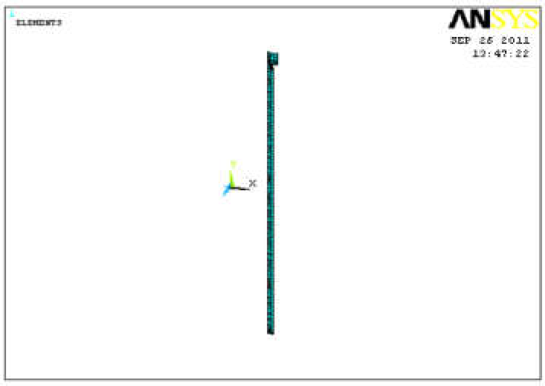
Material Properties: Density - 0.0000027kg/mm^3
Young's Modulus – 69000Mpa

Poisson's ratio - 0.32
For liner coating – Nickel Chrome alloy

Element Type: Solid 20 node 95

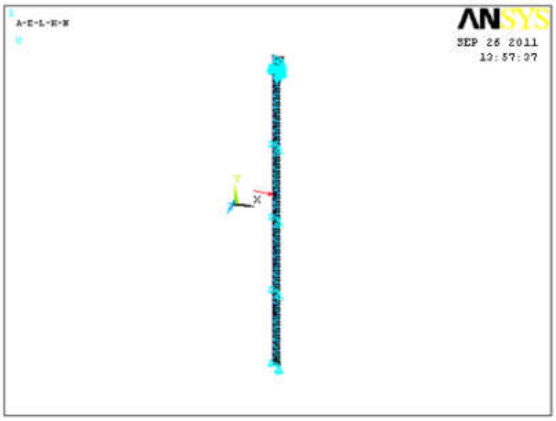
Material Properties: Density - 0.00000719kg/mm^3
Young's Modulus – 157000Mpa
Poisson's ratio - 0.31

Meshed Model



Four load cases are applied

- 10.9 N. The time at the end of the load step is 10 seconds.
- -10.9 N. The time at the end of the load step is 20 seconds.
- 15 N. The time at the end of the load step is 30 seconds.
- -15 N. The time at the end of the load step is 40 seconds.



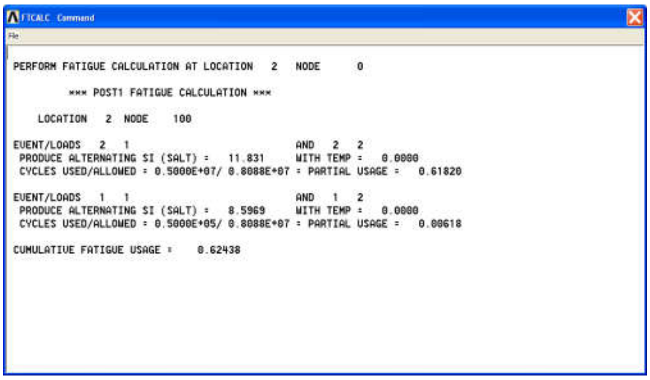
D.O.F Constraining

Stress Locations

NLOC = *1*
NODE = *328* (node at the open area)
NLOC = *2*
NODE = *100* (node at the constrained area)
NLOC = *3*
NODE = 295(node at the pressure area)

RESULTS

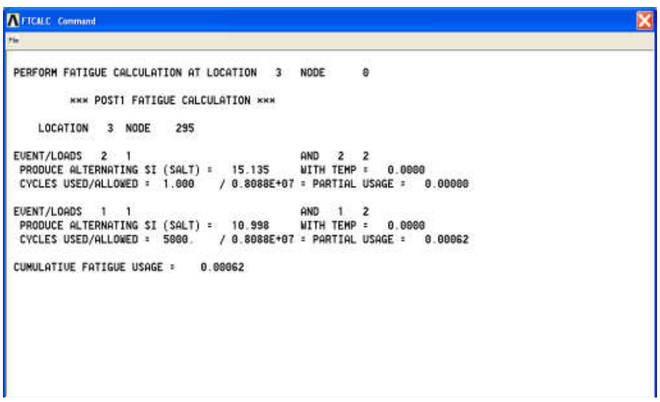
Node at constrained area



```
PERFORM FATIGUE CALCULATION AT LOCATION   2   NODE      0

       *** POST1 FATIGUE CALCULATION ***

   LOCATION   2  NODE    100

EVENT/LOADS   2   1                       AND   2   2
 PRODUCE ALTERNATING SI (SALT) =   11.831   WITH TEMP =   0.0000
 CYCLES USED/ALLOWED = 0.5000E+07/ 0.8088E+07 = PARTIAL USAGE =   0.61820

EVENT/LOADS   1   1                       AND   1   2
 PRODUCE ALTERNATING SI (SALT) =   8.5969   WITH TEMP =   0.0000
 CYCLES USED/ALLOWED = 0.5000E+05/ 0.8088E+07 = PARTIAL USAGE =   0.00618

CUMULATIVE FATIGUE USAGE =    0.62438
```

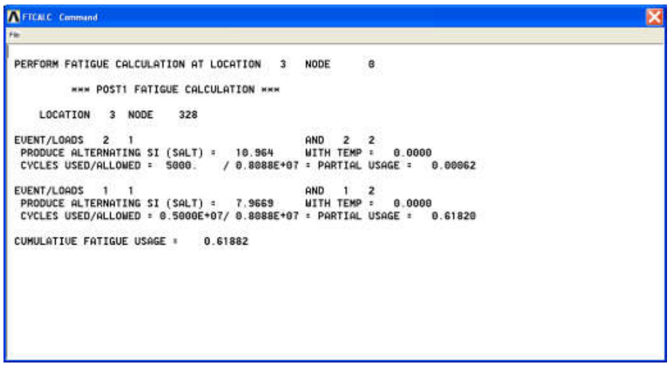
Node 100 at the constrained area.
The Cumulative Fatigue Usage value is 0.62438, is the sum of the partial usage factors (Miner's rule).

Node at pressure area



```
PERFORM FATIGUE CALCULATION AT LOCATION   3   NODE      0

       *** POST1 FATIGUE CALCULATION ***

   LOCATION   3  NODE    295

EVENT/LOADS   2   1                       AND   2   2
 PRODUCE ALTERNATING SI (SALT) =   15.135   WITH TEMP =   0.0000
 CYCLES USED/ALLOWED =   1.000     / 0.8088E+07 = PARTIAL USAGE =   0.00000

EVENT/LOADS   1   1                       AND   1   2
 PRODUCE ALTERNATING SI (SALT) =   10.998   WITH TEMP =   0.0000
 CYCLES USED/ALLOWED =   5000.     / 0.8088E+07 = PARTIAL USAGE =   0.00062

CUMULATIVE FATIGUE USAGE =    0.00062
```

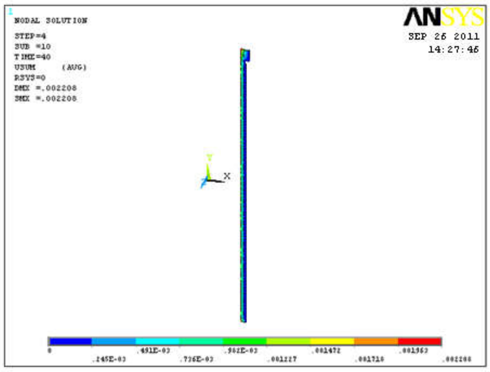
Node 295 at the pressure area:
The Cumulative Fatigue Usage value is 0.00062, is the sum of the partial usage factors (Miner's rule).

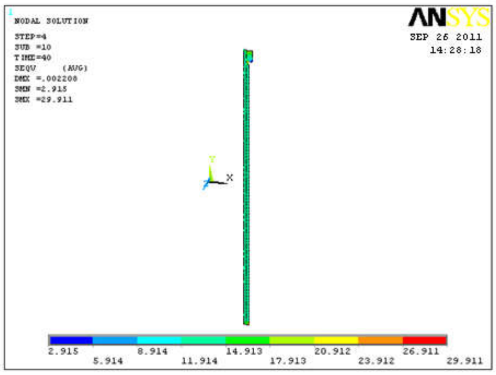


```
PERFORM FATIGUE CALCULATION AT LOCATION   3   NODE      0

       *** POST1 FATIGUE CALCULATION ***

   LOCATION   3  NODE    328

EVENT/LOADS   2   1                       AND   2   2
 PRODUCE ALTERNATING SI (SALT) =   10.964   WITH TEMP =   0.0000
 CYCLES USED/ALLOWED =   5000.     / 0.8088E+07 = PARTIAL USAGE =   0.00062

EVENT/LOADS   1   1                       AND   1   2
 PRODUCE ALTERNATING SI (SALT) =   7.9669   WITH TEMP =   0.0000
 CYCLES USED/ALLOWED = 0.5000E+07/ 0.8088E+07 = PARTIAL USAGE =   0.61820

CUMULATIVE FATIGUE USAGE =    0.61882
```

Node at open area

Node 328 at the open area. The Cumulative Fatigue Usage value is 0.61882, is the sum of the partial usage factors (Miner's rule).





Displacement, stress

Aluminium oxide coating

For Cylinder Liner – Cast Iron
Structural Properties

Element Type: Solid 20 node 95

Material Properties: Density - 0.00000719kg/mm^3
Young's Modulus – 157000Mpa
Poisson's ratio -0.283
For Fin – Aluminum Alloy 6101

Element Type: Solid 20 node 95

Material Properties: Density - 0.0000027kg/mm^3
Young's Modulus – 69000Mpa
Poisson's ratio - 0.32
For liner coating – Al_2O_3

Element Type: Solid 20 node 95

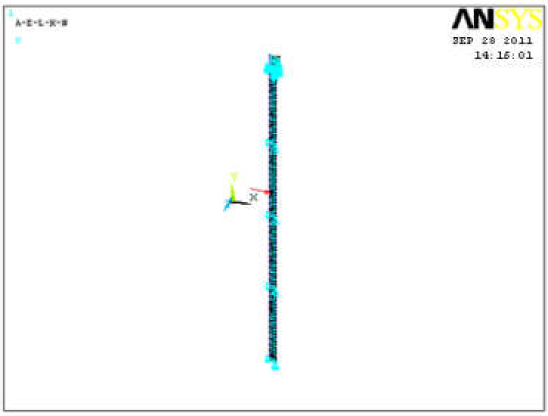
Material Properties: Density - 0.0000039kg/mm^3
Young's Modulus – 353000Mpa
Poisson's ratio - 0.22

Solution

Analysis type
New analysis
Transient
Ok
Ok

Four load cases are applied

- 10.9 N. The time at the end of the load step is 10 seconds.
- -10.9 N. The time at the end of the load step is 20 seconds.
- 15 N. The time at the end of the load step is 30 seconds.
- -15 N. The time at the end of the load step is 40 seconds.



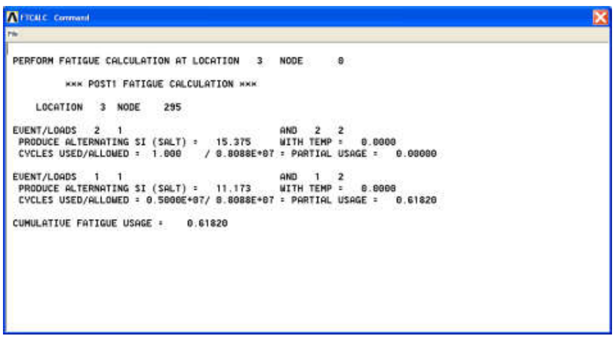
D.O.F Constraining

Stress Locations

NLOC = *1*
NODE = 246(node at the pressure area)
NLOC =*2*
NODE =*275* (node at the open area)
NLOC = *3*
NODE =*295* (node at the constrained area)

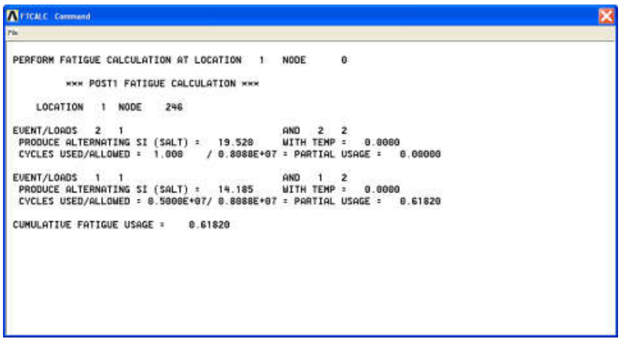
RESULTS

Node at constrained area

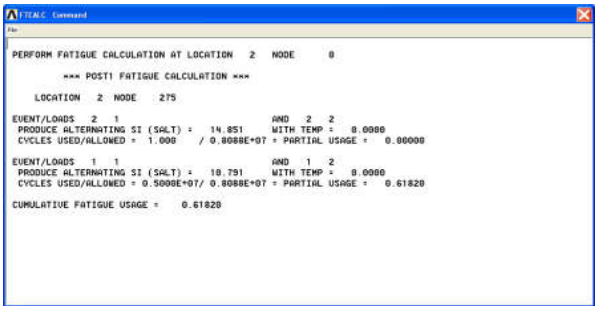


Node 295 at the constrained area.
The Cumulative Fatigue Usage value is 0.61820, is the sum of the partial usage factors (Miner's rule).

Node at pressure area



Node 246 at the pressure area:
The Cumulative Fatigue Usage value is 0.61820, is the sum of the partial usage factors (Miner's rule).



Node at open area

Node 275 at the open area.
The Cumulative Fatigue Usage value is 0.61820, is the sum of the partial usage factors (Miner's rule).

Displacement, stress

Ceramic coating

For Cylinder Liner – Cast Iron
Structural Properties

Element Type: Solid 20 node 95

Material Properties: Density - 0.00000719kg/mm^3
Young's Modulus – 157000Mpa
Poisson's ratio -0.283
For Fin – Aluminum Alloy 6101

Element Type: Solid 20 node 95

Material Properties: Density - 0.0000027kg/mm^3
Young's Modulus – 69000Mpa
Poisson's ratio - 0.32
For liner coating – ceramic coating

Element Type: Solid 20 node 95

Material Properties: Density - 0.00000745kg/mm^3
Young's Modulus – 115000Mpa
Poisson's ratio - 0.31

Solution

Analysis type
New analysis
Transient
Ok
Ok

Coupled field analysis

	Displacement (mm)	Von Mises Stress (N/mm^2)	Nodal Temperature (K)	Thermal Gradient (K/mm)	Thermal Flux (W/mm^2)
Without Coating	0.106946	1307	866.25	79.597	3.98
PSZ Coating	0.01249	127.977	866	334.196	2.073
Al_2O_3	0.000682	60.681	866	101.586	2.693
Nickel Chrome Coating	0.001286	128.464	866	121.084	1.985

Coupled field analysis

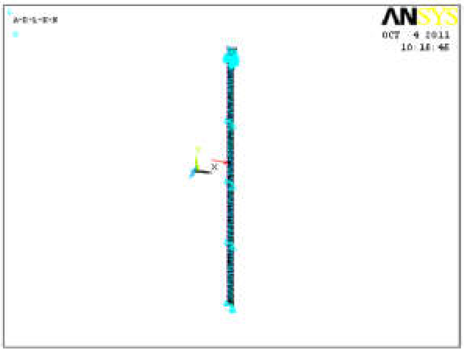
		Event 1 500000 Cycles	Event 2 5000 Cycles
Uncoated	Constrained Area	10.945	15.062
	Pressure Area	14.776	20.334
	Open Area	10.9	15
PSZ	Constrained Area	7.3871	10.166
	Pressure area	7.5616	10.406
	Open area	7.3499	10.144
Aluminum Oxide	Constrained area	11.173	15.375
	Pressure area	14.185	19.520
	Open area	10.791	14.851
Nickel Chrome	Constrained area	8.5969	11.831
	Pressure area	10.998	15.135
	Open area	7.9669	10.964

Coupled field analysis

		Event 1 500000 Cycles	Event 2 5000 Cycles
Uncoated	Constrained Area	10.945	15.062
	Pressure Area	14.776	20.334
	Open Area	10.9	15
PSZ	Constrained Area	7.3871	10.166
	Pressure area	7.5616	10.406
	Open area	7.3499	10.144
Aluminum Oxide	Constrained area	11.173	15.375
	Pressure area	14.185	19.520
	Open area	10.791	14.851
Nickel Chrome	Constrained area	8.5969	11.831
	Pressure area	10.998	15.135
	Open area	7.9669	10.964

Four load cases are applied

- 10.9 N. The time at the end of the load step is 10 seconds.
- -10.9 N. The time at the end of the load step is 20 seconds.
- 15 N. The time at the end of the load step is 30 seconds.
- -15 N. The time at the end of the load step is 40 seconds.



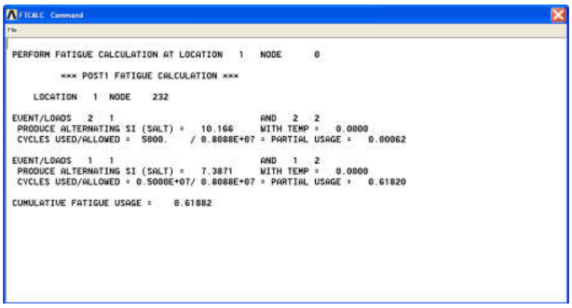
D.O.F Constraining

Stress Locations

NLOC = 1
NODE = 232(node at the constrained area)
NLOC = 2
NODE = 219(node at the pressure area)
NLOC = 3
NODE = 225(node at the open area)

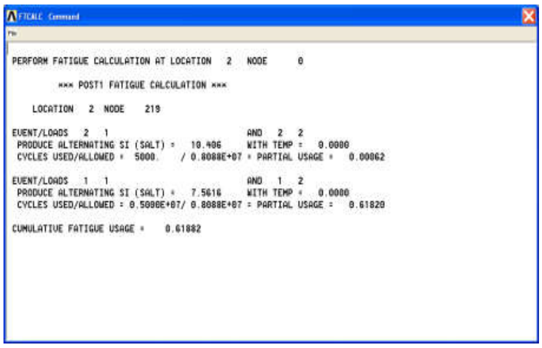
RESULTS

Node at constrained area



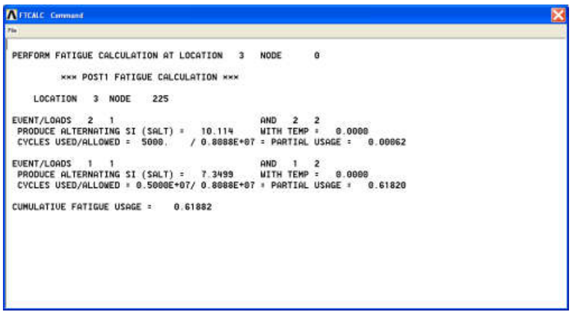
Node 232 at the constrained area.
The Cumulative Fatigue Usage value is 0.61882, is the sum of the partial usage factors (Miner's rule).

Node at pressure area

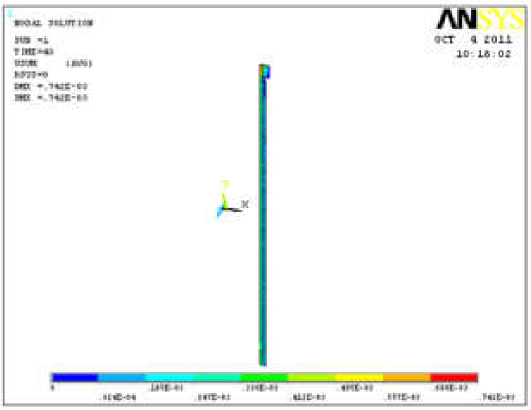


Node 219 at the pressure area:
The Cumulative Fatigue Usage value is 0.61882, is the sum of the partial usage factors (Miner's rule).

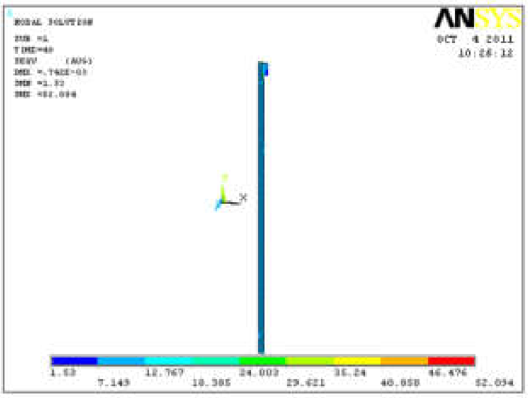
Node at open area



Node 225 at the open area.
The Cumulative Fatigue Usage value is 0.61882, is the sum of the partial usage factors (Miner's rule).



Displacement, stress



Conclusion

In our project the dry cylinder liner used in engine of Hino – X Ashok Leyland model. The dimensions of the liner are taken from "Kusalava Industries", Vijayawada. The modeling is done in Pro/Engineer. The coupled field and fatigue analysis on dry liner by uncoating the liner and coating the liner with three materials Nickel Chrome, PSZ and Aluminum Oxide. By not coating the cylinder liner, stress value is high and also thermal gradient is less than by coating the liner. And also dry liner wears out fastly. So it is better to coat the liner with a coating material.

Present used material for coating is Nickel Chrome. By observing coupled field analysis result, suggest PSZ coating for cylinder liner, since its thermal gradient is more and its analyzed stress value is 128Mpa which is less than its ultimate stress limit 448Mpa.By observing fatigue analysis results, for 500000 and 5000 cycles, the stress intensity is less for PSZ than other coating materials.

By observing above two results, using PSZ coating for cylinder liner is better than other two materials.

REFERENCES

Modern Diesel Technology: Diesel Engines by Sean Bennett
Diesel technology: fundamentals, service, repair by Andrew Norman, John A. Corinchock, Robert Scharff
Introduction to Ansys 10. 0 By Dr R B Choudary
ANSYS Tutorial 10 By Kent Lawrence

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