Proceedings of
International Conference on Future Technologies in Mechanical Engineering (ICFTME)

Under the Auspices of

International Conferences on
Trends in Information, Management, Engineering and Sciences
(ICTIMES)

MALLA REDDY COLLEGE OF ENGINEERING (MRCE)
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Dr. D.K. Nageswara Rao
HoD- Mech. Engg.

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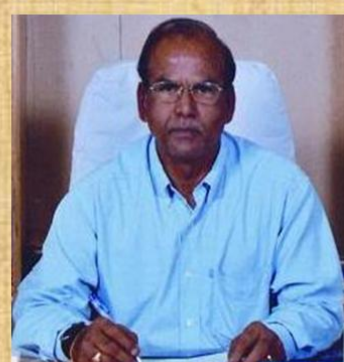

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Contents

Dyanamic Analysis of Machine Tools Structure

Sivasankara Gowda,B.Rajendra Prasad, BAshokkumar, DrV.V.Prathibhabharathi
Department of Mechanical Engineering, mrce,maisammaguda,secunderabad.

, Sivasankara Gowda

Abstract-Theobjectiveofthispresentworkistoestimateandthefrequenciesofmode shapes,Deflections,stressesthatinducedinthemachinepartusedinamac hinetoolstructure.Theemphasisinthisprojectisontheapplicationofcom puteraidedanalysisusingfiniteElementconcept.Amachinetoolisamach ineforshapingormachiningmetalorotherRigidmaterials,usuallybycutt ing,boring,grinding,shearing,orotherformsofDeformation.Machinet oolsemploysomesortoftoolthatdoesthecuttingorshaping.Allmachineto olshavesomemeansofconstrainingtheworkpieceandprovideaguided movementofthepartsofthemachine.Inanalysispartthe finiteelementofhollowmachinememberiscreatedusingsolidtetrahedro nelements,appropriateboundaryconditionsareapplied,materialpropert iesaregivenandloadsareappliedasperitsdesign,theresultantdeformatio nandstressesandfrequenciesobtainedare reportedanddiscussed.

I. INTRODUCTION

Beds,bases,columnsandboxtypehousingsarecalled“structures”inmachinetools.Inmachine tools,70-90%ofthetotal weightofthe machine is dueto the weight of thestructure.

Inthischapterclassificationandfunctionsofmachine toolstructureisdescribed.Researchershaveworkedwithdifferenttypesofmaterialslikecastiron,mildsteel,graniteand epoxyconcreteformachinetool structurefordifferentapplications. Profileof themachinetool andselection of differentstiffeners/ribsare suggestedbyresearchers.Qualityofthejobproduced onthesemachinetools depends directly onthe quality andperformanceofmachinetools.Todevelopgoodproducts,design engineersneedto studyhowtheir designs willbehaveinreal-worldconditions.

Thelimitationsofphysicalmodeltechniqueshaveledtothedevelopmentofmathematicalmodelsrepresentingavarietyofmechanicalstructures.Asinthisapproach,wholestructureisdividedintofiniteelements,itisknownas‘FiniteElementAnalysis’.TheFEAisaveryusefultoolinengineeringtodayandsamehasprovedtobeanimportanttechniqueinmachinetoolstructural analysis.Thus,Computerisaninvaluabletoolforadesignerinhistaskforevaluatingalternativedesignstoarriveattheoptimumdesignandalsopredictingthestatic, dynamicandthermalbehaviorofthemachinebeforearrivingatthefinaldesign.

DesignCriteriaforMachineToolStructure

Considerasimplemachinetoolbedwithtwosidewalls, whichmayberepresentedasasimplysupportedbeam loadedbyconcentratedforcePactingatitscenter,asshowninFig. 1.1below:

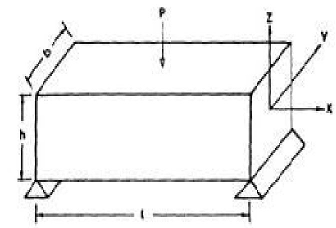


Fig. 1.1simplysupportedbeams

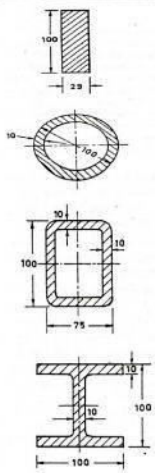
ProfilesofMachineToolStructures

Duringtheoperationofthemachinetool,amajorityofitsstructuresare subjected tocompoundloading andtheirresultantdeformationconsistsoftorsion,bendingandtensionorcompression.Undersimpletensileorcompressiveloading,thestrengthandstiffnessofanelementdependonlyupontheareaofcross-section.Itisknownfromclassicalmechanicsofelasticbodiesthatinthecaseofbendingandtorsionitispossibletodecreasetherequirementonmaterialbyasuitablechoiceof theformofthecross-section,byincreasingthesecondmomentofareaatconstantarea of thecrosssection i.e.atconstantweightoftheelement.

The stiffness offourdifferentcommonlyusedsectionsofstructuresiscomparedwithequalc/sareainTable1.3**.**

ItisevidentfromtheTable1.3thatthebox-typesectionhasthehighesttorsionalstiffnessandintheoverallassessmentseemsbestsuitedbothintermsofstrengthandstiffness.Theadditionaladvantagethatgoesinitsfavoristhe ease ofpropermatingwithothersurfaces.Thus,inthecaseofbendingandespeciallyfortorsiontheoptimumfromthepointofviewofstiffnessisthatofa closed boxcross-section,thebendingstiffnessofwhichisasadvantageousasthatofthe I-sectionanditstorsionalstiffnessapproachesthatofacircularsection.

Table1.3Comparisonofstiffnessofdifferentsectionshavingequal c/s area



Section	Area mm^2	Weight kgf/m	Relative value of permissible: Bending moment kgf.cm		Torque kgf.cm	
			Stress	Deflection	Stress	Angle of twist
	29.0	22	1	1	1	1
	28.3	22	1.12	1.15	43	8.8
	29.5	22	1.4	1.6	38.5	31.4
	29.5	22	1.8	1.8	4.5	1.9

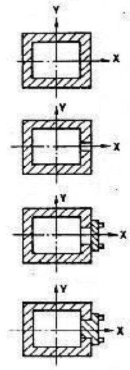
FactorsAffectingStiffnessofMachine ToolStructureandMethodstoImproveIt

Inordertosupporttheworkpieceandpositionitcorrectlywithrespecttothecutterundertheinfluenceofcuttingforcesitisnecessaryforthestructuretohavehighstaticanddynamicstiffnessvalues.Stiffnessofthestructureisrelatedtoits shapeofcross-section,cutsandaperturesinwallsofstructurescoverplates,arrangementofribsinternallyaswellasexternallyetc.

Effectofapertureontorsionalstiffness

Inthemostofthecasesmachinetoolsstructurescannotbemadeofcompleteclosedboxtypeprofile.Theremustbeapertures,openingsforfreeflowofchipsandotherpurposes.Thustheactualmachinetoolprofileisquitedifferentfromclosedboxprofile.Theaperturesandopeningsinthestructurehaveanadverseeffectuponitsstrengthandstiffness.Itcanbe seenthata circularholeofdiameterdaffectsalengthofapproximatelytwicethe diameter,i.e.affectedlength,P=2Q.Anelongatedapertureaffectsthestiffnessevenmore.Thereductioninthestaticanddynamicstiffnesofastructurecanbepartiallycompensatedbyusingsuitablecoverplates.ResultsusingcoverplatesarecomparedinTable1.4.

Table1.4Effect ofapertureandcoverplate onstiffnessofboxtypestructures



Section	Relative stiffness about			Relative natural frequency of vibrations about			Relative damping of vibrations about		
	X-X	Y-Y	Z-Z	X-X	Y-Y	Z-Z	X-X	Y-Y	Z-Z
	100	100	100	100	100	100	100	100	100
	85	85	28	90	87	68	75	89	95
	89	89	35	95	91	90	112	95	165
	91	91	41	97	92	92	112	95	185

EffectofEndCoverplateonstiffnessofstructure

Provisionofanendcoverplatereducesconsiderably,thedeflectionsinyandzdirectionsofathinwalled columnintorsionFig.1.3,whileincaseofbendingnosignificantimprovementisobserved.Thicknessofendcoverplateisvariedandbehaviorofstructureisobservedandafteranalysisoptimumthicknessofendcoverplateshouldbetaken.

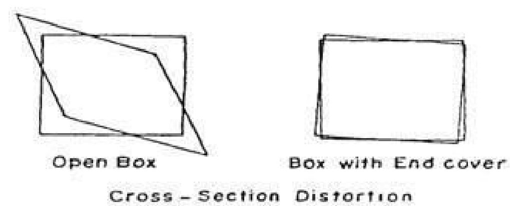


Fig.1.3Comparisonofcrosssectiondeformationwithandwithoutendcoversplate

Effectofribsarrangementinclosedboxstructure

Forthepurposeofdirectcomparison,differentribbingarrangementincaseofclosedbox-structureisshowninTable1.6.Butthemosteffectivearrangementofribsis'diamondshapedribs',whichisnotshowninabovetable.Theresultsofabovetablecanberealizedwithgraphicalplots,Fig. 1.4(a)and(b).

Fig.1.4 (a) Stiffnessvariationwithdifferentribbingarrangementwithandwithoutendcovers

(b) Stiffnessvariationasafunction of differentribbingarrangement

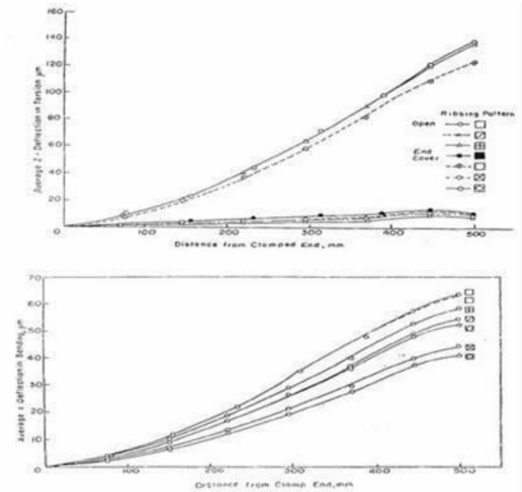


Table1.6Effectofstiffeneronbendingandtorsionalstiffnessofbox -typestructures

Stiffener arrangement	Relative stiffness under		Relative weight	Relative stiffness per unit weight under	
	Bending	Torsion		Bending	Torsion
1	1.0	1.0	1.0	1.0	1.0
2	1.10	1.63	1.1	1.0	1.48
3	1.08	2.04	1.14	0.95	1.79
4	1.17	2.16	1.38	0.85	1.56
5	1.78	3.69	1.49	1.20	3.07
6	1.55	2.94	1.26	1.23	2.39

EffectofFasteningboltsandExternalVerticalstiffenersatbottom

Thestiffnessofstructurescanalsobeimprovedbyprovidingaproperarrangementoffasteningbolts.Theeffectofboltarrangementandstiffeningribsonthebendingandtorsionalstiffnessof averticalcolumnisdepicted.ItisevidentfromtheFig.1.7thatbyarrangingthefasteningboltsuniformlythestiffnesscanbeimprovedby10-20%.Byadditionallyprovidingflangestiffeners,atbottom,thecolumnstiffnesscanbeincreasedbyalmost50%.Rigidityofthemachinetoolasawholedepends upontherigiditywithwhichvariousunitsareclamped.Itshouldbekeptinmindthosejointsbetweenvariousstructuralelements.

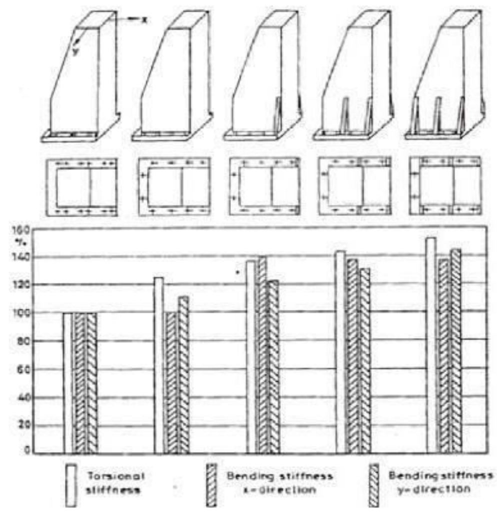
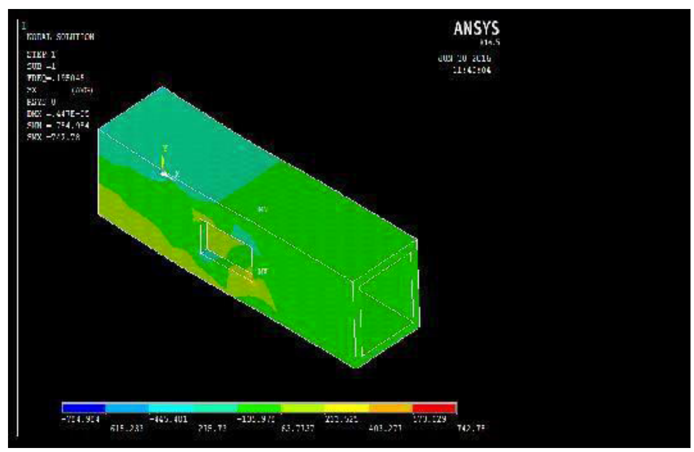


Fig.1.7differentarrangementofflangetypestiffeners

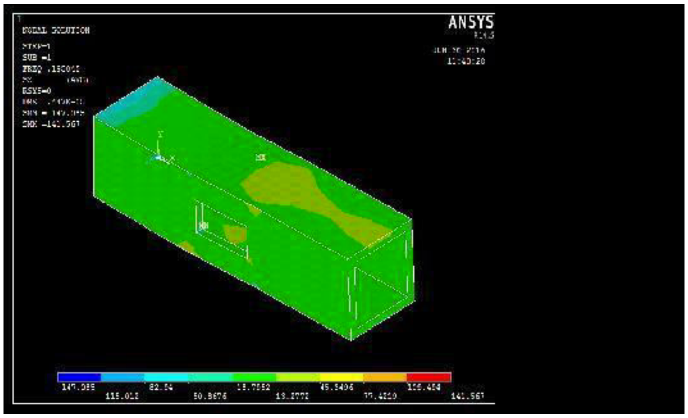
II. RESULTS

Plotresults→counterplot→nodalsolution→stresses→X direction→ok

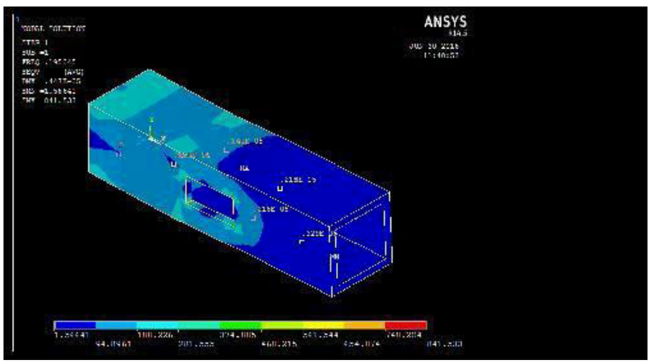


.Plotresults→counterplot→nodalsolution→stresses→Y direction→ok

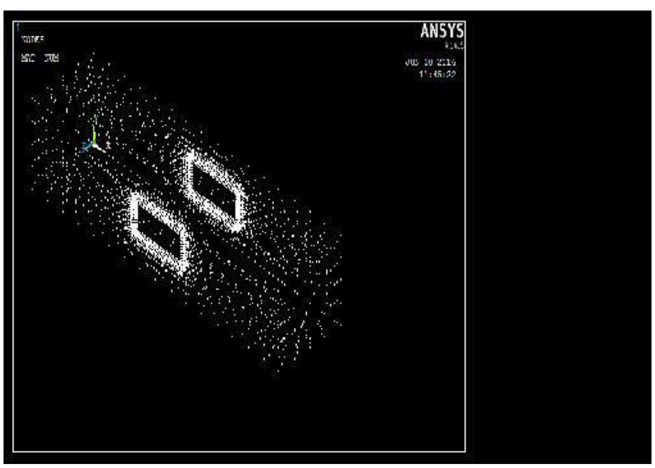
- Plotresults→counter plot→nodal solution→stresses→Zdirection→ok



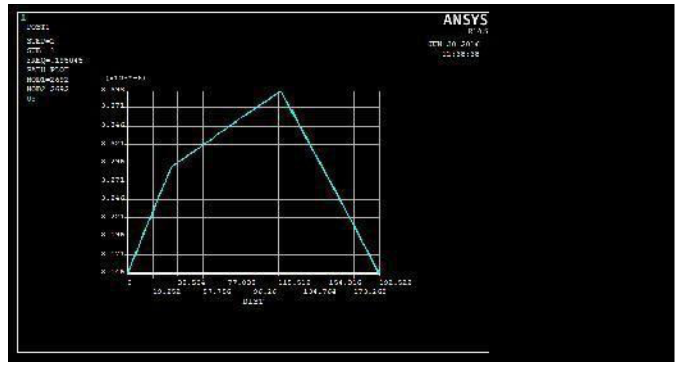
- Queryresults→subgridsolutions→alldof→UYdirection→ok



- Plot→nodes→pathoperation→definepath→bynodes→selectnodes→ok



Pathoperations→definepath→plotgraph→ok



III. CONCLUSION

Thelimitationsofphysicalmodeltechniqueshaveledtothedevelopment ofmathematicalmodelsrepresentingavarietyofmechanicalstructures.Asinthisapproach,wholestructureisdividedintofiniteelements,itisknownas'FiniteElementAnalysis'.TheFEAisaveryusefultool inengineeringtodayandsamehasprovedtobeanimportanttechniqueinmachinetoolstructuralanalysis.Thus,Computerisaninvaluable toolforadesignerinhistaskforevaluatingalternativedesignstoarriveattheoptimumdesignandalsopredictingthestatic,dynamicandthermalbehaviorofthemachinebeforearrivingatthefinaldesign. Inanalysispart thefiniteelementof hollowmachinememberiscreatedusingsolidtetrahedronelements,appropriateboundaryconditionsareapplied,materialpropertiesaregiven andloadsareapplied asperitsdesign,theresultantdeformationandstressesandfrequenciesobtainedarereportedanddiscussed

Static Analysis of Machine Tool Structure

Sivasankara Gowda, B.Rajendra Prasad, Dr.V.V.PrathibhaBharathi
Mechanical Engineering Department, Mallareddy College of Engineering, Maisammaguda,Secunderabad

***Abstract—* theobjectiveofthispresentworkistoestimatethedeflection,stressesandthevonmisesStressesthatincludeinthemachinepartusedinamachinetoolstructure.TheemphasisinThisprojectisontheapplicationofcomputeraided analysisusingfiniteelementconceptAmachinetoolisamachineforshapingormachiningmetalorotherrigid materials,byCutting,boring,grinding,shearing,orotherformsofdeformation.Machinetoolsemploysomesortoftoolthatdoesthecuttingorshaping.AllmachinetoolshavesomemeansofConstrainingtheworkpieceandprovideaguidedmovementofthepartsofthemachine.InanalysispartthefiniteelementofhollowmachinememberiscreatedusingsolidTetrahedronelements,appropriateboundaryconditionsareapplied,materialpropertiesAregivenandloadsareappliedasperitsdesign,theresultantdeformationandstressesandobtainedarereportedand discussed.**

Keywords: FEA,ANSYS, Meshingetc…

IINTRODUCTION

1.1 INTRODUCTIONTOMACHINETOOL

Beds,bases,columnsandboxtypehousingsarecalled“structures”in machinetools.Inmachinetools, 70-90%ofthetotalweightofthemachineisduetotheweightofthestructureInthischapterclassificationandfunctionsofmachinetoolstructureisdescribed.Researchershaveworkedwithdifferenttypesofmaterialslikecastiron,mildsteel,graniteandepoxyconcreteformachinetoolstructurefordifferentapplications.Profileofthemachinetool andselectionofdifferentstiffeners/ribsaresuggestedbyresearchers.Qualityofthe job producedonthesemachinetoolsdependsdirectlyonthequalityandperformanceofmachinetools.Todevelopgoodproducts,designengineersneedtostudyhowtheir designs willbehaveinreal-worldconditions.

1.2 FUNCTIONSOFMACHINETOOLSTRUCTUREANDTHEIRREQUIREMENTS

Machinetool parts, such asbeds, bases,columns, box-typehousings,overarms,carriages,tableetc.areknownasstructures.Basicfunctionsofmachinetoolstructureareasfollows:

a) Toproviderigidsupporton whichvarioussubassembliescanbe mountedi.e.beds,bases.
b) Toprovide housingsforindividualunitsor theirassemblieslikesgearbox,spindlehead.
c) Tosupportandmovetheworkpieceandtoolrelatively, i.e.table,carriage,tailstocketc.

Machinetool structures mustsatisfy the followingrequirements:

a) Allimportantmatingsurfaceofthestructuresshouldbemachinedwithahighdegreeofaccuracytoprovidethedesiredgeometricalaccuracy;
b) Theinitialgeometricalaccuracyofthestructuresshouldbemaintainedduringthewholeservicelifeofthemachinetool;and
c) Theshapesandsizesofthestructuresshouldnotonlyprovidesafeoperationandmaintenanceofthemachinetoolbutalsoensurethatworkingstressesanddeformationsdonotexceedspecificlimits;itshouldbenotedthatthestressesanddeformationsareduetomechanicalaswellasthermalloading.
d) Efficientthermalcontrolonmachineelementsuchasspindle,ballscrewandbearingsforbetterpartaccuracy.
e) Fastertoolchangesystem.
f) Veryhighrapidtraverseratesofround40-60m/minforfastertoolpositioningandveryhighcuttingfeedratesforincreasedmetalremovalrates.

Thedesignfeaturesthatprovideforeaseofmanufacture,maintenance,etc.are peculiartoeachstructureandwill,therefore,bediscussedseparatelyfordifferentstructures.However,therearetwocommonfeatures,whicharefundamentaltothesatisfactoryfulfillmentofaboverequirementsforallstructures.Theseare:

1. Properselectionofmaterial.
2. Highstaticanddynamicstiffness.

1.3 CLASSIFICATIONOFMACHINETOOLSTRUCTURE

Classificatio nofmachinetoolstructureswhichcanbesubdividedbyvariouscharacteristicsintothefollowinggroups:

a) Bypurposeinto:
   1. Beds,frameworks,carryingbodies.
   2. Bases,bedplatesetc.
   3. Housing,boxes,columns,pillar,brackets.
   4. Castingsandcovers.
b) Bythemethodofmanufactureinto:
   1. Cast.
   2. Welded.
   3. Combinedcastandwelded.
c) Byfunctionstheyperform:
   1. Beds and bases, upon which the varioussubassembliesaremounted.
   2. Boxtypehousingsinwhichindividualunitsareassembled.
   3. Partsthoseserveforsupportingandmovingworkpieceandtooli.e.table,carriageetc.

1.4 BASICDESIGNPROCEDUREFORMACHINETOOLSTRUCTURE

Inordertodesignaparticularmachinetoolstructure,itisfirstessentialtodrawupitsdesigndiagram.Machinetoolstructureshave,asarule,highlycomplicatedprofiles.Indesigningthestructureofamachinetoolanumberofrequirementsmustberespected.Thesearethepossibilityofplacingthewholerangeofworkpiecesintothemachine,thenecessary rangesoftravel,sufficientroomforchips,roomforallmechanismsandforhydraulic,electricandotherequipment,thepossibilityofeasy assemblyofthestructureandofitspartsandofsubsequentdismantling, easyaccessfortheoperatorwherevernecessary,andthelimitationofthermaldistortionsofthestructure.Further,itisnecessarytodesignallpartsof theframewith suchshapesandofsuchdimensionsastoensuresuitablerigidityoftheframe.

Forcesoccurduringthemachiningoperationgivingrisetodeformations,whichdisturbtheaccuracyofmachining.Someoftheforcesdonot dependonthe intensityofthecutting processasforinstancetheweightforcesofthemovingpartsofthemachine.Theinfluenceonaccuracyoftheothers,suchascuttingforces,isrelatedtotherateofmachining.Therelationbetweenforcesanddeformationsandtheircombinedeffectonthemachiningoperationleadstorequirementsonthestiffnessoftheindividualpartsofthestructureandofthestructureasa whole.

According tovariouskindsofforces,whichoccurduringthemachiningoperation,variousspecifications ofrequirementsonstiffnessmaybestated.Theseforceswillbeclassifiedintofourgroupscorrespondingtofourdifferentcriteria

A. DEFORMATIONS CAUSEDBYWEIGHT FORCES

Duringthemovementoftheindividualpartsofthestructurethedistributionoftheirweightsandoftheweightoftheworkpiecevaries.Consequentlythedeformationsoftheframevary.Thecriterionisthatanydeviations arisingdonotdisturbtheprescribedgeometricaccuracyofthe machinetool.

B. DEFORMATIONS CAUSEDBYCUTTINGFORCES

Duringtheoperationthecuttingforcevariesanditspointofapplicationmoves.Inconsequence,thedeformationsoftheframewillvarycausingdeviationsoftheformofthemachinedsurfaces. Thiseffectmaybe limitedbydecreasingthecuttingconditionsandconsequentlytheoutputoftheoperation.Cuttingforcedependsupontheworkpiecematerial;machiningparameters,wearofcuttingtooletc. Foradesigneraknowledgeaboutthenatureanddirectionoftheforceandthepointwhereitactsonthestructureisoftenmoreimportantthanaverypreciseknowledgeofitsmagnitude.

C. FORCEDVIBRATIONS

Inthemachine tooldisturbing periodicforcesoccur.Theyarecausedmainlybytheunbalanceofrotatingpartsandbyerrorsofaccuracyinsomedrivingelements.They exciteforcedvibrations,whichresultinthewavinessofmachinedsurfaces.Thecriterionistolimitforcedvibrationssoastoachievetotherequiredsurfacequality.

D. SELF-EXCITEDVIBRATIONS

Undercertainconditions,generallyconnectedwiththeincreaseofthemachiningrateself-excitedvibrationsoccurandtheseareenergizedbythecutting process.Theycauseunacceptablewavinessofthemachinedsurfaceandendangerthestrengthandlifeofthepartsofthemachineandofthetools.Thecriterionisthatintherequiredrangeofoperationsandofcuttingconditionsself-excitedvibrationsshallnotoccurandthecuttingprocess mustbestable.

Theindividualcriteriaarealmostindependentofoneanother. Nevertheless,experience showsthatcriterion4prevailsandifitissatisfiedthencriterion2andoftenalsocriterion1and3aremorethanfulfilled.Theproblem ofstabilityoftheframeagainstself-excitedvibrationsenergizedby thecuttingprocessisnotonlythemostimportantonebutalsothemostdifficult.Allfourcriteriadeterminerequirementsonsomeresultingstiffness,staticordynamic,betweenthetoolandtheworkpiece.Byanalyzingthisresultingstiffness,requirementsontheindividualpartsoftheframemaybederived.

IIMETHODS

2.1 FINITEELEMENTMETHOD

2.1.1 NeedofFiniteElementMethod

Topredictthebehaviorofthestructurethedesigneradoptsthreetoolssuchasanalytical,experimentalandnumericalmethods.Theanalyticalmethodisusedfortheregularsectionsofknowngeometricentitieswherethecomponentgeometryisexpressedmathematically.Thesolutionobtainedthroughanalyticalmethodisexactandtakeslesstime.Thismethodcannotbeusedfortheirregularsectionsandtheshapeswhichrequireverycomplexmathematicalequations.

TheFiniteelementmethodissopopularbecauseofitsadaptabilitytowardsuseofdigitalcomputers.TheFiniteelementmethodpredictsthecomponentbehavioratdesiredaccuracyofanycomplexandirregulargeometryatleastprice.

2.1.2 GeneralDescriptionofFiniteElementMethod

IntheFiniteelementmethod,theactualcontinuumorbody ofmatterlike,solid,liquidorgasisrepresentedasanassemblageofsubdivisionscalledfiniteelements.Theseelements areconsideredtobeinterconnected atspecificjoints,whicharecallednodesornodalpoints.Thenodesusuallylieontheelementboundarieswhereadjacentelementsareconsideredtobeconnected.Sincetheactualvariationofthefieldvariable(likedisplacement,temperature,pressureandvelocity)insidethecontinuumisnotknown.Weassumethatthevariationofthefieldvariable inside afiniteelementcanbeapproximatedbya simple function.These approximating functions(alsocalledasinterpolationmodels)aredefinedintermsof thevaluesatthenodes.

Whenfieldequations(likeequilibriumequations)forthewh olecontinuumarewritten, thenewunknownwillbethenodalvaluesofthefieldvariable.Bysolv ingthefieldequations,aregenerallyintheformofmatrixequations,t heapproximatingfunctiondefinesthefieldvariablethroughoutthea ssemblageofelements.

Thesolutionofa generalcontinuumbythe finiteelementmethodalwaysfallowsanorderlystepbystepprocess. Thestepbystepprocedureforstaticstructuralproblemcanbestateda sfallows

STEP1: Discretizationofstructure(domain)
Thefirststepinthefiniteelementmethodistodividethestructureors olutionregionintosub-divisionsorelements.
STEP2: Selectionofaproperinterpolationmodel.
Sincethedisplacement(fieldvariable)solutionofacomplexstructur eunderanyspecifiedloadconditionscan'tbepredictedexactly.Wea ssumesomesuitablesolutionwithinanelementtoapproximatetheun knownsolution.Theassumedsolution mustbesimple fromcomputationalpoint ofview,anditshouldsatisfycertainconvergencerequirements.
STEP3: Elementstiffnessmatrices(characteristicmatrices)andlo advectors.
Fromtheassumeddisplacementmodelthe stiffnessmatrix[K(e)] andtheloadvector F(e)ofelement'e'aretobederivedbyusingeitherequiibriumconditi onsorasuitablevariationprinciple.
STEP4: Assemblageofelementequationstoobtaintheoverallequil ibriumequations.Sincethestructure iscomposedofseveralfiniteelements,theindividualelementstiffne ssmatricesandloadvectorsaretoassembledinasuitablemannerandt heoverallequilibriumequationshavetobeformulatedas

[K]q=F

[K]iscalledassembledstiffnessmatrix,qiscalledthevectorofnodal displacementandFisthevectorofnodalforcesofthecompletestruct ure.
STEP5: Solutionofsystemequationshavetobemodifiedtoaccount fortheboundaryconditionsoftheproblem.Afterincorporationofth eboundaryconditions,theequilibriumcanbeexpressed

[K]q=F

Forlinearproblems,thevector'q'canbesolvedveryeasily,Butforno n-linearanalysisproblems,thesolutionhastobeobtainedinasequence ofsteps,eachstepinvolvingthemodificationofthestiffnessmatrix[k]and/ortheloadvectorF.
STEP6: ComputationofElementStressesandStrains.
From theknownnodaldisplacements,ifrequired,theelementstressesand strainscanbecomputedbyusingthenecessaryequationsofsolidorst ructuralmechanics

2.1.3ExplanationofFEMbyStepbyStepProcedure:

TheStepsinvolvedinthefiniteelementanalysis arestatedinthissection.

1. Discretizationofthedomain:

Thediscretizationofthedomainorsolutionregioninthesub-region (finiteelements) is thefirststepinthe finiteelementmethod. Thisisequivalenttoreplacingthedomainhavingandinfinitenumber ofdegreesoffreedombysystemhavingfinitenumberofdegreeoffre edom.Theshapes,size,numberandconfigurationoftheelementsha vetobechosencarefullysuchthattheoriginalbodyissimulatedasclo selyaspossiblewithoutincreasingthecomputationaleffortfortheso lution.

2. BasicElementShapes:

Foranygivenphysicalbodywehavetouseengineeringjudgme ntinselectionofappropriateelementsfordiscretization.Thetypeofe lementisindicatedbythegeometryofthebodyandthenumberofinde pendentspatialco-ordinatesnecessarytodescribethesystem. Thegeometry,material,propertiesandotherparameterslikestress,d isplacement,pressureandtemperaturecanbedescribedintermsofo nespatialco-ordinatewecanuseone-dimensionalelement.Whentheconfigurationandthedetailsofthepr oblemcanbedescribedintermsoftwoindependentspatialco-ordinates,wecanusethetwo-dimensionalelement.Thebasicelementusefulforthetwo-dimensionalanalysisisthetriangularelement.Ifthegeometry,mater ialpropertiesandotherparameterofthebodycanbedescribedbythre espatialco-ordinates,wecanidealizethebodybyusingthethreedimensionalele ments.Thebasicthree-dimensionalelementsanalogoustotriangularelementsarethetetrah edralelements.

3. SizeofElements:

Thesizeofelementsinfluencestheconvergenceofthesesol utionsdirectlyandhenceithastobechosenwithcare. Ifthesizeoftheelementissmall,thefinalsolutionisexpectedtobemor eaccurate. Thesizeoftheelementshastobeverysmallneartheregionwherestres sconcentrationisexpectedcomparedtofarawayplaces. Anothercharacteristicrelatedtothesizeofelements,whichaffects thefiniteelementsolutionisthe aspectratio ofthe elements.Fortwo-dimensionoftheelementtothesmallestdimension.Elementswithan aspectratioofnearlyunitygenerallyyieldbestresults.

4. LocationofNodes:

Ifthebodyhasnoabruptchangesingeometry,materialprop ertiesandexternalconditions(likeload,temperatureetc)thebodyca nbedividedintoequalsub-divisionsandhencethespacingofthenodescanbeuniform.Ontheot herhand,iftherear eanydiscontinuitiesintheproblem,nodeshaveto beintroducedobviously,atthesediscontinuities.

5. NumberofElements:

The numberof elementstobechosenforidealizationisrelatedtotheaccuracydesire d,sizeofelementsandthenumberofdegreesoffreedominvolved.Al thoughandincreasein numberofelementsgenerallymeansmoreaccurateresults,foranygi venproblemtheywillbecertainnumberofelementswhichmeansm oreaccurateresults,andtherecanevenbenumberofelementsbeyond whichtheaccuracycannotbeimprovedbyanysignificantamount.

Moreover,sincetheuseoflargenumberofelementsinvolveslargenumberofdegreesoffreedom,wemaynotbeabletostoretheresultingmatricesintheavailablecomputermemory.

2.2ANSYS

Thefollowingpagesshouldgiveyouabriefandbasicintroductiontothearchitectureandstructureofacommercialfiniteelementanalysis program.ThebasicideascanbeappliedinmostprogramsbutexamplesaretakenfromthesoftwareANSYS.WewillhereonlyfocusonstructuralmechanicsinANSYS.

2.2.1BASICPROGRAMSTRUCTURE:

Utilitymenu:Hereyou can access andadjustproperties aboutyoursession, suchasfilecontrols,listingandgraphic controls.**Toolbar**:Pushbuttonstocommonlyusedcommands.
Mainmenu:Here youcanfindtheprocessorsusedwhenanalyzingyourproblem.
Graphicswindow:Inthe graphicswindowyourmodel isdisplayed:geometry.
Inputwindow:Youcantypecommandsintheinputwindow.

1. Preprocessor:

Withinthepreprocessorthemodelissetup.Itincludesanumberofstepsandusuallyinthefollowingorder:
Buildgeometry.Dependingonwhethertheproblemgeometry isone,twoorthreedimensional,thegeometryconsistsofcreatinglines,areasorvolumes.Thesegeometriescanthen,ifnecessary,beusedtocreateothergeometriesbytheuseofBooleanoperations.Thekeyideawhenbuildingthegeometrylikethisistosimplifythegenerationoftheelementmesh.Hence,thisstepisoptionalbutmostoftenused.Nodesandelementscanhoweverbecreatedfromcoordinatesonly.
Definematerials.Amaterialisdefinedbyitsmaterialconstants.Everyelementhastobeassignedaparticularmaterial.
Generateelementmesh.Theproblem is discretizedwithnodalpoints.Thenodesareconnectedto formfiniteelements,whichtogetherformthe materialvolume.Dependingontheproblemandtheassumptionsthataremade,theelementtypehastobedetermined.Commonelementtypesare*truss,beam,plate,shell*and*solidelements*.Eachelementtypemaycontainseveralsubtypes,e.g.2D4-nodedsolid,3D20-nodedsolidelements.Therefore,carehastobetakenwhentheelementtypeischosen.

TheelementmeshcaninANSYSbecreatedinseveralways.Themostcommonwayisthatitisautomaticallycreated,howevermoreorlesscontrolled.Forexampleyoucanspecifyacertainnumberofelementsinaspecificarea,oryoucanforcethemeshgeneratortomaintainaspecificelementsizewithinanarea.Certainelementshapesorsizesare notrecommendedandiftheselimitsareviolated,awarningwillbegeneratedinANSYS.Itisuptotheusertocreate ameshwhichisabletogenerateresultswithasufficientdegreeofaccuracy.

2. Solutionprocessor:
Here yousolve theproblem bygathering all specifiedinformationabouttheproblem:

3. Postprocessor:
Withinthispartoftheanalysis youcanforexample:
Visualizetheresults:Forexampleplotthedeformedshape ofthegeometryorstresses.
Listtheresults:Ifyouprefertabularlistingsorfileprintouts,itispossible.

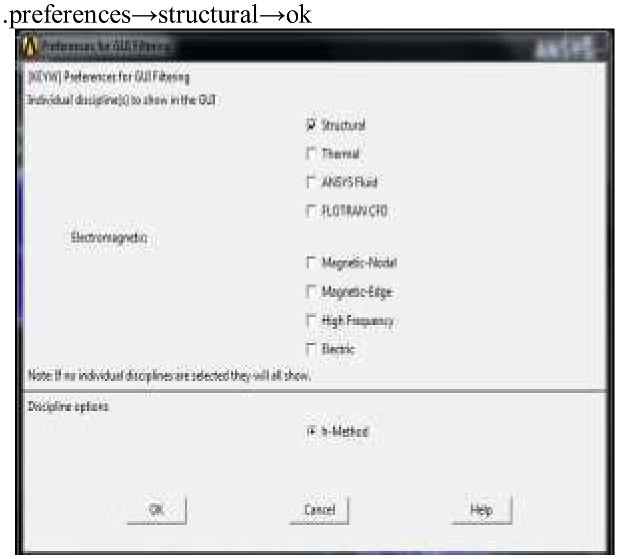
3. PROBLEM FORMULATIONAND METHODOLOGY

3.1 problemformulation:

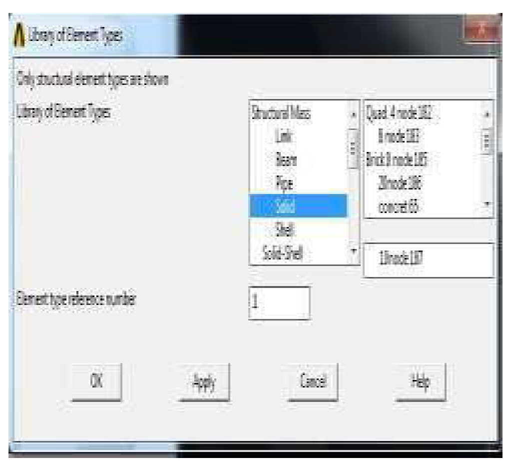
Theobjectiveofthispresentworkistoestimatethedeflection,stressesandthevonmisesstressesThatinducedinthemachinepartusedinamachinetoolstructure.Theemphasisinthisprojectisontheapplicationofcomputeraidedanalysisusingfiniteelementconcept.

3.2 Methodology

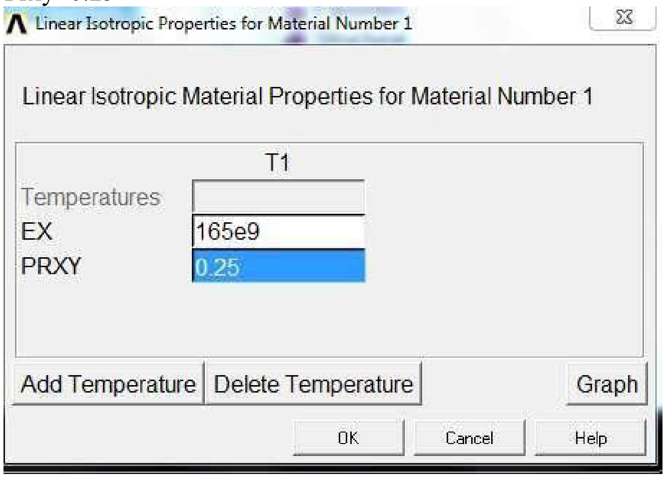
1.preferences→structural→ok



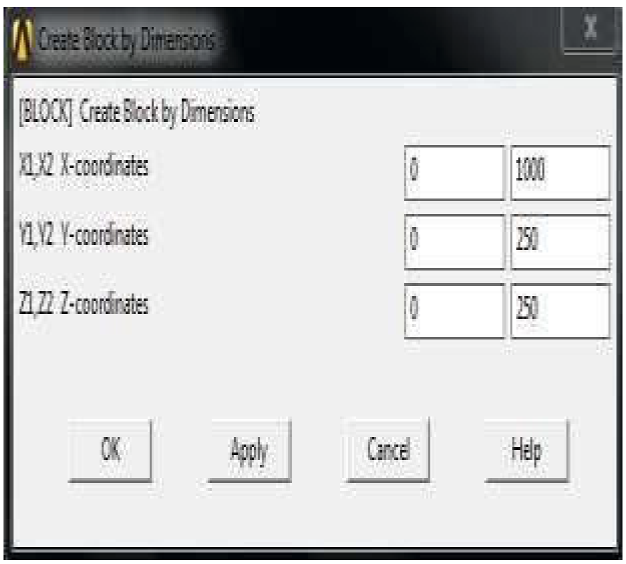
2.Preprocessor→elementtype→add→nondefined→add→solid→10node187→ok→close



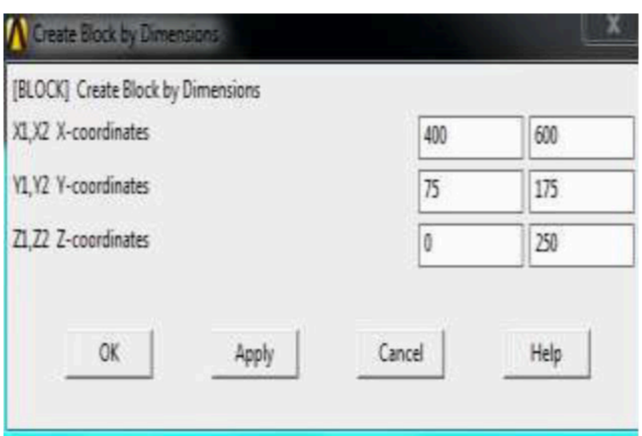
3.Materialpropereties→materialmodel→structure→linear→elastic→isotropicEx=165e9 Prxy=0.25



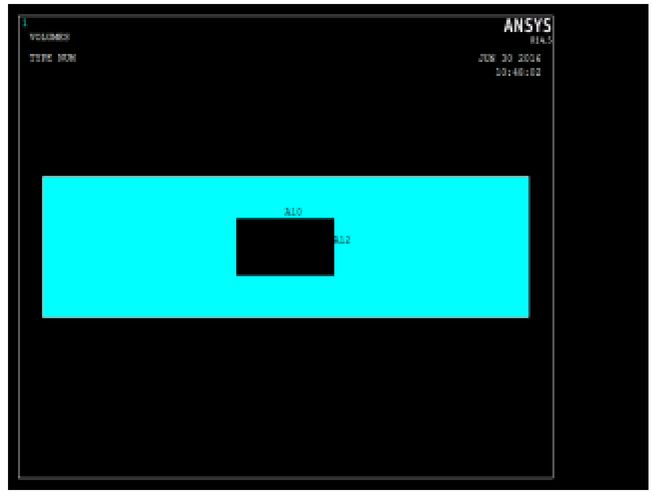
4. Modeling→create→volumes→block→bydimensions



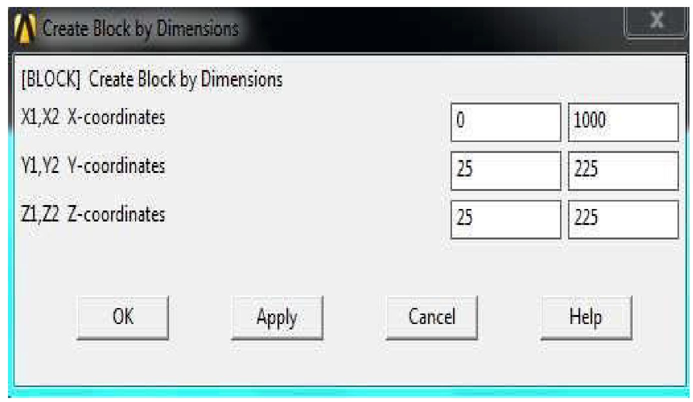
5 Modeling→create→volumes→block→bydimensions



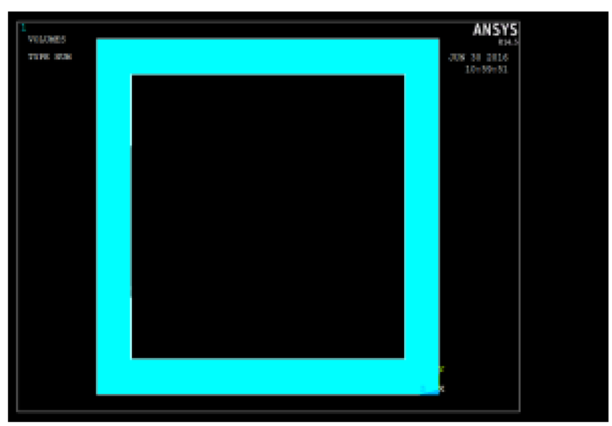
6 Modeling→operate→booleans→subtract→ volumes



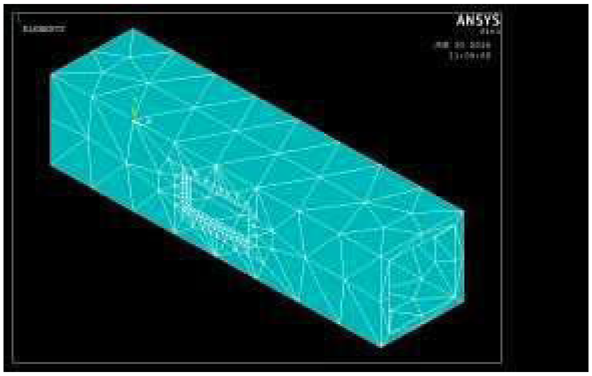
7 Modeling→ create →volumes→ block→ bydimensions



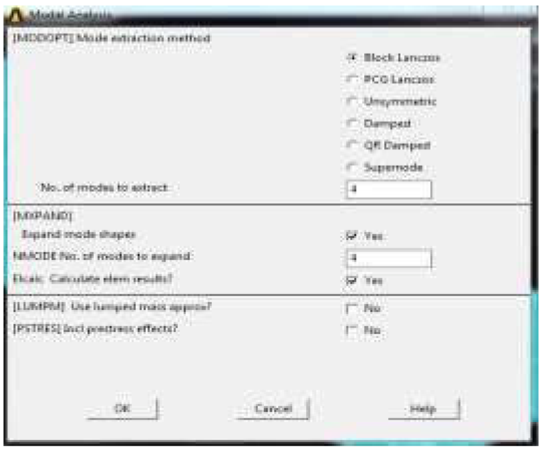
8 Modeling→operate→Booleans→subtract→volumes



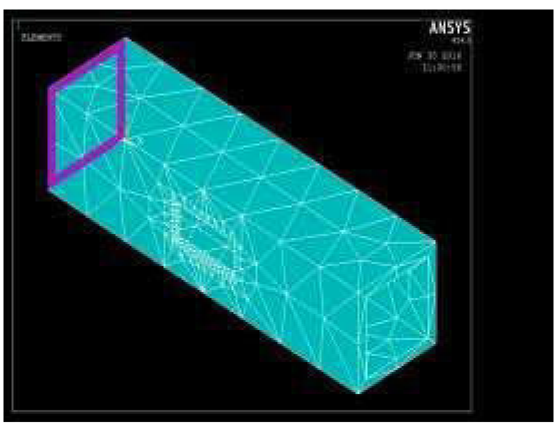
9 Meshing→ mesh →volume→ free→ selectvolume→ok



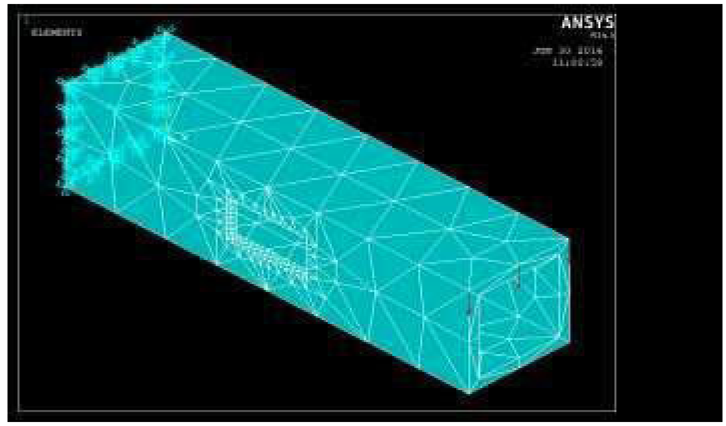
10 Loads→analysis→options→ok



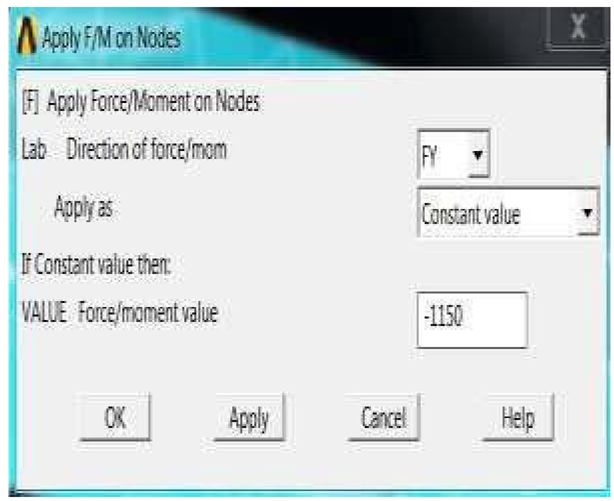
11. Loads→defineloads→apply→structural→displacement →onarea→selectarea→ok



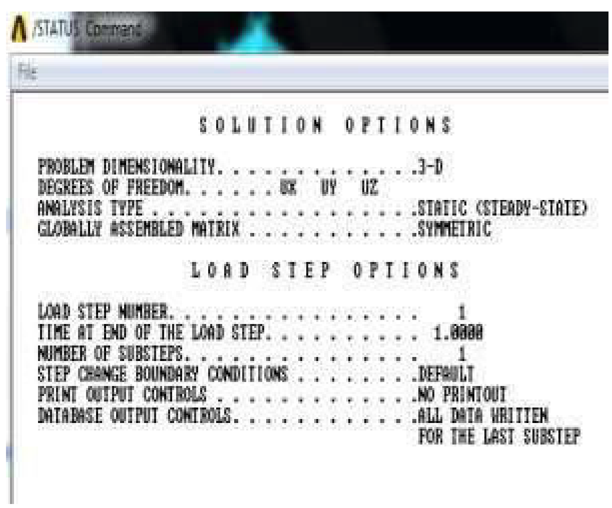
12. Loadsforcemomentonnodesselectnodesok



13. Select→ direction oftheload→ giveforce/momentvalue→ok

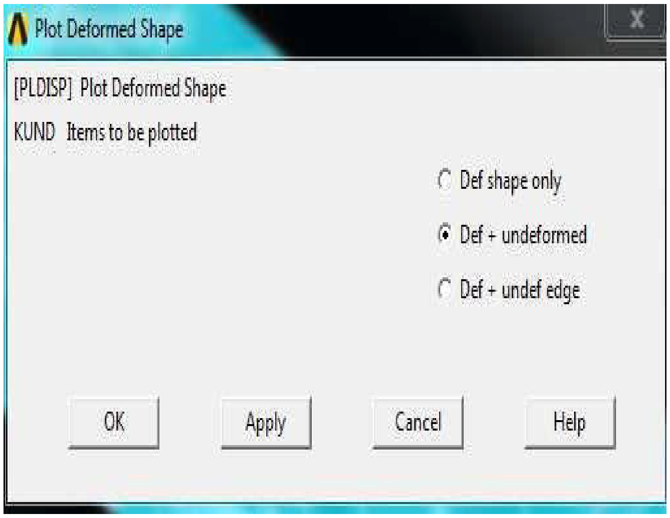


14. Solution→solve→currentL.S→ok→close



11 Generalpostprocessor→readresults→firstset

12 Plotresults→deformedshapes→def+undeformed →ok



5RESULTSANDDISCUSSIONS

5.1Deformedstructure

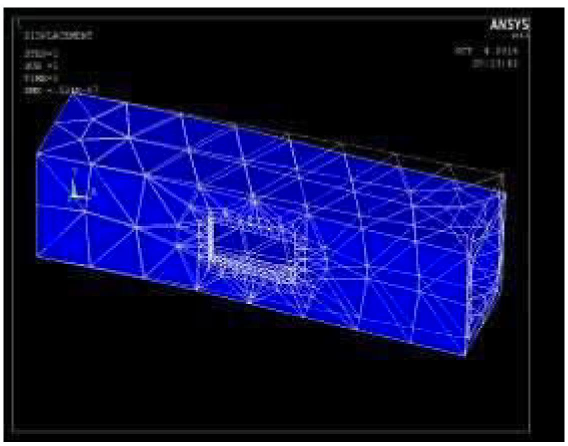


Fig5.1deformedstructure

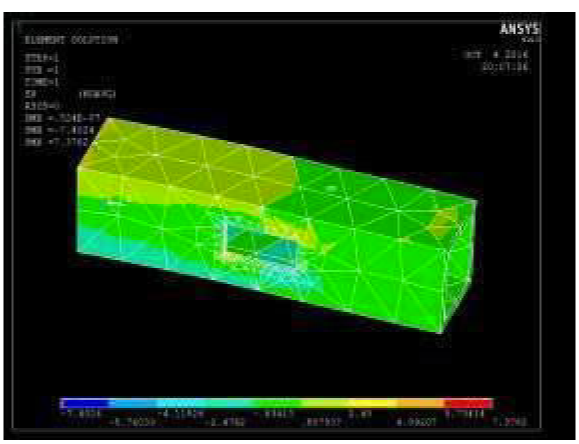


Fig5.2ElementalsolutionofstressesinXdirection.

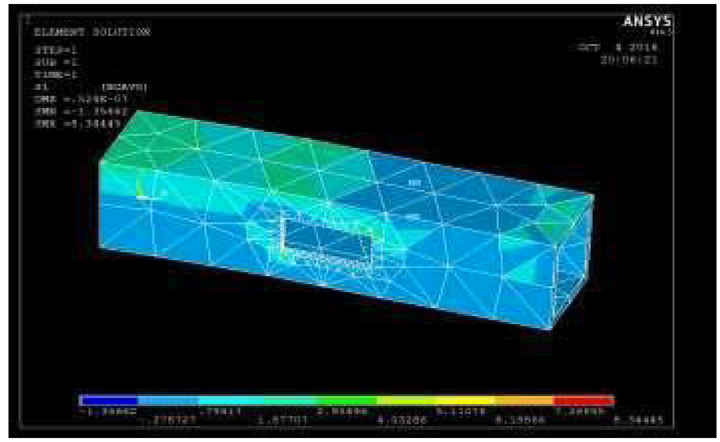


Fig5.3ElementalsolutionofstressinS1direction.

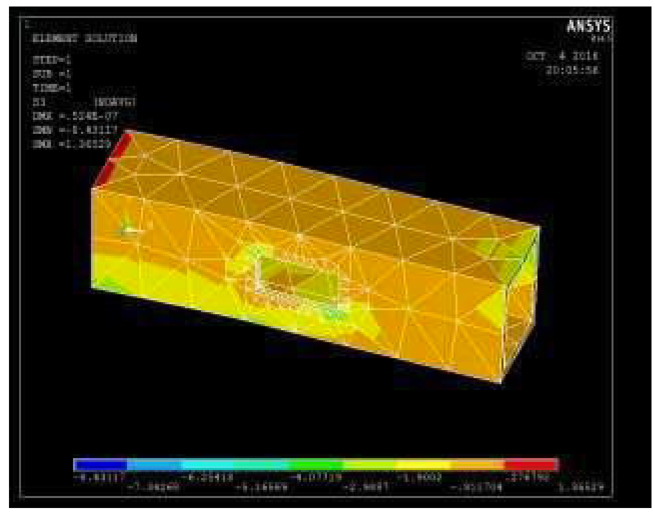


Fig5.4ElementalsolutionofstressesinS3direction

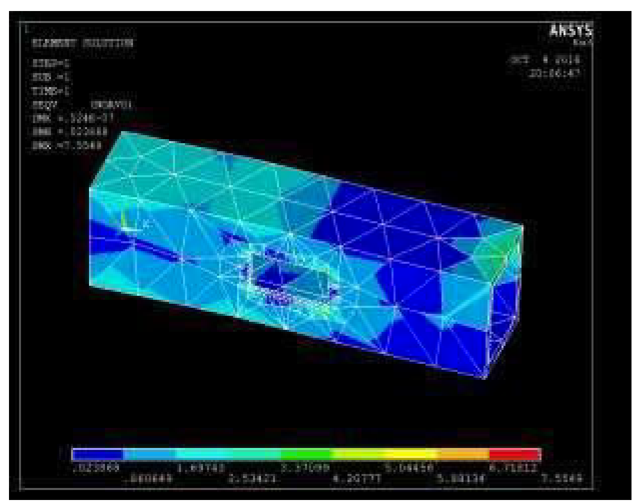


Fig5.5ElementalsolutionsofEqualentvonmisesstresses

6CONCLUSION&FUTURESCOPE

Thelimitationsofphysicalmodeltechniqueshaveledtothedevelop mentofmathematicalmodels representingavarietyofmechanicalstructures.Asinthisapproach, wholestructureisdividedintofiniteelements,itisknownas'FiniteEl ementAnalysis'.TheFEAisaveryusefultoolinengineeringtodaya ndsamehasprovedtobeanimportanttechniqueinmachinetoolstruc turalanalysis.Thus,Computerisaninvaluabletoolforadesignerinhi staskforevaluatingalternativedesignstoarriveattheoptimumdesig nandalsopredictingthestaticbehaviorofthemachinebeforearrivin gatthefinaldesign.Machinetoolshavesomemeansofconstrainingt heworkpiece andprovideaguidedmovementofthepartsofthemachine.Inanalysi spartthefiniteelement ofhollow machinememberiscreatedusingsolidtetrahedronelements,appro priateboundaryconditionsareapplied,materialpropertiesaregiven andloadsareapplied asperits design, theresultantdeformationandstressesvonmisesstresesobtainedarer eportedinResults.

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[6]Chandrapatla,Belugunda,"FEA".

Study of Mechanical and Water Absorption Behavior of Short Natural Fiber Reinforced Hybrid Composites

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[*]*Corresponding author*

Abstract—**The natural fiber composite materials are rapidly showing both in terms of their, individual applications and fundamental research they are renewable bio-degradable,availability, low density, ecofriendly, price as well as satisfactory mechanical properties to make them attractive & ecological alternative to glass fibers used for manufacturing composite materials. The natural fiber composite materials are used in transportation, military applications, building and constructions industries, packing. .In the present work hybrid composites are made using the *Kenaf* and *Cocus Nucifera* of 7mm lengths and PVC resin. Mechanical properties like tensile strength, impact strength and water absorption properties are evaluated.**

Keywords—Hybrid Short natural fiber composites; Mechanical propertie; water absorption properties .

I. INTRODUCTION

Present day quality of human life can be attributed to the advances taking place in materials and technologies in various fields. In fact, any technological advancement has its impact on biodiversity. Land, water and air are being polluted without concern for the flora and fauna causing extinction of various living species. Global warming and greenhouse effect are due to undue exploitation of the gifts of nature. To help our future generations in sustaining the hardships of life, it is our responsibility to preserve the earth as safe abode for human existence. It is possible by adopting policies for development and application of materials and technologies that cause least damage to the environment. Earlier concept of producing things that are rare, exotic and for trade gains has altogether changed towards preserving or enhancing the environment and life processes giving birth to concepts like: sustainable, eco-friendly or green. Green composites are reinforced plastic materials developed from renewable sources using natural fibers and polymers. Different kinds of plant or animal based of natural fibers and polymers from organic substances like cellulose, starch or vegetable oils are used for developing these composites.

II. IMPORTANCE OF GREEN COMPOSITES

All human activity is entwined with the use of materials. For millennia, humans have endeavored to use the readily available materials like stone, clay, mud, wood, bone, hide and other vegetable produce for construction of their homes, tools and implements and means of transport. As Centuries rolled over, man discovered the secrets of nature and started its exploitation. He started building synthetic materials. There has been a gradual decline of the direct application of natural resources. Further we have reached to view that the use of traditional materials is inferior to synthetic materials. Fiber reinforced composites have attracted the aerospace and transportation industry due to their weight savings and many other superior properties. Today they find wide applications in containers, sports goods, electronics and appliances as well as in medical field. These composites are synthesized from different kinds of fibers such as: glass, aramid, graphite, carbon, boron, etc. and matrix materials: polyester and epoxy resins. They have excellent properties but they are not biodegradable. Mostly they are incinerated or disposed in landfills resulting in emission of toxic gases or cause soil impermeability. Recycling and disposal pose adverse effect on the environment. Thus the need for sustainable technology has driven the concerned scientists and engineers for reviving the use of natural materials and development of composites called green composites.

The natural fiber composites are CO_2 neutral, consume low energy for their production, give less problem for health and safety of workers, less abrasive, more pleasant to handle and give natural image. They have good specific, thermal and acoustic properties. They are costly compared to glass fiber reinforced plastics but use of inexpensive fibers and biodegradable matrices may balance the cost. Moisture adsorption, fluctuation in quality, dimensional instability, susceptibility to rotting, swelling, etc., are certain limitations

A. Historical Applications [1]

The ‘green’ concept in materials is not entirely new but dates back to the early examples of straw reinforced bricks, composite bows of mediaeval times. It was noted that even 3000 years ago, there have been designs of Egyptian chariots whose wheels were made of heat formed wood, laminated and bound with skin that made the wheel a tough and resilient composite and biodegradable vehicle part.

The advent of synthetic polymers and modern natural fiber reinforced polymers go back to the early part of the twentieth century. Even before that in 1850, frames for photographs were made using compound of shellac and wood flour. Consumer goods such as radio and speaker cases were made using Bakelite molding resin along with wood flour or waste string and rags.

During 1924-1930s, there was an increased interest in the use of natural fibers and synthetic resins for the construction of air screws and primary materials for the aircraft. There were several war time applications for cellulose based composites employing paper impregnated with adhesives. Much interest was shown in making parts for several important applications such as wing spar, fuselage, pilot seat, and the fuel drop tank, etc. With the advent of strong, and stable synthetic fibers and liquid polymers such as unsaturated polyesters and epoxies, use of cellulose fiber reinforced composites in structural applications was superseded by wholly synthetic composites. Gordon-Aerolite was produced by laying up skeins of resin impregnated unbleached flax yarn to form a cross-ply laminate structure. Strengths comparable to duralumin were noted. The Cord-Aerolite was produced with reinforcement of woven cotton fabric in which number of cords in the warp direction formed around 90% of the total. These cords were embedded in bakelite matrix and the resulting composite has a tensile strength of 180 MPa and Young's modulus around 13.8 GPa. Early green composites were not only found in air craft structures but also in several automotive applications of the Ford Motors.

B. Contemporary Applications

Waste fibers from recycled wood or news print and different natural fibers and resins produced from vegetable oils and other plant derivatives are used to produce the present day green composites. These composites find applications ranging from aerospace to consumer goods. The so-called Wood-fiber Plastic Composites (WPCs) produced using the above constituents help in removing waste stream materials that would otherwise be difficult to dispose off. Recycled wood fiber, waste agricultural fibers or byproducts from textile manufacture have all been considered as reinforcement in green composite materials. The wood-fiber plastic composites have advantages over the basic wood products such as good appearance, no splintering, improved resistance to biodegradation and insect attack as well as low maintenance.

Several products for building construction such as decking, window/door profiles, railings, fencing, siding, decorative trim, etc., offer great competition to the wood products. Several infrastructural applications include, boardwalks, bridge, guardrails, marine, small fishing boats, etc. In automobiles, upholstery, interior panels, rear shelves, truck floor, door trim panels, ducting, head liners can be made. Furniture, toys, gardening equipment, playground benches/tables, pallets and other consumer products can be made. Components such as computers and monitors, mobile phone covers could be produced from biodegradable composite materials. Bio-packaging can be introduced in the packaging industry.

III. Literature Review

To utilize and design the materials successfully for industrial applications, it is first imperative to determine their properties that affect the performance. A summary of investigations by various researchers is presented here.

Wambua, P.[2] has investigated mechanical properties of sisal, kenaf, hemp, jute and coir reinforced polypropelene(PP) composites processed by compression molding using film stacking method. Akessonm, D.[3] has used two different bio-resins anepoxidized soy-bean oil(Tribest) resin and a functionalized PLA resin for hemp, wool, flax mats to develop natural fiber composites with spray impregnation from bio-based thermoset resins to investigate curing behavior and mechanical properties. Joffe, R.[4] has studied matrix/fiber compatibility, stiffness, strength and fracture toughness to select the best resin/fiber combination. Five different thermoset resins were used to manufacture flax fiber composites by resin transfer molding. Arbelaiz[5]has investigated the influence of maleic anhydraide grafed polypropelene(MAPP)coupling agent on the mechanical properties of short flax fiber reinforced PP composites. Khalid, M.[6] has studied the effect of MAPP as coupling agent for PP-cellulose derived from oil palm empty fruit bunch fiber.

It was found that treatment of fiber has significant influence on mechanical properties. George, J.[7] has investigated fiber surface modifications by alkali, silane and isocyanate treatments to improve the fiber-matrix interactions of flax fiber reinforced epoxy composites. Karmakar, A.C.[8] has studied short jute fibers reinforced in PP. Addition of 50wt% of jute fibers increased bonding strength of virgin PP from 32.33MPa to 49.97MPa. Further improvement up to 87.66MPa was achieved by adding 3wt% MAPP as coupling agent. Santos P.A,[9] studied mercerization and N_2-plasma treatment for polyamide-6/vegetable fiber composite prepared by extrusion and injection molding. Caustic soda fiber treatment improved both tensile, flexural strengths and modulus. Soykeabkqcw, N. [10] has investigated jute and flax reinforced starch based composite foams. Addition of flax or jute fiber resulted in increase in tensile, flexural strengths and moduli. Doan, T.T.L. [11] has investigated jute fiber PP composites with respect to fiber content, matrix molecular weight and with or without matrix modifier. Modification of jute/pp composites using 2wt% MAHgPP has improved thermal, hydrothermal resistance.

It is found in the literature review that no work has been reported on hybrid composites of *Kenaf* and *Cocus Nucifera* fiber composites. Further, *Kenaf* trees and *Cocus Nucifera* are abundantly found in the forest areas that yield strong fibers from stem and are traditionally used by the farmers in domestic and agricultural applications. Observing these features, the *Kenaf* and *Cocus Nucifera* fibers have been chosen to produce green composite products that can be used for several applications such as panels in construction, casings for various domestic products, packaging applications, sport goods etc.

IV. Experimental Work

The objective of the present proposal is to develop biodegradable hybrid composite products using natural fibers from *Kenaf and Cocus nucifera* that belongs to the *Malvaceae* family and its Telugu vernacular name is *Gogu* and ***Kobbari.***

The wooden mould is made of dimensions 300mm x 300mm x 3mm. After making the mould the laminates of 2mm thick are made by using *Kenaf* and *Cocus Nucifera* fibers and PVC as resin. Specimens for flexure test, tensile test and water absorption test are prepared as per ASTM standards.

In order to study the hybridization, *Cocus Nucifera* fiber is added to *Kenaf (Gogu)* fiber composite. The fiber length is fixed to 7mm and weight of composite is maintained at 50 g, and the fiber weight percentage of *Cocus Nucifera* fiber weight is varied from 0-50g.

VIII. Results and Discussion

The effect of hybridization of Kenaf and Cocus Nucifera fibers is investigated on the mechanical properties and also on water absorption properties. Results of hybridization are tabulated in Table I.

TABLE I. PROPERTIES OF KENAF/ COCUS NUCIFERA HYBRID COMPOSITES

Fiber –A Kenaf (*grams)*	**Fiber-B Cocus Nucifera (grams)**	**Flexural strength (MPa)**	**Tensile strength (MPa)**	**Water absorption (%)**
0	50	48.2	14.6	2.8
20	**30**	**74.0**	**11.1**	**4.5**
25	25	35.9	14.4	3.5
30	**20**	**54.4**	**15.8**	**3.7**
50	0	70.1	8.6	1.5

The optimum fiber length and weight of Kenaf, Cocus Nucifera composites are 7mm and 50*g* respectively, which provides a flexural and tensile strengths of 75MPa and 15.8 MPa. Comparison of composites made of purely with each of the two fibers, it is found that Kenaf (Gogu) fiber composite showed good flexural strength compared to Cocus Nucifera fiber composite, whereas Cocus Nucifera fiber composite exhibited good tensile strength compared to Kenaf fiber composite.

Addition of Kenaf fiber in Cocus Nucifera fiber composite has resulted in increase in flexural strength of the composite with marginal variation in tensile properties which may be due to poor interfacial bonding between matrix and fiber.

When the composite is made either with either Kenaf or Cocus Nucifera fiber, the moisture absorption is very less. But, when it is hybridized, the moisture absorption is increased due to poor interfacial bonding and voids.

IX. Conclusion

Single fiber composites have exhibited extreme values for flexure and tensile strengths and water absorption properties. Reasonably good properties are noted for a combination of 3:2 ratio of either *kenaf* or *Cocus Nucifera* fibers. For other combinations, decrease in properties can be expected due to poor interfacial bonding due to mismatch of diameters and variation in bonding characteristics of fibers. Since the fibers taken are only untreated by any surface modification process, they can be very much improved by proper choice of alkali treatment, all the properties can be improved.

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Dynamic Analysis of L-Shape Bracket

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Abstract-
Bracketisanarchitecturalelementastructuralordecorativemember.Itcanbemadeofwood,stone,plaster,metal,orothermediums.Itprojectsfromawall,usuallytocarryweightandsometimestostrengthenanangle"Inmechanicalengineering a bracketisanyintermediatecomponentforfixingoneparttoanother,usuallylarger,part.Whatmakesabracketabracketisthefactthatitisintermediatebetweenthetwoandfixestheonetotheother Bracketsvarywildlyinshape,butaprototypicalbracketwouldbetheL-shapedmetalpiecethatattachesashelf(thesmallercomponent)toawall(thelargercomponent)itsverticalarmisfixedtoone(usuallylarge)element,anditshorizontalarmprotrudesoutwards andholdsanother(usuallysmall)element.InthisprojectL-shapedbracketismodeledinAnsyssoftware.Boundaryconditionsapplieddynamicallyrespective frequencies formodeshapeswere reported.

Key words- Lshape bracket,dynamicanalysis

I. INTRODUCTION

Bracketsareusedtosupport beams,conduits,pipesetc.Whentheroofingworkisfinishedforaportal structure,theoverhangof thesheets issupportedbybrackets,Thelouvreswhichareessentialfor ventilationinashedsystemaresupportedbybrackets.Therailingsprovidedarounda Walkwayaresupportedbybrackets.Thetypicalcross-sectionofabracketischannel. Thebest exampleofabracketsis thecatenarysupportsystemusedbyrailways.

The structure ofamachine toolforms thevitallinkbetweenthecuttingtoolandworkpieceonametalcuttingmachine.Themachinetool‟smetalremovalrate,accuracy,overallcost,methodofproductionandleadtimes,dependuponthetypeofstructuralmaterialanditsproperties. Thecommonlyusedmaterialsformachinetoolstructuresarecastironandsteel.

WhileinsomeapplicationsGraniteand„EpoxyConcrete‟,newlydevelopedmaterial,isalsointroduced.Castironstructureswerealmostexclusivelyusedinmachinetoolstillad ecadeorsoago,butlatelyweldedsteel structuresare finding widerapplicationduetoadvancesin weldingtechnology.Thechoiceofwhetherthestructureshouldbemadefromcastironorsteeldependsuponanumberoffactors.

II. MATERIALPROPERTIES

Importantmaterialpropertiesofrelevanceareasunder:

- Modulusofelasticity:Forhighstiffnessitisnecessarytochoosematerialswithahighvalueof E.Forinstance,thehighstrengthnodulargraphitecastironhasdoubled themodulusofelasticitythanthenormalcastiron,apartfrom itshighinternaldamping.

AllsteelshavepracticallythesameEandthereforemostlythenon-expensivegoodcommercialqualitysteelisusedformachine toolstructures.

- Specificstiffness:Materialshouldhavehighspecificstiffness.

- Damping:Castironhashigherinherentdampingproperties,dampinginsteelstructures occursmainlyinwelds,ifweldedjointsareproperlydesigned,thedampingofsteelstructuremayapproachthatofcastiron.
- Long-termdimensionalstability:Themachinetoolstructuralmaterialmustalsohaveagoodlong-termdimensionalstability.Lockedinstresslevelsshouldbereducedtoasclosetozeroaspossibletoachievethis.

- Coolantresistance: Thematerialshould be unaffectedbycoolant.

- Wearrateandfrictionalproperties:Materialshouldhavelowwearrateandlowcoefficientoffriction.

- Thermalexpansioncoefficient:Thematerialusedshould haveareasonably lowcoefficientofexpansion.Ifseveralcompositematerials areused,eachshouldhavethesamecoefficientofexpansiontoavoidthermalbending/distortion

DifferentMaterialsUsedformachinetoolstructureAs already stated, commonly usedmaterialsformachinetoolstructurearecastironandsteel.Whileinrecenttimes,graniteandepoxyconcrete are alsodevelopedandusedforstructures.Thesematerialsarediscussedhere:

*a)CastIron:*Fromearlytimescastironhasbeenthemostcommonlyusedmaterialformachinetoolstructures.Itmaybecastintocomplexandintricateshapes.Itiseasilymachinedand maybehand-scrapedandlappedtoahighdegreeofaccuracy.Ithasfairlygooddampingpropertiesandalsohasreasonablygoodantifrictionpropertieshelpedbythegraphitecontainedinit.Itcanbegivenverygoodlong-termdimensionalstabilitybygivingitaspeciallongcyclestressreliefannealingtreatment.Castironshouldbepreferredforcomplexstructuressubjectedtonormalloading,whenthesestructuresaretobemadelargeinnumbers.Itdoes,however,haveseveraldisadvantages.Onemajordisadvantageisthetimeandcosttakentoproduceafinishedcasting.Againcarehastobetakenatdesign stagetoensurenoabruptchangesinsectionthickness.Most manufacturingstagesinvolvethemovingofthecomponent eitherinoroutsidethefactory.

b) Mildsteelweldments:since1950"smildsteelweldment shavebeenusedmoreandmoreasamachinetoolstructuralm aterial.Theyhaveahighstiffnessandthestrengthisalsohigh. Valuesofpropertiesofsteelarelistedintable.Ithaslowerwei ghtcomparetocastiron.Ifnecessary,inmildsteelstructurest hinwallsectionscanbeused.Whilewithcastironthewallthic knessislimitedbytheaccuracyofcasting.Steel shouldbepreferredfor simple, heavilyloadedstructures,whicharetobemanufacturedins mallnumbers;thisisduetothefactthatinlightlyloadedstruct uresthehighermechanicalpropertiesofsteelcannotbefully exploited.

Thismaterialtoohassomedisadvantages.Thematerial dampingislowandmildsteelweldmentshaveamarkedtend encyto„ring". Frictionpointsaresometimesbuilt-infrictionis highandcastiron orplasticinsetshave tobeused to reduce frictionto avoid „pick-up". Againforthis material, manufacturingtimesarelong.Thismaterialwillrust,too.Long-termdimensionalstabilityhasnotbeenverifiedtothesamed egreeascastiron.Finally,combinedweldedandcaststructur esarebecomingpopular,nowdays.Theyaregenerallyused whereasteelstructureiseconomicallysuitablebutisdifficul ttomanufactureowingtothecomplexityofsomeportions;th esecomplexportionsareseparatelycastandweldedtothema instructure.

c) Granite:graniteisusedforsurfacetablesandmeasuring machinestructures.Itsinternaldampingisbetterthanthatof castiron.Itswearpropertiesaregood.Itisreputedtobeveryst abledimensionally.Granitehasanumberofdisadvantages.I tisbecomingmoreandmorescarce.Ittakesalongtimetocuti t outtosize,grindandlapittoshape. Therearemanytypesofgranite,butmostabsorbwaterandth esurroundingairhumidityaffectsitsdimensionalstabilitya ndthusgeometricalaccuracy.

d) Epoxyconcrete:itisanewmaterialspecificallydevelop edoverthepasttwodecadesforhighprecisionmachinetools tructure.Itisthemixtureofbindingagentreactionresinandth ehardenertogetherwithcarefullyselectedandmixedaggreg ates.Itiscompletelynewtechnologyascomparedwiththose ofthematerialsmentionedabove.Epoxyconcreteoffersgre atdesignfreedom,similartocastiron.Ithasoutstandingdam pingproperties–betterthantraditionalconcrete.Itcostsapproximatelythesa meassteelreinforcedconcreteorevenless.Epoxyconcreted oesnotexpandandcontractwithchangeinhumidity,asdoes ordinaryconcrete.Againvariousmaterialpropertiescanbe controlledinepoxyconcretebythetypeofmixturechosen.E poxyconcrete hasaveryhighlong-termdimensionalstability.

Anotherimportantfactorfordecidingthechoiceofmat erialconcernstheproblemsofmanufacturingthatareassoci atedwiththeuseofsteelorcastironstructures:

• Wallthickness:Foragivenweightofthestructure, highstrengthandstiffnesscanbeachievedbyusinglargeove ralldimensionsandsmallwallthickness.Thuswallsofmini mumpossiblethicknessshouldbeemployed.Generally,red uctionof wallthicknessincastironstructuresisrestrictedbyprocessc apabilityanddependsupon thesizeofthecasting in caseof castiron.Weldedstructuresmadeofsteelcanhavemuchthin nerwallsascomparedtocaststructuresasthetechnologicalc onstraintsaremuchless.
Steelstructuresinwhichthewallthicknessislessthanthatoft hecaststructurebyupto50%areknownasthickwalledstruct ures.Theyaremadeof10-12mmthickplatesandareeasy tomanufacture,buttheyarenotparticularlyeffective frompointofviewofeconomyofmetal.Machiningallowan ceforcaststructuresaregenerallylargerthanforweldsteelstr uctures,thisisessentialtoremovethehardenedskinofcastin gandalsotoaccountforcastingdefects,suchasinclusions,sc ales,drops,etc.,thatresultduetothefallingofsandintothemo uldcavity.weldedstructurecan,ifrequired,beeasilyrepaire dandimproved.Anycorrectionsinacaststructurearemuch moredifficult.
Thispropertyofsteelstructuresisparticularlyusefulin preparingaprototype.Thefinalselectionofmaterialforstru cturewillin most casesrestupon whichofthemprovidesforalowercostofthestructure

Correctselectioncanbemadeonly onthebasisofacomprehensiveanalysisofvariousfactors,so meofwhicharelistedbelow:

• Economyofmetal:Hereitisimportanttorememberthatalt houghtheweightofthefinishedsteelstructuremay below,theactualmetalconsumptionmay behigh;thisisduetothefactthatwhereasholesincastingsare obtainedwiththehelpofcores,thoseinwelded structureshavetobe machined.Thisresults notonlyinscrapbutalsoinadditionallaborcost.

• Costofpatternandweldingfixtures.

• Costofmachining.

Further,itisnecessarytodesignallpartsoftheframewit hsuchshapesandofsuchdimensionsastoensuresuitablerigi dityoftheframe.

Forcesoccurduringthemachiningoperationgivingris etodeformations,whichdisturbtheaccuracyofmachining. Someoftheforcesdonotdependontheintensityofthecutting processasforinstancetheweightforcesofthemovingpartso fthemachine.Theinfluenceonaccuracyoftheothers,suchas cuttingforces,isrelatedtotherateofmachining.Therelation betweenforcesanddeformationsandtheircombinedeffect onthemachiningoperationleadstorequirementsonthestiff nessoftheindividualpartsofthestructureandofthestructure asa whole.

Accordingtovariouskindsofforces,whichoccurdurin gthemachiningoperation,variousspecificationsofrequire mentsonstiffnessmaybestated.Theseforceswill be classifiedintofourgroups correspondingtofourdifferentcriteria.

a) Deformationscausedbyweightforces
Duringthemovementoftheindividualpartsofthestructuret hedistributionoftheirweightsandoftheweightoftheworkpi ecevaries.Consequentlythedeformationsoftheframevary. Thecriterionisthatanydeviationsarisingdonotdisturbthep rescribedgeometricaccuracyofthemachinetool.

b) Deformationscausedbycuttingforces
Duringtheoperationthecuttingforcevariesanditspoint of application moves. In consequence, thedeformationsoftheframewillvarycausingdeviationsof theformofthemachinedsurfaces.Thiseffectmaybelimited bydecreasingthecuttingconditionsandconsequentlytheo utputoftheoperation.Cuttingforcedepends upon theworkpiecematerial;machiningparameters,wearofcutti ngtooletc.Foradesigneraknowledgeaboutthenatureanddi rectionoftheforceandthepointwhereitactsonthestructurei softenmoreimportantthanaverypreciseknowledgeofitsm agnitude.

c) Forcedvibrations
Inthemachinetooldisturbingperiodicforcesoccur.Theyar ecausedmainlybytheunbalanceofrotatingpartsandbyerro rsofaccuracyinsomedrivingelements.Theyexciteforcedv ibrations,whichresultinthewavinessofmachinedsurfaces. Thecriterionistolimitforcedvibrationssoastoachievetothe requiredsurfacequality.

d) Self-excitedvibrations
Undercertainconditions,generallyconnectedwiththeincr easeofthemachiningrateself-excitedvibrationsoccurandtheseareenergizedbythecuttin gprocess.Theycauseunacceptablewaviness ofthemachinedsurfaceandendangerthestrengthandlifeoft hepartsofthemachineandofthetools.Thecriterionisthatint herequiredrangeofoperationsandofcuttingconditionsself-excitedvibrationsshallnotoccurandthecuttingprocessmus tbestable.Theindividualcriteriaarealmostindependentofo neanother.Nevertheless,experienceshowsthatcriterion4p revailsandifitissatisfiedthencriterion2andoftenbalsocrite rion1and3are morethanfulfilled.Theproblemofstabilityoftheframeagai nstself-excitedvibrationsenergizedbythecuttingprocessisnotonl ythemostimportantonebutalsothemostdifficult.Allfourcr iteriadeterminerequirementsonsomeresultingstiffness,st aticordynamic,betweenthetoolandtheworkpiece.Byanal yzingthisresultingstiffness,requirementsontheindividual partsoftheframemaybederived.

*Group1:*Structureslikebedsandcolumnswithfullyor partiallyclosed thinboxprofilesorconsistingof twowallsconnectedbyparallelanddiagonalstiffeners maybeanalyzedasstaticallyindeterminatethin-wallbars.

*Group2:*Closedboxtypestructureslikehousingofspeedan dfeedboxesaredesignedforforcesperpendiculartothewall s,asthelatterhavesufficient stiffnessintheirownplane.

*Group3:*Supportingstructureslike tablesknees,etc.which aregenerallyloadednormaltotheirbaseplaneanalyzedaspl ates.

Undergeneralconditionsofcompoundloading,mosto fthemachinestoolsstructuresareanalyzedaselementssubje ctstobendingintwoperpendicularplanesandtorsion.Itwas pointedoutearlieralsothatthebasicdesignrequirementofm achinetoolsistheirstiffness.Thecommondesignstrategyfo rmachinetoolstructurescanthereforebesummedupas:

1. Designforbendingstiffness,
2. Designingfortorsionalstiffness

III. EFFECTOF APERTUREONTORSIONALSTIFFNESS

Indesignofmachinetoolstructure,designerisoftenfac edwithadecisionastoonwhichplanethejointshouldbeprov idedbetweentwoelements. Againjointsarepresentasanessentialpartofthefunctionalr equirementsintheoperationalmovements,andalsoenable themanufacture andmachiningof the elements.Inlargemachinetools,jointsarealsorequiredtoas sistinthetransportationofthefinishedmachine.Jointsinma chinetoolsmaybeoftwobasicforms,dependingupontherel ativemovement,whichtakesplacebetweenthejointinterfa ces:

- Joints,whichconnectstructuralpartswithoutanyi ntendedmotion,e.g.,thejointsbetweentheheadst ockandbedofalathe,thesearecalled“fixedjoints”
- Joints,whichconnectparts,whicharetohaveinten dedrelativemotiontooneanother,e.g.jointsbetwe enthesaddleandbedofalathe,thesearecalled“slid ingjoints”.Itissometimesnecessaryforelementst obejointedtogetherandpossessboththequalities offixedandslidingjoints,asinthecase ofthejointbetweenthetailstockandbedofthelathe.

Asthejointsformalinkoranumberoflinksinthechaino felementsclosingtheflowofthecuttingforces,theyshouldp ossessastiffnessmatchingthatoftheotherstructuralelemen ts;evenhavingotherstructuralelements ofahighstiffnesswouldnothelpiftherewereonlyoneflexibl ejointinthechainofelements,i.e.springsinseries.
Followingpropertiesofjointsrequireattention:
a) Thestaticanddynamicstiffnessofjointfacesloadedinapl anenormaltothejoint surface;
b) Thesignificanceofjointsontheoveralldeflectionofthest ructure
c) Thedampingeffectofjoints
Researchintotheoverallstiffnessofstructurehasshownthat thejointsusuallyincorporateahighpercentageoftheoverall deflection.Accordingtosomeresults,deflectionduetojoint sisoftheorderof85to90%ofthetotalstructuralstaticdeflecti oninamachinetool.

Investigationstostudythedynamiccharacteristics ofjointshaveshownthatdampingmaybeobtainedinajointbutonlyattheexpenseofstiffness.Fromthemetalremovalviewpoint, dampinginamachinetool isadvantageous.Jointsdointroducefrictionaldampingwhichis greaterinvaluethaninternalmaterialdamping.Therelative displacement betweenslidingelementshavetobelimitedespeciallywhen theyaresituatedinserieswithotherelements.Inthiscase,anincreaseoffrictionaldampingwithinjoints,attheexpenseof decreasingtheirstaticstiffness,ishardlyjustified.

Withregardstoabovefacts,themostefficientmethodtoachievebothstiffnessanddampingwouldbetodesignthejointsformaximumstiffnessandtointroducedampingbyexternalmeanssuchasvibrationabsorbers.

IV. RESULT

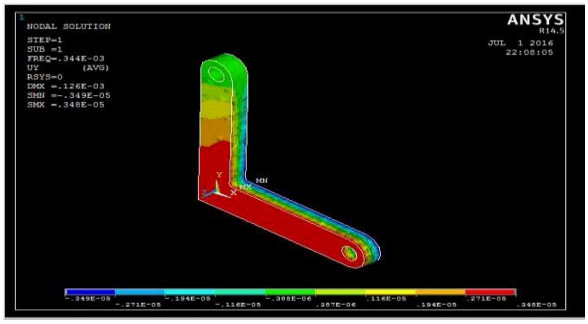

Fig1.Deformation aty

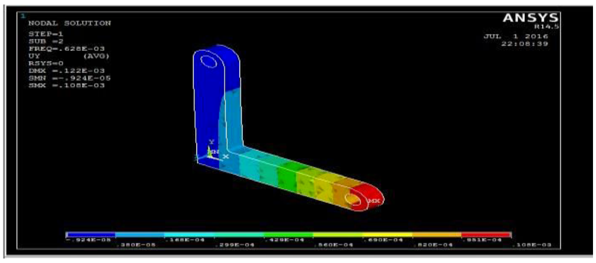

Fig1.**Deformationaty**

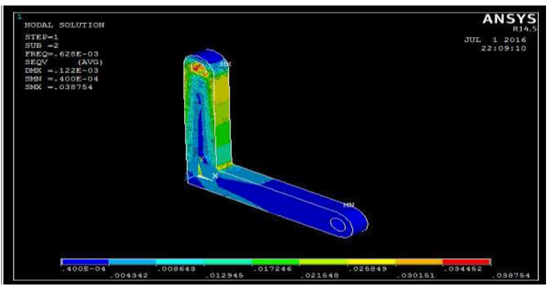

Fig2.*Vonmisesstress*

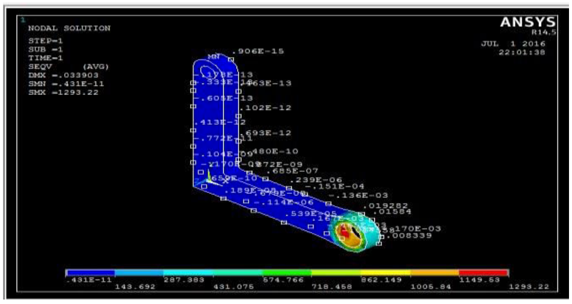

Fig3.*Stress*

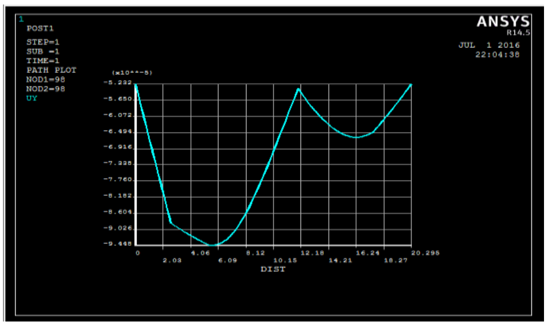

Fig 4.*Set 1 graph*

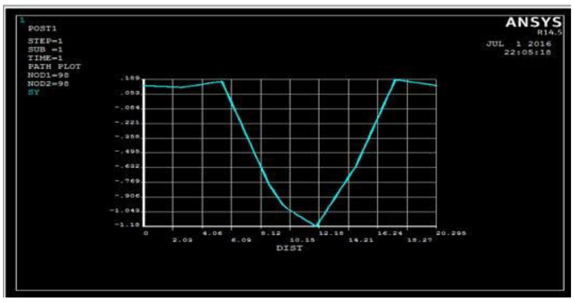

Fig5.*Set 2 graph*

V. CONCLUSION

Generallythebracketthicknessmustbethintoreduceweightand costand toserveitspurposeinextremeenvironment.Anycrackfoundinabracketmaycausetheductingtobecomeunstableduringamissionandthusinducehighcyclicfatigueloadontheoverallmajorstructuresandshortenthestructurelife.Inthisproject BracketismodelledinClassicalAnsyswiththerespectivedimensionswithdefinedmaterialproperties.Loadsappliedmodaldeformations,stresses ,vonmisesstressandfrequencieswereobtainedrecordedin Resultsandgraphsplotted.

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Performance and Emission characteristics of a VCR engine fueled with Rice bran oil- diesel blends

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Abstract— ***Biodiesel, a promising substitute as an alternative fuel has gained significant attention due to the predicted shortness of conventional fuels and environmental concern. The Rice bran oil is converted into biodiesel by transesterification process. Experiments has been carried out to estimate the performance, and emission characteristics of a single cylinder four stroke variable compression ratio engine fuelled with rice bran oil and its blends with standard diesel. Test has been conducted using the fuel blends of B15, and B30 biodiesel with standard diesel, with an engine speed of 1500 rpm. During the test runs the compression ratio of the engine was varied from 15:1to18:1and the torque is adjusted from zero to maximum value of 22 Nm. The performance characteristics such as the brake thermal efficiency, brake specific fuel consumption and mechanical efficiency of the engine are analyzed. The emission characteristics HC, NO_X, CO are also analyzed. The performance characteristics, and engine emission are effective in the variable compression ratio engine with biodiesel and it is compared with diesel. B30 blend was found to be a favorable alternative for CI engine due to increased BTE, reduced BSEC at higher loads and lower CO, HC, emissions over the entire operating range at CR 18.***

Keywords—VCR Engine; bio fuel; rice bran oil; diesel engine

1. Introduction

Energy demand is increasing due to ever-increasing number of vehicles employing internal combustion engines. Also, world is presently confronted with the twin crisis of fossil fuel deflection and environmental degradation. Fossil fuels are limited resources; hence, search for renewable fuels is becoming more and more prominent for ensuring energy security and environmental protection. There has been renewed interest in the use of vegetable oils for making biodiesel because it is less polluting and renewable. It is biodegradable and nontoxic, and has low emission profiles. Worldwide biodiesel production is mainly from edible oils such as soybean, peanut, coconut, sunflower and canola oils Ramdas et al. [1] observed significant improvement in engine performance and emission characteristics for the biodiesel fuelled engine compared to diesel-fuelled engine. Thermal efficiency of the engine improved, brake specific energy consumption reduced and a considerable reduction in the exhaust smoke opacity was observed. Masjuki et al. [2] investigated preheated palm oil methyl ester in a diesel engine. Puhan et al. [3] transesterified mahua oil using methanol in presence of alkali and the biodiesel obtained was studied for fuel properties. The properties of rice bran oil compares well against other Vegetable oils have comparable energy density, cetane number, heat of vaporization and stoichiometric air-fuel ratio with that of the diesel fuel can be easily mixed with diesel in any proportion and can be used to partially substitute diesel. Therefore, in this study a simple method of increasing the efficiency and reducing the exhaust gas emissions of the diesel engine without any compromise on the power output of the engine has been adopted.[4-6].

Nomenclature

VCR	Variable compression ratio
B10	Diesel blended with 10% biodiesel
B30	Diesel blended with 30% biodiesel
BSFC	Brake specific fuel consumption
HC	Hydrocarbon
NO_X	Oxides of nitrogen
CO	Carbon monoxide
CR	Compression Ratio

2.Experiental

2.1. Bio diesel production

Vegetable oils have to undergo the process of transesterification to convert into biodiesel and it is usable in IC engines. In transesterification, rice bran oil was chemically reacted with an alcohol in the presence of a catalyst to produce vegetable oil esters. Glycerol is produced as a by-product of the reaction. The mixture is stirred continuously and then allowed to settle under gravity in a separating funnel. Two distinct layers form after gravity settling for 24 h. The upper layer was ester and lower layer was of glycerol. The lower layer is separated out. The separated ester was mixed with some warm water (around 10% volume of ester) to remove the catalyst present in the ester and is allowed to settle under gravity for another 24 h. The ester was then blended with mineral diesel to be used in CI engine[7].

2.2 Fuel properties

The fuel properties are listed in Table 1.

2.3 Experiental setup

The present study was carried out to investigate the performance and emission characteristics of VCR engine using rice bran oil blended with diesel and the results are compared with pure diesel. The engine specifications are shown in table 2.

2.4. Experimental Procedure

The enginewas first started by Manual cranking with diesel as fuel and it was allowed to reach its steady state (for about 10 min). The test fuels used during this program were neat neat(100%) diesel fuel, and blends of 15 and 30 percent biodiesel by volume in the diesel fuel.
The engine was sufficiently warmed up and stabilized before taking all readings. The performance of the engine and emissions were studied at variable loads corresponding to the load at maximum power at an average speed of 1500 rpm. After the engine reached the stabilized working condition, the load applied, fuel consumption, brake power and exhaust temperature were measured from which brake specific fuel consumption, thermal efficiency and mechanical efficiency were computed. The emissions such as CO, HC, and NOx were measured using exhaust gas analyzer. Each test was repeated at CR 15, 16.5,18. These performance and emission characteristics for different fuels are compared with the result of baseline diesel.

TABLE1. Fuel properties of diesel oil and biodiesel blend

Properties	***Diesel***	***B10***	***B30***	***B100***
KinematicViscosity at 32^0 C, c st	4.2	4.53	5.54	16
Densityat kg/m^3	860	846	842	832
Flash point (°C)	56	65	68	111
Fire point(°C)	63	71	73	116
Calorific Value (kJ/kg)	42800	41510	40340	35406

TABLE 2. ENGINE SPECIFICATIONS

Make	Kirloskar
Number of Strokes	4
Number of cylinders	single
Rated power	3.7kW
Speed	1500rpm
Number of cylinder	Single cylinder
Compression ratio	12:1–20:1(variable)
Bore	80mm
Stroke	110mm

3. RESULTS AND DISCUSSIONS

3.1. Engine performance

The engine performance is evaluated in terms of brake thermal efficiency, Break specific fuel consumption, and Mechanical efficiency at different load conditions and at different CR's

3.1.1. Brake Thermal Efficiency

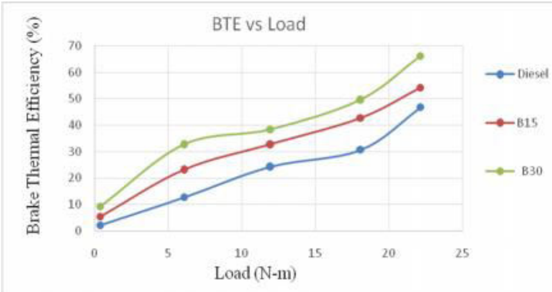
The variations of brake thermal efficiency (BTE) with different torque, for three compression ratio and three test fuels are analysed. The increase in BTE is observed for increase in torque for all the test runs. Fig. 1 shows the results in variation of brake thermal efficiency of test runs. It is evident that the brake thermal efficiency of the blended fuels has higher value than that of diesel fuel. The blended fuel of B30 has higher thermal efficiency with the diesel fuel full load is observed for CR16.5:1.

3.1.2. Mechanical Efficiency

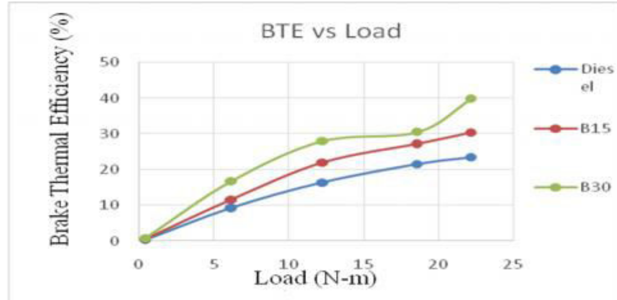
The variations of mechanical efficiency (ME) with different torque, for three compression ratio and three test fuels are analysed. The increase in ME is observed for increase in torque for all the test runs. Fig. 2 shows the results in variation of mechanical efficiency of test runs. It is evident that the mechanical efficiency of the blended fuels has higher value than that of diesel fuel. The blended fuel of B30 has higher mechanical efficiency with the diesel fuel around 80% of rated loading is observed for CR16:1. The maximum thermal efficiency is 60% for B30 at CR16:1.

3.1.3.Brake specific fuel consumption

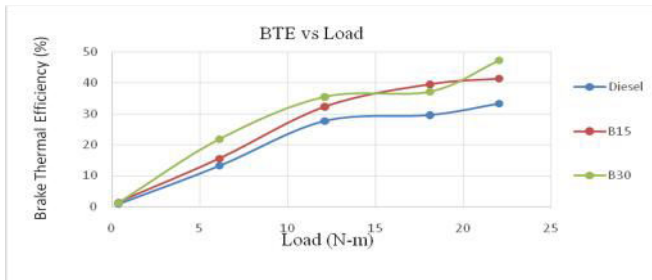
The results of the BSFC of the study are shown in Fig. 3. The BSFC is found to be decreasing by the increase of torque for the entire compression ratio for all the three fuels tested in the present work. This may be due to better combustion and additional lubricity of the biodiesel.



a. At CR 15:1

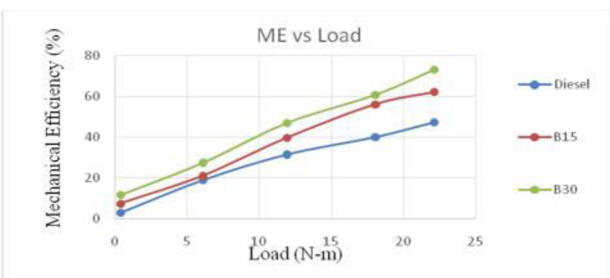


b. At CR 16.5:1

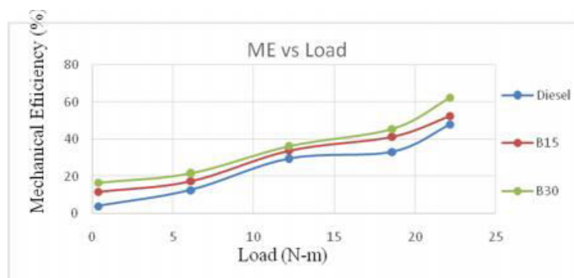


c. At CR 18:1

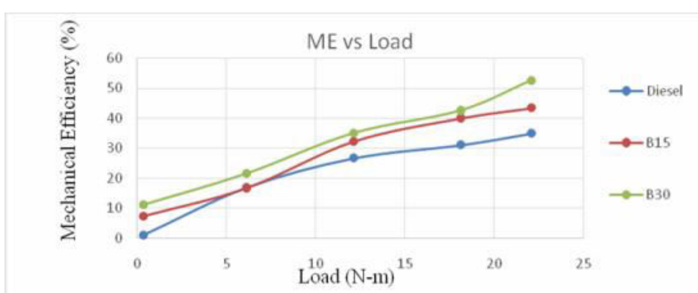
Fig 1：Variation of Break thermal efficiency with varying loads at different Compression ratios



a. At CR =15:1

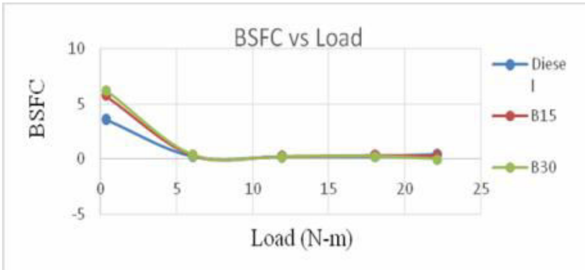


b. At CR = 16.5:1

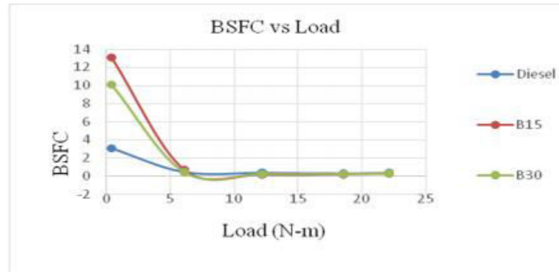


c. At CR =8:1

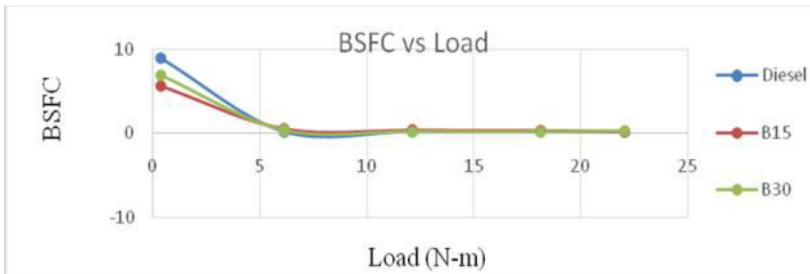
Fig 2: Variation of Mechanical Efficiency with Varying loads at different Compression Ratios



a. At CR =15:1

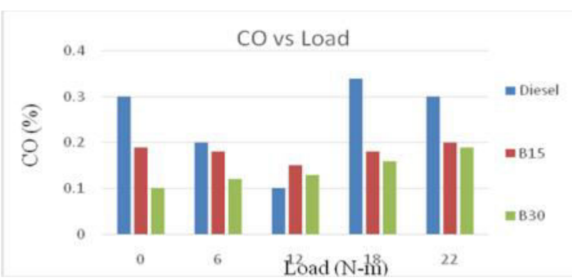


b. At CR =16.5

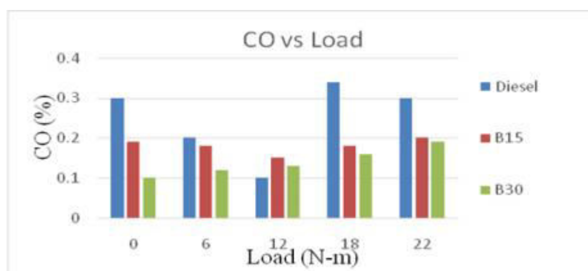


c.At CR=18:1

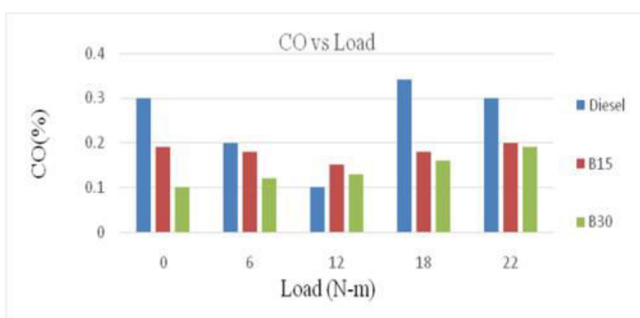
Fig 3: Variation of BSFC with varying loads at different Compression ratios



a. At CR = 15:1

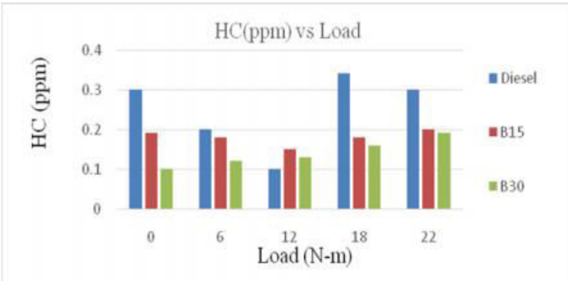


b. At CR =16.5:1

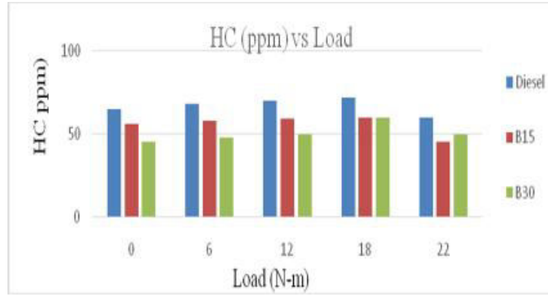


c.At CR=18:1

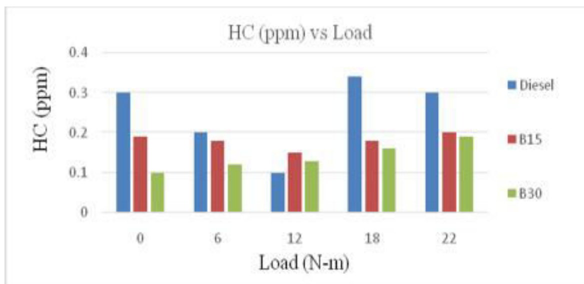
Fig 4. Variation of CO% with varying loads at different compression ratios



a. At CR=15:1

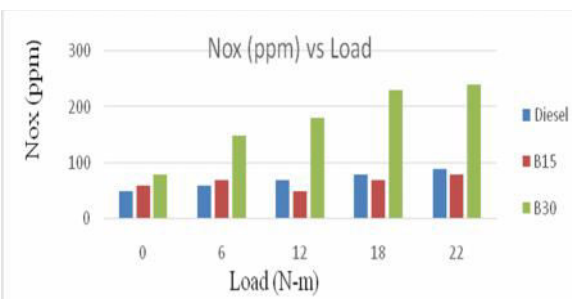


b. At CR = 16.5 :1

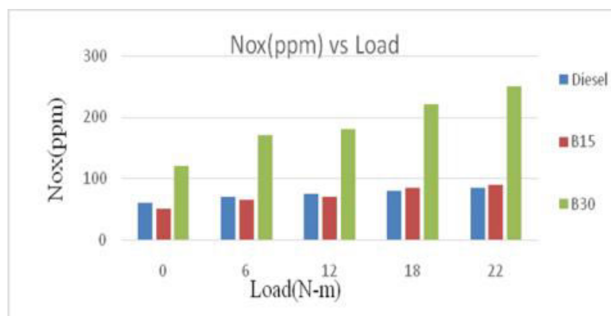


c.At CR= 18:1

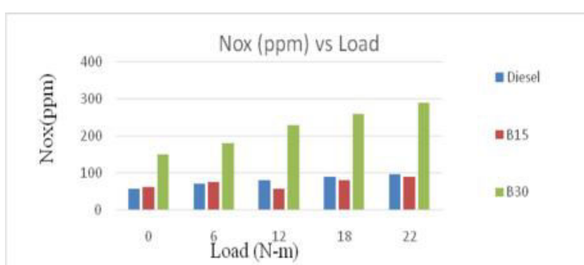
Fig 5. Variation of HC emissions with Varying loads at different Compression ratios



a. At CR =15:1



b. At CR= 16.5:1



c.At CR =18:1

Fig -6. Variation of No_x emissions with varying loads at different compression ratios

3.2 .Engine emissions

3.2.1. CO emissions

Fig.4 presents the variation of carbon monoxide emission with respect to VCR of the diesel engine using diesel, rice bran oil blends at different engine loads. As shown, CO emission decreases with the increase in load

3.2.2 HC emissions

Fig.5 depicts the variation of unburned HC emission for diesel, and rice bran oil blends at different engine loads with respect to VCR. HC concentration in the exhaust of the diesel engine decreases with load applied for both diesel and blended fuel forms. The HC emissions are increased with B30 at CR 14& CR 18 due to insufficient combustion. The HC emissions are less at CR 16.5

3.2.3. NO_X Emissions

Fig. 6 represents the effect of changing CR and rice bran oil blends with diesel on NOx emission formed inside the engine cylinder at different engine load conditions. Fig.6 illustrates that the NOx level increases with increase in engine loads and CR for both diesel and blended fuel operations and also decreases with the increase in rice bran oil percentage in the blends.

4. Conclusions

Based on the performance results and investigation, It is concluded that the brake power of biodiesel is little more than that of standard diesel for all compression ratio in part load operation. The brake specific fuel consumption of the blended fuel is very close to the diesel fuel. The combustion duration of the biodiesel is decreased by increase of compression ratio as expected. Most significant reduction in emissions of blended fuel is achieved for all compression ratios. It proves that there is a necessity to identify the ways of exploitation of the energy from the biodiesel in a big way. It is proposed to carry out the analysis of the higher blend ratio under operating condition in future to account for the better use of biodiesel.

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Structural Analsys of Household Gas Cylinder

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***Abstract*— thepresentworkinvolvedtheFiniteElementAnalysisofexistingLPGgascylindertoverifytheburstpressure.TheLPGgascylinderismanufacturedfromlowcarbonsteel.TheLPGtanksaresubjected toincrementalinternaluniformpressureintheFEAmodel.2Dnonlinearplanemodelsaredevelopedandevaluatedundernon-uniformandaxissymmetricboundaryconditions.Fortheanalysis,therequiredactualshellpropertiesincludingweldzoneandthicknessvariationareinvestigated.Thereforethestressdistributionhasbeenanalyzed usingANSYS14.0 softwareforwhich maximumshear stress;equivalentshearstressatcriticalareahasbeencalculated.Therefore3Dsolidmodelhasbeenchoseninordertopredictthedetailedstress.**

Computeraidedinvestigations arecarried usingANSYStoverifymaximumstressanditslocation.Topredictdetailedstress3Dsolidmodelhasbeenchosenwiththehelpof PROEsoftware. TwodifferenttypesofnonlinearFEmodels,planeand shell,weredevelopedusing2D axisymmetricfiniteplaneandshellelements,respectively.TocreatetheseFEmodelsandsimulatethe experimental burst,first, shellMPsandthicknessvariationsoftheLPGtanksduetospinningprocessesareinvestigatedandinputtothecomputermodelingprocesses.Additionally,afterselectingtheloadingandboundaryconditionsandappropriatefiniteelements,thenonlinearaxisymmetric2DFE modelsweregeneratedandsimulatedinnon-uniformandnon-homogeneousconditions.

Keywords–LPG,Burstpressure,nonlinearfailure analysis

IINTRODUCTION

1.1. Introductiontohouseholdgascylinder:

Liquefiedpetroleum gas(alsocalledLPG,GPL,LPGas,autogas,orliquidpropanegas)isaflammablemixtureofhydrocarbongasesusedasafuelinheatingappliancesandvehicles.Itisincreasingly usedasanaerosolpropellantandarefrigerant,replacingchlorofluorocarbonsinanefforttoreducedamagetotheOzonelayer.

Withtherelatedliteraturereviewandobjectiveofthisconcernproject,wewillfindrelationbetweeninputparametersandcorrespondingoutputparameters andformulaterelationbetweenthemtogetrequiredresult.

Thisprojectsetouttoverifyfiniteelementanalysis,orFEA, whenappliedtopressurevesseldesign.Whilefiniteelementanalysisoffersanotherwaytoanalyzestructures,itrequiresasunderstandingoftheprogramandsubjectbeingmodeled.Iftheoperatordoesnotusethecorrectmodel,timeiswastedandmoreimportantlythedataisuseless.Theprimaryproblemofthemanufacturer istodeterminetheburstpressuresandvolumeexpansionsofthe LPGtankswhoseserviceandtestpressuresareknownbythedefinitionsoftheECR-RandTSrules.

Theservicepressure(SP)istheworking(operating)pressurewherethetanksarefilledandusedinindustrialapplications.Thetestpressure(TP)isagivenpressurethatisappliedandreleasedatwhichthepermanentvolumeexpansionsofthetankmustexceed10%oftheinitialmeasuredvolume.

Finiteelementanalysisisapowerfultoolinthefieldofengineering.Initially,finiteelementanalysiswasusedinaerospacestructuralengineering.Thedifficultyisanalysisofstressandstressandstraininstructuralengineeringdependsonthestructureinvolved.Asthe structuregrowsincomplexity,so doesthe analysis.Manyofthemore commonlyusedstructuresinengineeringhavesimplifiedcalculationstoapproximatestressandstrains.However,thesecalculationsoften providesolutionsonlyforthemaximumstress and strainatcertainpointsinthestructure.Furthermore,thesecalculationsareusuallyonlyapplicablegivenspecificconditionsappliedtothestructure.

Liquefied petroleum gas or liquid petroleumgas(**LPG**or**LPgas**), also referred toassimplypropaneorbutane, areflammable mixturesofhydrocarbongasesusedasfuel inheatingappliances,cookingequipment,andvehicles.Itisincreasinglyusedasanaerosol propellantand arefrigerant,replacingchlorofluorocarbonsozone layer. Whenspecificallyusedasavehiclefuelitisoftenreferredtoasautogas.

VarietiesofLPGboughtandsoldincludemixesthataremostlypropane(C_3H_8),mostlybutane(C_4H_{10})and,mostcommonly,mixesincludingbothpropaneandbutane.Inthenorthernhemispherewinter,themixescontainmorepropane,whileinsummer,theycontain morebutane.IntheUnitedStates,mainlytwogradesofLPGaresold: commercialpropaneandHD-5.ThesespecificationsarepublishedbytheGasProcessorsAssociation(GPA)andtheAmericanSocietyofTestingandMaterials(ASTM).Propane/butaneblendsarealsolistedinthesespecifications.

Propylene,butyleneand variousother hydrocarbonsareusuallyalsopresentinsmallconcentrations.HD-5limitstheamountofpropylenethatcanbeplacedinLPGto5%,andis utilized asanauto gasspecification. Apowerfulodorant,ethanol,isaddedsothatleakscanbedetectedeasily.TheinternationallyrecognizedEuropeanStandardisEN589.IntheUnitedStates,tetrahydrotheophany(thiophane)oramylmercaptanarealsoapprovedodorants,althoughneitheriscurrentlybeingutilized.

LPG is prepared byrefiningpetroleumor"wet"naturalgas,andisalmostentirelyderivedfromfossilfuelsources, being manufacturedduring therefining of petroleum(crudeoil),orextractedfrompetroleumornaturalgasstreamsastheyemergefromtheground.Itwasfirstproducedin1910byDr.WalterSnelling,andthefirstcommercialproductsappearedin1912.Itcurrentlyprovidesabout3%ofallenergy consumed,andburnsrelativelycleanlywithnosoot andveryfewsulfuremissions.Asitisagas,itdoesnotposegroundor waterpollutionhazards,butitcancause airpollution. LPG has a typicalspecificcalorificvalueof46.1MJ/kg compared with42.5MJ/kg for fueloiland 43.5MJ/kg for premiumgradepetrol(gasoline)However,itsenergydensitypervolumeunitof26MJ/Lislowerthaneitherthatofpetrolorfueloil,asitsrelativedensityislower(about0.5–0.58 kg/L,comparedto0.71–0.77kg/Lforgasoline).

Asitsboilingpointisbelowroomtemperature,LPGwill evaporate quickly atnormaltemperaturesandpressuresandisusuallysuppliedinpressurisedsteelvessels.Theyaretypicallyfilledto80–85%of theircapacity to allowforthermal expansionofthecontainedliquid.Theratio between thevolumes ofthevaporized gasand the liquefied gas varies depending oncomposition,pressure, and temperature,but is typicallyaround250:1.Thepressureat whichLPGbecomesliquid,called itsvapourpressure, likewisevariesdepending oncompositionandtemperature;forexample,itisapproximately220kilopascals(32psi)forpure butaneat20°C(68°F),andapproximately2,200kilopascals(320psi)forpurepropaneat55°C(131 °F).LPGisheavierthanair,unlikenaturalgas,andthuswillflowalongfloorsandtendtosettleinlowspots,suchas basements.Therearetwomaindangers fromthis.ThefirstisapossibleexplosionifthemixtureofLPGandair iswithintheexplosivelimitsandthereisan ignitionsource.ThesecondissuffocationduetoLPGdisplacingair,causingadecreaseinoxygenconcentration.

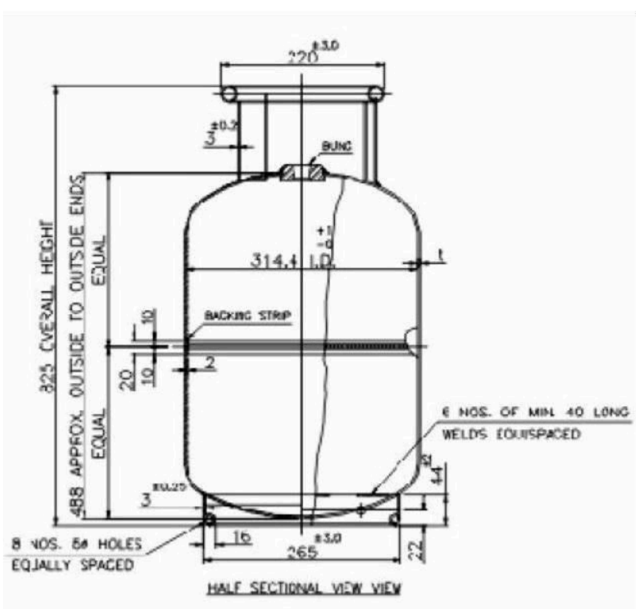


Fig.1:LPGgascylinder

1.2. Usesofhouseholdgascylinder

LPG hasaverywide varietyofuses,mainlyusedfor cylindersacrossmanydifferentmarketsasanefficientfuelconta0iner intheagricultural,recreation,hospitality,calefaction,construction, sailingandfishingsectors.Itcanserveasfuelfor cooking,centralheatingandtowater heatingand isaparticularlycost-effectiveandefficientwaytoheatoff-gridhomes.InthesafetyfontLPGcylindersmustbeupdatedtonewstandardsinsafetyanduserexperience,givingahugecontributionfor domesticusage.

- **Cooking**

LPGisusedforcookingin manycountriesforeconomicreasons,forconvenienceorbecauseitisthepreferredfuelsource.

Accordingtothe2011censusofIndia,33.6million(28.5%) Indianhouseholds usedLPGascookingfuelin2011,whichissupplied to theirhomesinpressurisedcylinders.LPGissubsidisedbythegovernmentinIndia.IncreaseinLPGpriceshasbeenapoliticallysensitivematterinIndiaasitpotentiallyaffectstheurbanmiddleclassvotingpattern.

LPGwasonceapopularcooking fuelinHongKong;however,thecontinuedexpansionoftowngastobuildingshasreducedLPGusagetolessthan24%ofresidentialunits.

LPGisthemostcommoncookingfuelinBrazilianurbanareas,beingusedinvirtually allhouseholds,withtheexceptionofthecitiesofRiodeJaneiroandSãoPaulo,whichhaveanaturalgaspipelineinfrastructure.Poorfamiliesreceivea governmentgrant("ValeGas")usedexclusivelyfortheacquisitionofLPG.

LPGiscommonlyusedinNorthAmericafordomesticcookingandoutdoorgrilling.

- **Ruralheating**

PredominantlyinEuropeandruralpartsofmanycountries,LPGcan provideanalternativetoelectricheating,heatingoil,orkerosene.LPGismostoftenusedinareasthatdonothavedirectaccesstopipednaturalgas.

LPGcanbeusedasapowersourceforcombinedheatandpowertechnologies(CHP).CHPistheprocessofgeneratingbothelectricalpowerandusefulheatfromasinglefuelsource.ThistechnologyhasallowedLPGtobeusednotjustasfuelforheatingandcooking,butalsofordecentralizedgenerationofelectricity.

LPGcanbestoredinavarietyofmanners.LPG,aswithotherfossilfuels,canbecombinedwith renewablepowersourcestoprovidegreaterreliabilitywhilestillachievingsomereductioninCO_2emissions.

- **Motorfuel**

WhenLPGisusedtofuelinternalcombustionengines,itisoftenreferredtoasautogasorautopropane.Insomecountries,ithasbeenusedsincethe1940sasapetrolalternativeforsparkignitionengines.Insomecountries,thereareadditivesintheliquidthatextendenginelifeandtheratioofbutanetopropaneiskeptquitepreciseinfuelLPG.TworecentstudieshaveexaminedLPG-fuel-oilfuelmixesandfoundthatsmokeemissions andfuelconsumptionarereducedbuthydrocarbonemissionsareincreased.ThestudieswereresplitonCOemissions,withonefindingsignificantincreasesandtheotherfindingslightincreasesatlowengineloadbutaconsiderabledecreaseathighengineload.Itsadvantage isthatitisnon-toxic,non-corrosiveandfreeoftetraethylleadoranyadditives,andhas a highoctanerating(102–108RON dependingonlocalspecifications).Itburnsmorecleanlythanpetrol orfuel-oil and isespecially freeoftheparticulatespresentinthelatter.

LPGhasalowerenergydensitythaneitherpetrolorfuel-oil,sotheequivalentfuelconsumptionishigher.Manygovernments imposelesstaxonLPGthanonpetrolorfuel-oil,whichhelpsoffsetthegreater consumptionofLPGthanofpetrolorfuel-oil.However,inmanyEuropeancountriesthistaxbreakisoftencompensatedbyamuchhigherannualroadtaxoncarsusingLPGthanoncarsusingpetrolorfuel-oil.Propaneisthethirdmostwidelyusedmotor fuel intheworld.2013estimatesarethatover24.9millionvehiclesarefueledbypropanegasworldwide.Over25milliontonnes(over9billion USgallons)areusedannuallyasavehiclefuel.

NotallautomobileenginesaresuitableforusewithLPGasafuel.LPGprovideslessuppercylinderlubricationthanpetrolordiesel, soLPG-fueledenginesaremorepronetovalvewearifttheyarenotsuitablymodified.ManymoderncommonraildieselenginesrespondwelltoLPGuseas asupplementaryfuel.ThisiswhereLPGisusedasfuelaswellasdiesel.SystemsarenowavailablethatintegratewithOEMenginemanagementsystems.

IIMETHODS

2.1 FINITEELEMENTMETHOD

2.1.1 NeedofFiniteElementMethod

Topredictthebehaviorofthestructurethedesigneradoptsthreetoolssuchasanalytical,experimentalandnumericalmethods.Theanalyticalmethodisusedfortheregularsectionsofknowngeometricentitieswherethecomponentgeometryisexpressedmathematically.Thesolutionobtainedthroughanalyticalmethodisexactandtakeslesstime.Thismethodcannotbeusedfortheirregularsectionsandtheshapeswhichrequireverycomplexmathematicalequations.

TheFiniteelementmethodissopopularbecauseofitsadaptabilitytowardsuseofdigitalcomputers.TheFiniteelementmethodpredictsthecomponentbehavioratdesiredaccuracyofanycomplexandirregulargeometryatleastprice.

2.1.2 GeneralDescriptionofFiniteElementMethod

IntheFinite elementmethod,theactualcontinuumorbodyofmatterlike,solid,liquidorgasisrepresentedasanassemblageofsubdivisionscalledfiniteelements.Theseelementsareconsideredtobeinterconnected atspecificjoints,whicharecallednodesornodalpoints.Thenodesusuallylieontheelementboundarieswhereadjacentelementsareconsideredtobeconnected.Sincetheactualvariationofthefieldvariable(likedisplacement,temperature,pressureandvelocity)insidethecontinuumisnotknown.Weassumethatthevariationofthefieldvariable inside afiniteelementcanbeapproximatedbyasimplefunction.Theseapproximatingfunctions(alsocalledasinterpolationmodels)aredefinedintermsofthevaluesatthenodes.

Whenfieldequations(likeequilibriumequations)forthewhole continuumarewritten, thenewunknownwillbethenodalvaluesofthefieldvariable.Bysolvingthefieldequations,aregenerallyintheformofmatrixequations,theapproximatingfunctiondefinesthefieldvariablethroughouttheassemblageofelements.

Thesolutionofageneralcontinuumbythefiniteelementmethodalwaysfallowsanorderlystepbystepprocess.Thestepbystepprocedureforstaticstructuralproblemcanbestatedasfallows

STEP1: Discretizationofstructure(domain)
Thefirststepinthefiniteelementmethodistodividethestructureorsolutionregionintosub-divisionsorelements.
STEP2: Selectionofaproperinterpolationmodel.
Sincethedisplacement(fieldvariable)solutionofacomplexstructureunderanyspecifiedloadconditionscan'tbepredictedexactly. Weassumesomesuitablesolutionwithinanelementtoapproximatetheunknownsolution.Theassumedsolution mustbesimplefromcomputationalpointofview,anditshouldsatisfycertainconvergencerequirements.
STEP3: Elementstiffnessmatrices(characteristicmatrices)andloadvectors.
Fromtheassumeddisplacementmodelthestiffnessmatrix[K(e)] andtheloadvectorF(e) ofelement'e'aretobederivedbyusingeitherequiibriumconditions orasuitablevariationprinciple.
STEP4: Assemblageofelementequationstoobtaintheoverallequilibriumequations.Sincethestructure iscomposedofseveralfiniteelements,theindividualelementstiffnessmatricesandloadvectorsaretoassembledinasuitablemannerandtheoverallequilibriumequationshavetobeformulatedas

$$[K]q=F$$

[K]iscalledassembledstiffnessmatrix,qiscalledthevectorofnodal displacementandFisthevectorofnodalforcesofthecompletestructure.
STEP5: Solutionofsystemequationshavetobemodifiedtoaccount fortheboundaryconditionsoftheproblem.Afterincorporationoftheboundaryconditions,theequilibriumcanbeexpressed

$$[K]q=F$$

Forlinearproblems,thevector'q' canbesolvedveryeasily,Butfornon-linearanalysisisproblems,thesolutionhastobeobtainedinasequence ofsteps,eachstepinvolvingthemodification ofthestiffnessmatrix[k]and/ortheloadvectorF.
STEP6: ComputationofElementStressesandStrains.
Fromtheknownnodaldisplacements,ifrequired,theelementstressesandstrainscanbecomputedbyusingthenecessaryequationsofsolidorstructuralmechanics

2.1.3ExplanationofFEM byStepbyStepProcedure:
TheStepsinvolvedinthefiniteelementanalysisarestatedinthissection.

1. Discretizationofthedomain:

Thediscretization ofthedomainorsolutionregioninthesub-region (finite elements) is thefirststepin the finiteelementmethod.Thisisequivalenttoreplacingthedomainhavingandinfinitenumberofdegreesoffreedombysystemhavingfinitenumberofdegreeoffreedom.Theshapes,size,numberandconfigurationoftheelementshavetobechosencarefullysuchthattheoriginalbodyissimulatedascloselyaspossiblewithoutincreasingthecomputationaleffortforthesolution.

2. BasicElementShapes:

Foranygivenphysicalbodywehavetouseengineeringjudgmentinselectionofappropriateelementsfordiscretization.Thetypeofelementisindicatedbythegeometryofthebodyandthenumberofindependentspatialco-ordinatesnecessarytodescribethesystem. Thegeometry,material,propertiesandotherparameterslikestress,displacement,pressureandtemperaturecanbedescribedintermsofonespatialco-ordinatewecanuseone-dimensionalelement.Whentheconfigurationandthedetailsoftheproblemcanbedescribedintermsoftwoindependentspatialco-ordinates,wecanusethetwo-dimensionalelement.Thebasicelementusefulforthetwo-dimensionalanalysisisthetriangularelement.Ifthegeometry,materialpropertiesandotherparameterofthebodycanbedescribedbythreespatialco-ordinates,wecanidealizethebodybyusingthethreedimensionalelements.Thebasicthree-dimensionalelementsanalogoustotriangularelementsarethetetrahedralelements.

3. SizeofElements:

Thesizeofelementsinfluencestheconvergenceofthesesolutionsdirectlyandhenceithastobechosenwithcare.Ifthesizeoftheelementissmall,thefinalsolutionisexpectedtobemoreaccurate.Thesizeoftheelementshastobeverysmallneartheregionwherestressconcentrationisexpectedcomparedtofarawayplaces.Anothercharacteristicrelatedtothesizeofelements,whichaffects thefiniteelementsolutionistheaspectratio oftheelements.Fortwo-dimensionoftheelementtothesmallestdimension.Elementswithanaspectratioofnearlyunitygenerallyyieldbestresults.

4. LocationofNodes:

Ifthebodyhasnoabruptchangesingeometry,materialpropertiesandexternalconditions(likeload,temperatureetc)thebodycanbedividedintoequalsub-divisionsandhencethespacingofthenodescanbeuniform.Ontheotherhand,iftherearanydiscontinuitiesintheproblem,nodeshavetobeintroducedobviously,atthesediscontinuities.

5. NumberofElements:

The numberofelementstobechosenforidealizationisrelatedtotheaccuracydesired,sizeofelementsandthenumberofdegreesoffreedominvolved.Althoughandincreasein numberofelementsgenerally means moreaccurateresults,foranygivenproblemtheywillbecertainnumberofelementswhichmeansmoreaccurateresults,andtherecanevenbenumberofelementsbeyondwhichtheaccuracycannotbeimprovedbyanysignificantamount.

Moreover,sincetheuseoflargenumberofelementsinvolveslargenumberofdegreesoffreedom,wemaynotbeabletostoretheresultingmatricesintheavailablecomputermemory.

2.2ANSYS

Thefollowingpagesshouldgiveyouabriefandbasicintroductiontotthearchitectureandstructureofacommercialfiniteelementanalysisprogram.Thebasicideascanbeappliedinmostprogramsbutexamplesaretakenfromthesoftware ANSYS.Wewillhereonlyfocusonstructuralmechanicsin ANSYS.

2.2.1BASIC PROGRAM STRUCTURE:

Utilitymenu:Hereyoucan accessandadjustpropertiesaboutyoursession,suchasfilecontrols,listingandgraphiccontrols.**Toolbar**:Pushbuttonstocommonlyusedcommands.

Mainmenu:Here youcanfindtheprocessorsusedwhenanalyzingyourproblem.

Graphicswindow:Inthe graphicswindowyourmodelisdisplayed:geometry.

Inputwindow:Youcantypecommandsintheinputwindow.

1. Preprocessor:

Withinthepreprocessorthemodelissetup.Itincludesanumberofstepsandusuallyinthefollowingorder:

Buildgeometry.Dependingonwhethertheproblemgeometry isone,twoorthreedimensional,thegeometryconsistsofcreatinglines,areasorvolumes.Thesegeometriescanthen,ifnecessary,beusedtocreateothergeometriesbytheuseofBooleanoperations.Thekeyideawhenbuildingthegeometrylikethisistosimplifythegenerationoftheelementmesh.Hence,thisstepisoptionalbutmostoftenused.Nodesandelementscanhoweverbecreatedfromcoordinatesonly.

Definematerials.Amaterialisdefinedbyitsmaterialconstants.Everyelementhastobeassignedaparticularmaterial.

Generateelementmesh.Theproblem isdiscretizedwithnodalpoints.Thenodesareconnectedto formfiniteelements,whichtogetherformthe materialvolume.Dependingontheproblem andtheassumptionsthataremade,theelementtypehastobedetermined.Commonelementtypesare*truss,beam,plate,shell*and*solidelements*.Eachelementtypemaycontainseveralsubtypes,e.g.2D4-nodedsolid,3D20-nodedsolidelements.Therefore,carehastobetakenwhentheelementtypeischosen.

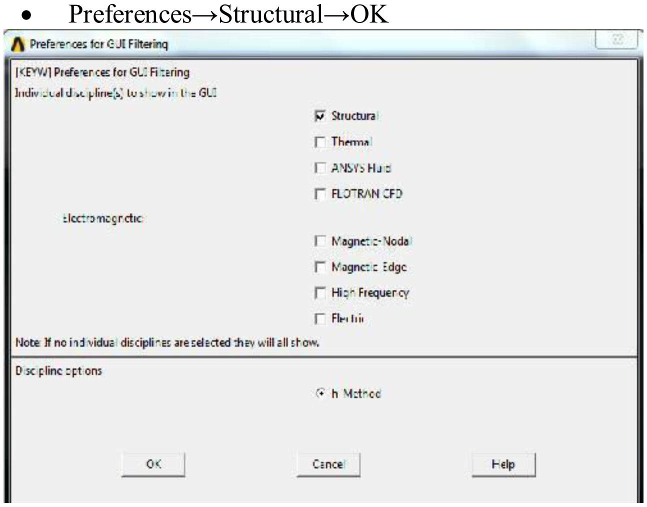
Theelementmesh caninANSYSbecreatedinseveralways.Themostcommonwayisthatitisautomaticallycreated,howevermoreorlesscontrolled.Forexampleyoucanspecifyacertainnumberofelementsinaspecificarea,oryoucanforcethemeshgeneratortomaintainaspecificelementsizewithinanarea. Certainelementshapesorsizesare notrecommendedandiftheselimitsareviolated,awarningwillbegeneratedinANSYS.It isuptotheusertocreate ameshwhichisable togenerateresultswith asufficientdegreeofaccuracy.

2. Solutionprocessor:
Here yousolve theproblem bygathering all specifiedinformationabouttheproblem:

3. Postprocessor:
Withinthis part ofthe analysis youcanforexample:
Visualizetheresults:Forexampleplot thedeformedshapeofthegeometryorstresses.
Listtheresults:Ifyou prefertabularlistingsorfileprintouts,itispossible.

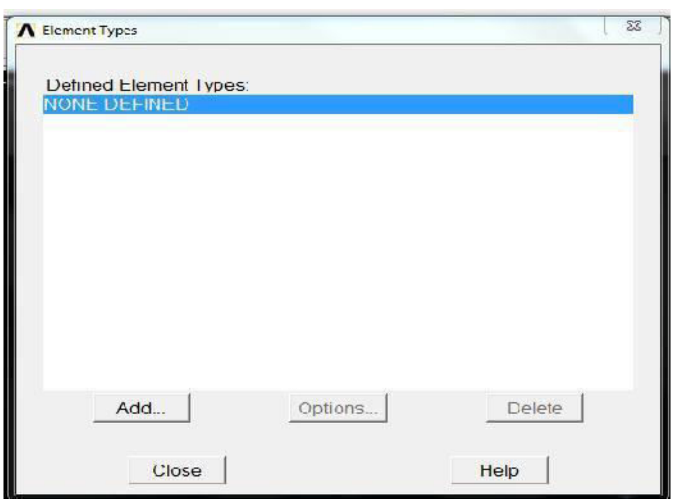
IIIANALYSES

- Preferences→Structural→OK

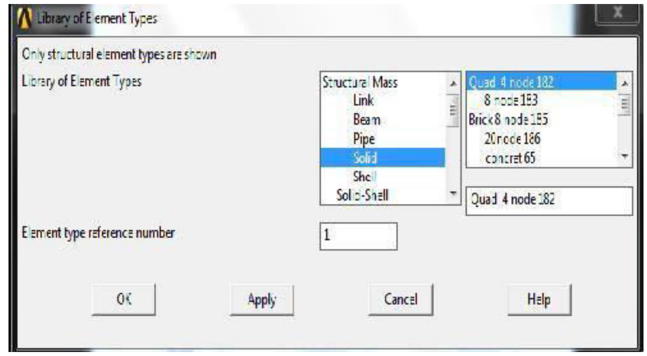


Pre-Processor

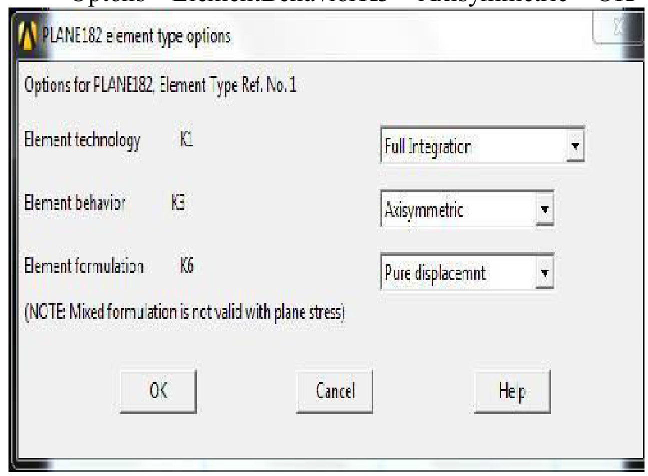
- Elementtype→Add/Edit/Delete→Add



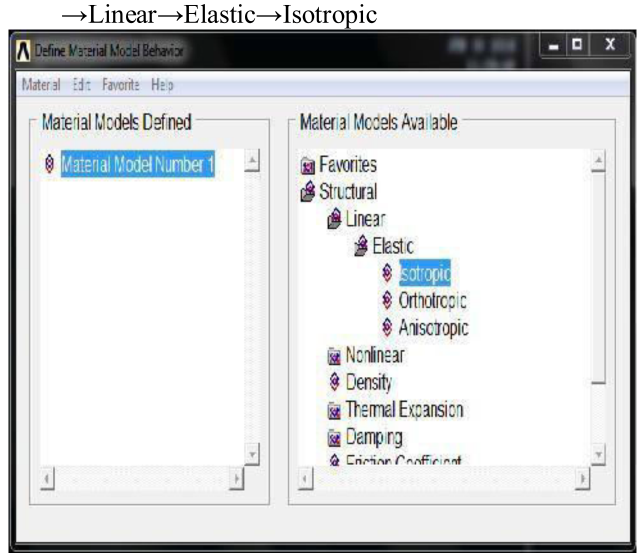
- Solid→Quad4Node182→OK



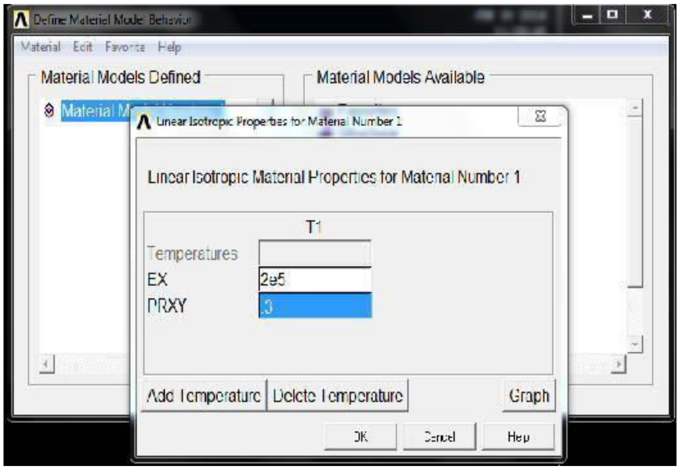
- Optons→ElementBehaviorK3→Axisymmetric→OK



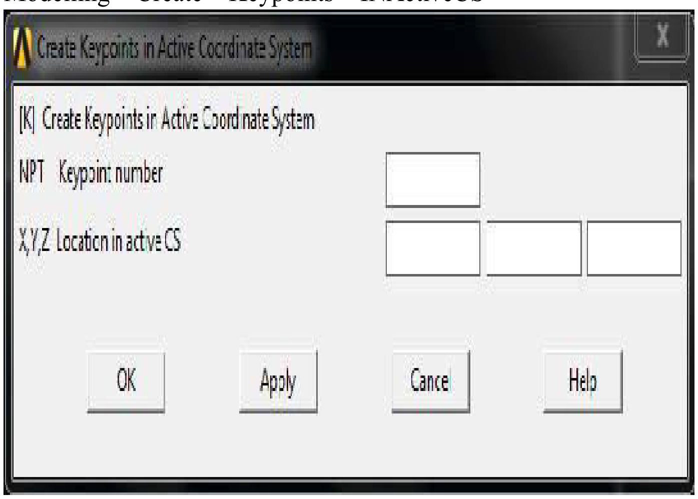
- MaterialProperties→MaterialModels→Structural →Linear→Elastic→Isotropic

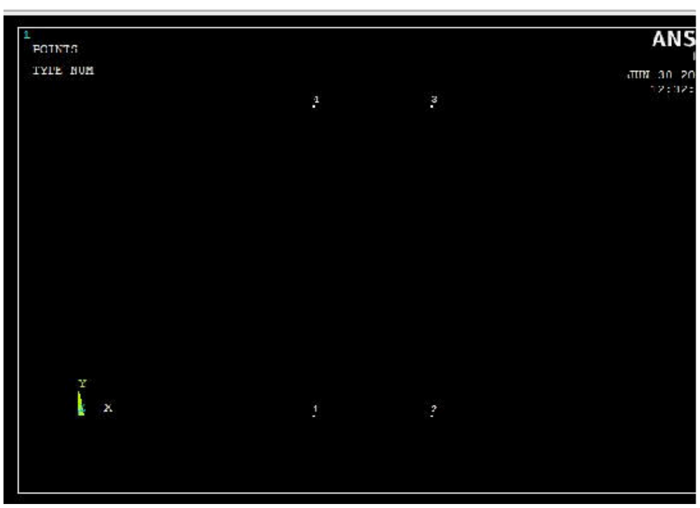


Young'sModulus–$2*10^5$Poison'sratio–0.3

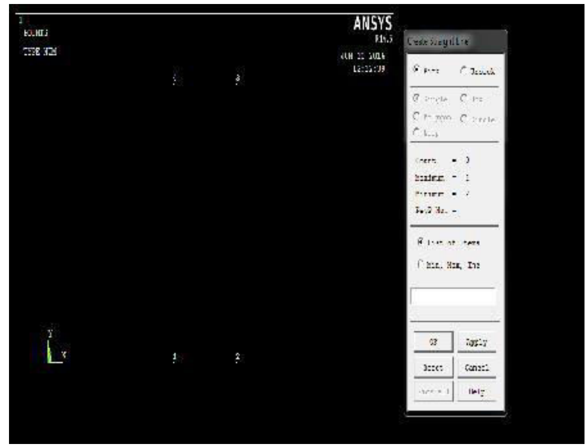


Modelling→Create→Keypoints→INActiveCS

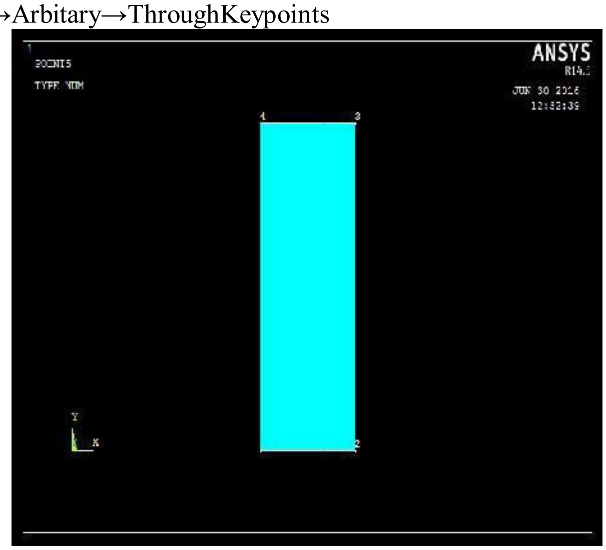




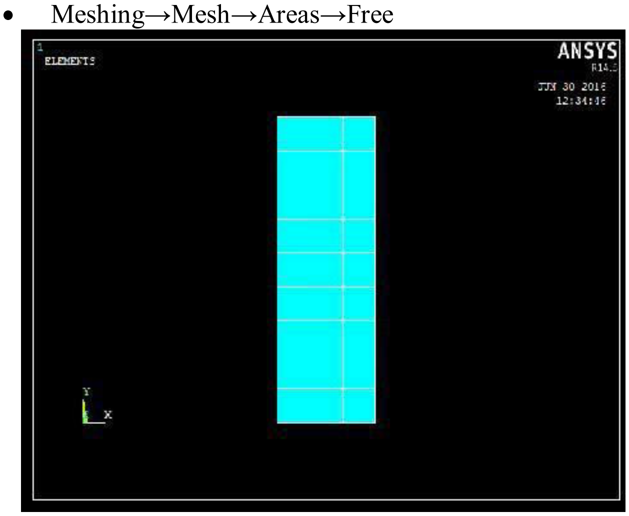
Lines→Lines→Straightlines→ThroughKeypoints



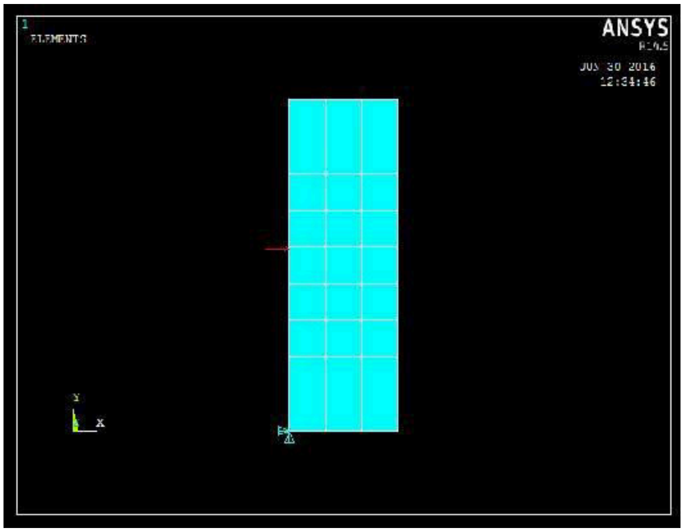
Area→Arbitary→ThroughKeypoints



- Meshing→Mesh→Areas→Free

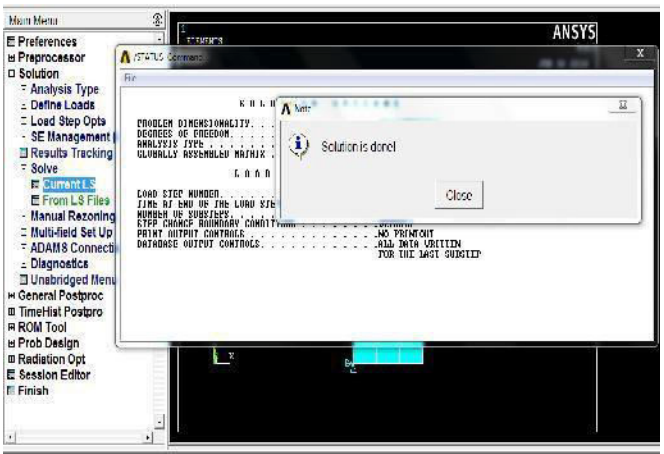


- Loads→DefineLoads →Apply→Structural→Displacement→OnKeyPointOnkeyPoint–AllDOF
- Loads→DefineLoads →Apply→Structural→Pressure→OnlinePressure-$2.5*10^6$MPa

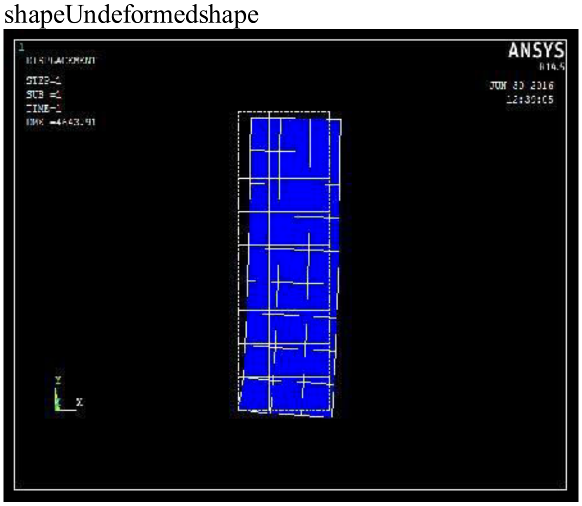


IVRESULTS

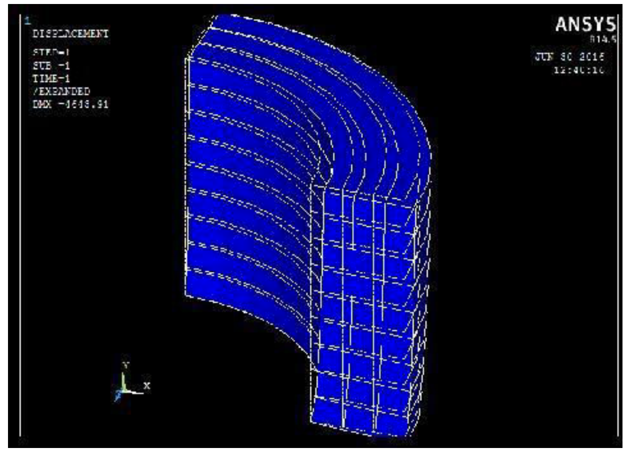
- Solve→CurrentLS→OK



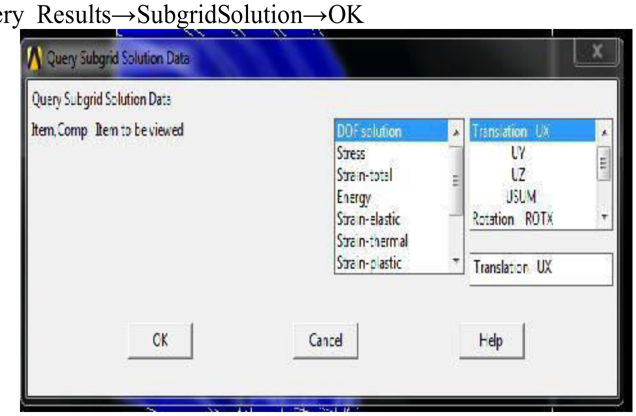
- Plot Results→Deformed →Deformed + shapeUndeformedshape



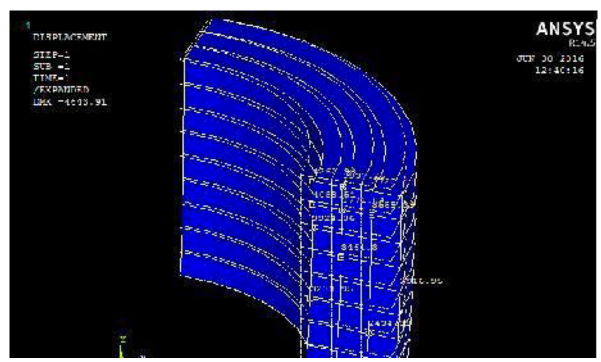
- Plot controls→Style→Symmetry→2D Axissymmetry



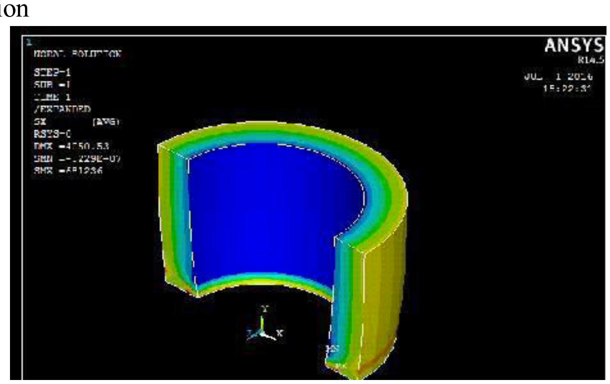
Query Results→SubgridSolution→OK

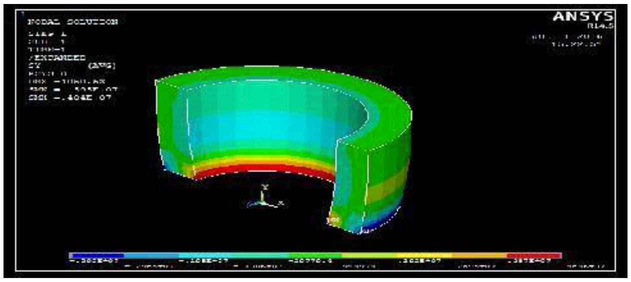


Tocheck thedisplacementvalues, clickatdifferentpositionsinXdirection

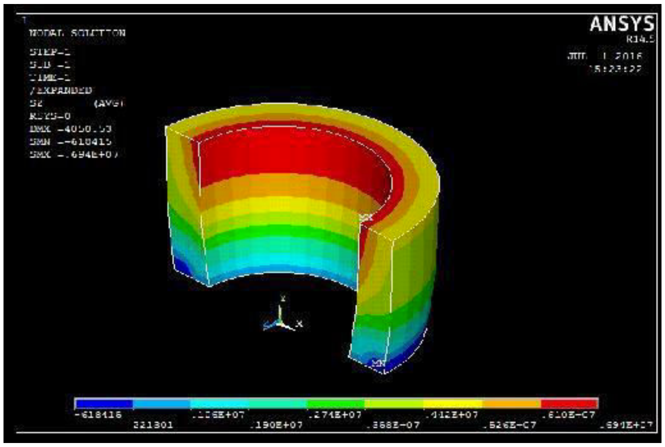


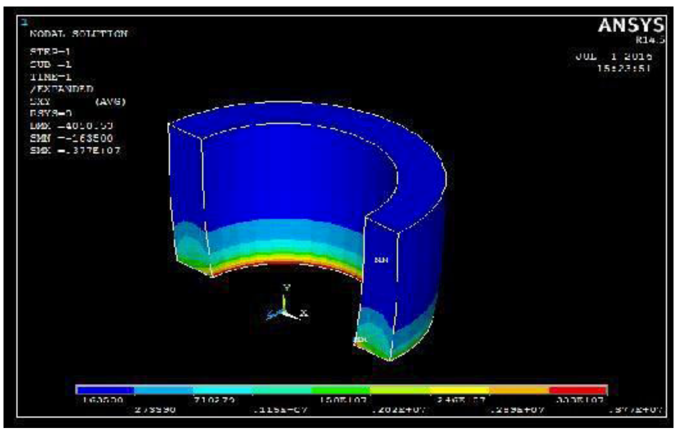
Plotresults→Counturplot→NodalsolutionX direction





Nodalsolution YdirectionNod alsolutionZdir ection





NodalSolutionXY direction

Asweseenaboveanalysisandresultsforappliedloadsandconditio nstheburstpressureofLPGgascylinderhasbeendeterminedbyuseo ffinite elementanalysismax.Andmin.equivalentstress,maximumshears tressanddeformationat criticalareahasbeencalculated.

5CONCLUSION&FUTURESCOPE

Thelimitationsofphysicalmodeltechniqueshaveledtothedevelop mentofmathematicalmodelsrepresentingavarietyofmechanicalst ructures.Asinthisapproach,wholestructureisdividedintofiniteele ments,itisknownas'FiniteElementAnalysis'. TheFEA isaveryusefultoolinengineeringtoday andsamehasprovedtobeanimportanttechniqueinmachinetoolstru cturalanalysis.Thus,Computerisaninvaluabletoolforadesignerin histaskforevaluatingalternativedesignstoarriveattheoptimumdes ignandalsopredictingthestaticbehaviorofthemachinebeforearrivi ngatthefinaldesign.Machinetoolshavesomemeansofconstraining theworkpiece andprovideaguidedmovementofthepartsofthemachine.Inanalysi s partthefiniteelementofhollowmachinememberiscreatedusingsol idtetrahedronelements,appropriateboundaryconditionsareapplie d,materialpropertiesaregivenandloads areappliedasperits design, theresultantdeformationandstressesvonmisesstresesobtainedare reportedinResults.

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[6]Chandrapatla,Belugunda,"FEA".

Design and Analysis of Bearing House

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DepartmentofMechanicalEngineeringMallareddyCollegeofEngineering

***Abstract*—Bearings are precisioncomponents;theyrequirecleanlubricantsinadequateamountsto survive,andevenseeminglysmallamountsofcontaminationcangreatlyreduceequipmentreliabilityanduptime.Theforgingprocessissuperiortocastinginthatthepartsformedhavedensermicrostructures,moredefinedgrainpatterns,andlessporosity,makingsuchpartsmuchstronger thanacasting. Allmetalsandalloysare forgeable,but eachwill haveaforge abilityratingfrom highto lowor poor.Thefactorsinvolvedarethematerial'scomposition,crystalstructureandmechanicalpropertiesallconsideredwithin atemperaturerange.Thewiderthetemperaturerange,thehigherthef orgeabilityrating.Mostforgingisdoneonheatedworkpieces. "Coldforging"canoccur atroomtemperatures. Themostforgeablematerialsarealuminum,copper,and magnesium.Lower ratingsareappliedto thevarioussteels,nickel,andtitaniumalloys.Hotforgingtemperatures rangefrom 93 0C (2000F)to 16500C (30000F) for refractorymetals.**

InthisprojectacomponentanddiewillbedesignedinCATIAV5R20and analysiswere carriedoutinANSYS.

Keyword-bearinghouse,coldforging,analysis

I. INTRODUCTION

Housingisoneoftheaccuratecomponentstokeepthebearingreliabilityandsafety.

Anewgenerationofbearingprotectorsisnowavailablethatcan helpmaintainlubricantcleanliness,preventlossoflubricants,andprolongthelifeofyourrotatingequipment.

Dependinguponthedesignofashaftorhousing,theshaftmaybeinfluencedbyanunbalancedloadorotherfactorswhichcanthencauselargefluctuationsinbearingefficiency.Forthisreason,itisnecessarytopayattentiontothe followingwhendesigningshaftandhousing:

- Bearingarrangementselection;mosteffectivefixingmethodforbearingarrangement
- Selectionofshoulderheightandfilletradiusofhousingand shaft.
- Shapeprecisionanddimensionsoffitting;arearunouttoleranceofshoulder.
- Machiningprecisionandmountingerrorofhousingandshaftsuitableforallowablealignmentangleandinclinationofbearing.

II. MODELINGANDMESHING

A. IntroductiontoCATIA

CATIAisarobustapplicationthatenablesyoutocreaterichandcomplexdesigns.Thegoalsof theCATIAcoursearetoteachyouhowtobuild partsandassembliesinCATIA,andhowtomakesimpledrawingsof thosepartsandassembliesThis course focuses on thefundamentalskillsandconceptsthatenableyoutocreateasolidfoundationforyourdesigns

B. WhatisCATIA?

CATIA ismechanicaldesignsoftware.Itisafeature-based,parametricsolidmodelingdesigntoolthattakesadvantageof theeasy-to-learnWindowsgraphicaluserinterface.Youcancreatefullyassociative3-Dsolidmodelswithorwithoutconstraintswhileutilizingautomatic oruser-definedrelationstocapturedesignintent.Tofurtherclarifythisdefinition,theitalictermsabove willbefurtherdefined:

C. Feature-based:

Likeanassemblyismadeupofanumberofindividualparts,aCATIAdocumentismadeupofindividualelements.Theseelementsare calledfeatures.Whencreatingadocument,youcanaddfeaturessuchaspads,pockets,holes,ribs,fillets,chamfers,anddrafts.Asthefeaturesarecreated,theyareapplieddirectlytotheworkpiece.

Featurescanbeclassifiedassketched-basedordress-up:

- Sketched-basedfeaturesarebasedona2Dsketch.Generally,thesketchistransformedintoa3Dsolidbyextruding,rotating,sweeping,orlofting.
- Dress-upfeaturesarefeaturesthatarecreateddirectlyonthe solidmodel.Filletsand chamfersareexamplesofthistypeoffeature.

D. Parametric:

The dimensions andrelations usedtocreateafeature arestoredinthemodel.Thisenablesyoutocapturedesignintent,andtoeasilymakechangestothemodelthroughtheseparameters. Drivingdimensionsare the dimensions usedwhencreatingafeature.Theyincludethedimensionsassociatedwiththesketchgeometry,aswellasthoseassociatedwiththefeatureitself.Consider,forexample,acylindricalpad.Thediameterofthe padiscontrolledbythediameterofthesketchedcircle,andtheheight ofthepadiscontrolledbythedepthto whichthecircleisextruded.

*a) Concentricity:*Thistypeofinformationistypicallycommunicatedondrawingsusingfeaturecontrolsymbols.Bycapturingthisinformationinthesketch,CATIAenablesyoutofullycaptureyourdesignintentupfront.

b) SolidModeling:Asolidmodelisthemostcompletetypeofgeometricmodelusedin CADsystems.Itcontainsallthewireframeandsurfacegeometrynecessarytofullydescribetheedgesandfacesofthemodel.Inadditiontogeometricinformation,solidmodelsalsoconvey their―topology‖,whichrelatesthegeometrytogether.Forexample,topologymightincludeidentifyingwhichfaces(surfaces)meetatwhichedges(curves).Thisintelligencemakesaddingfeatureseasier. Forexample,ifamodelrequiresafillet,yousimplyselectanedgeand specifyaradiustocreateit.

c) FullyAssociative:- ACATIAmodelisfullyassociativewiththedrawingsandpartsorassembliesthatreferenceit.Changesto themodelare automatically reflected inthe associated drawings,parts,and/orassemblies.Likewise,changesinthecontext ofthedrawingorassemblyarereflectedbackinthemodel.

d) Constraints:- Geometricconstraints(suchasparallel,perpendicular,horizontal, vertical,concentric,andcoincident)establishrelationshipsbetweenfeaturesinyourmodelbyfixingtheirpositionswithrespecttooneanother.Inaddition,equationscanbeusedtoestablishmathematicalrelationshipsbetweenparameters.Byusingconstraintsandequations,youcanguaranteethatdesignconceptssuchasthroughholesandequalradiiarecapturedandmaintained.

*e) CATIAUserInterface:*Belowisthelayoutoftheelementsofthestandard CATIAapplication.

A. MenuCommands

B. SpecificationTree

C. WindowofActivedocument

D. FilenameandextensionofcurrentdocumentIco nstomaximize/minimizeandclosewindow

F. Iconoftheactiveworkbench

G. Toolbarsspecifictotheactive workbench

H. Standardtoolbar

I. Compass

J. Geometryarea

f) CATIAMODELING:

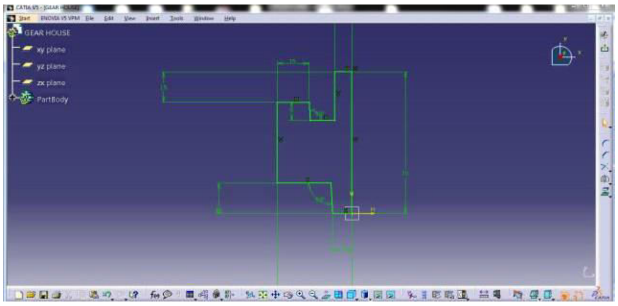

Fig-1:Dimensionsofbearing house

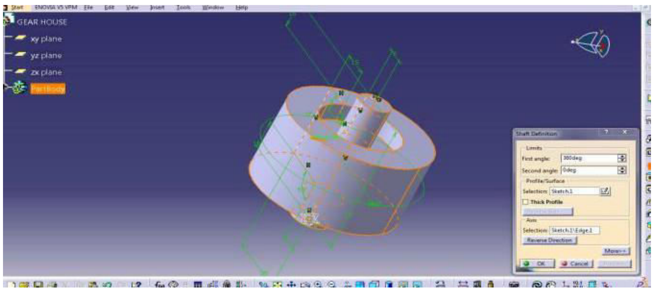

Fig-2:Isometricviewof bearing house

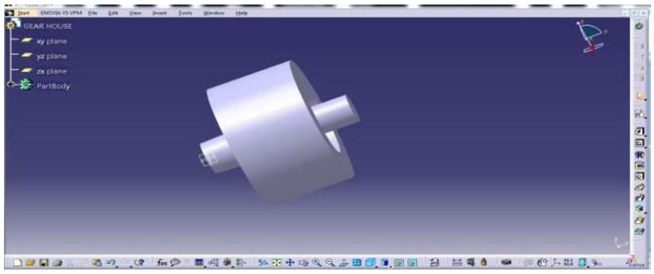

Fig-3: bearing housemodel

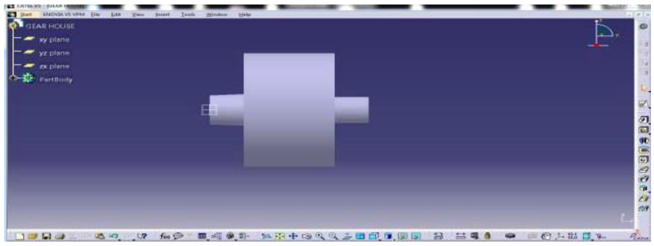

Fig-4: bearing housefrontview

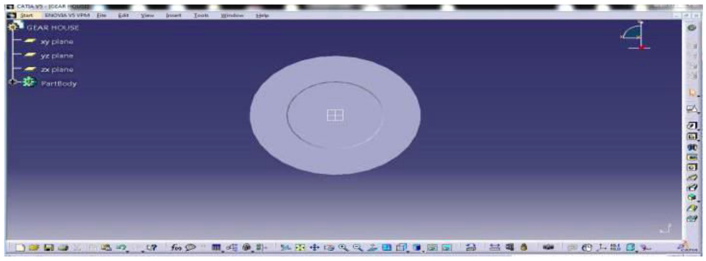

Fig-5: Bearing housebottomview

Fig-6: Bearing housetop view

*G) MESHING:*Meshingisgeneratedbyusinghypermeshsoftware .Meshthegeometrybyusingtetrahedralelements.Elementtypeissolid45.

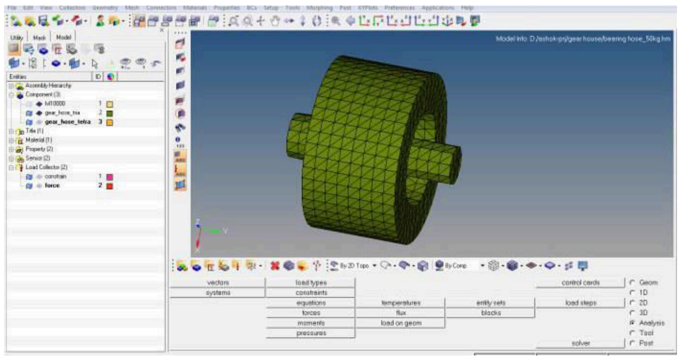

Fig-7: Meshmodel of agear boxhouse

H) ANALYSISOFAGEARBOXHOUSE:

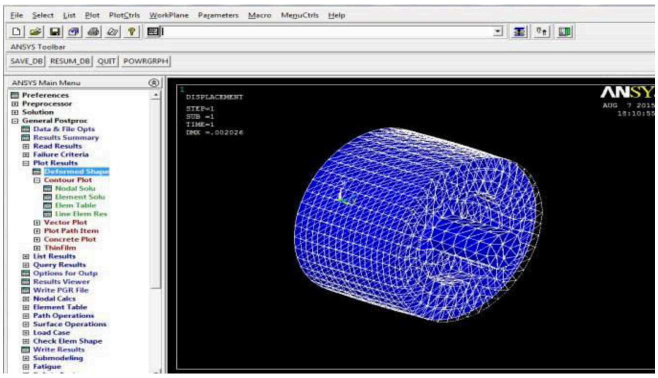

Fig-8:Deformed-undeformedshapeof agear box house

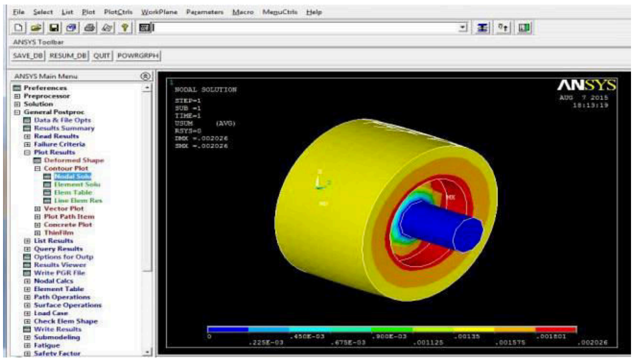

Fig-9: Displacementvector sumof agear box houseis 0.002mm

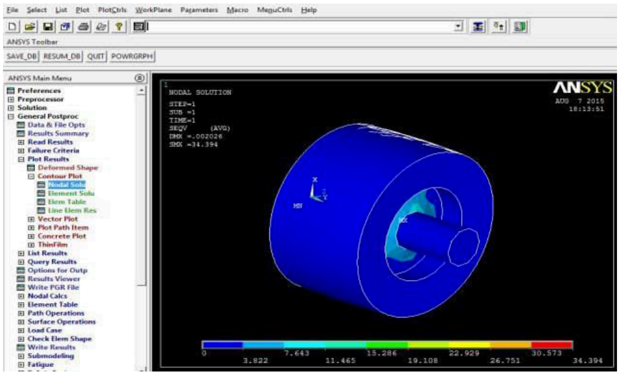

Fig-10: Vonmisesstressof agearbox houseis34.39n/mm^2

III. CONCLUSION

Designedhousingforbearingwhichwillbeconnectedtoshaftof anaxleofavehicleusedforCultivation.Forthepurposeoflargequantityofproductionweareproducingthecomponentsbyusingamethodcalledforging.

TheBearingHousewasanalyzedbyfiniteelementmethods.FromtheaboveresultstheMaximumVonmisesstressobservedis34.39 N/mm^2.Thisvalueisundersafeloadcondition.

TheMaximumDisplacementforBearingHouseobservedis0.002mm,whichcanbeomittedforverysmallvalues.

TheStressLevelsformaxloadconditionwassafeanditsuggestedusingforHeavyEngineeringEquipment.

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Static Analysis of Lathe Cutter

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Abstract:-Latheis amachine toolusedinthe manufacturingindustry;latheisthemotherofallmachines.Whenamachineismanufactureditmayfailduetostressactingofthelathe,themanufacturedpartmayfailduetovibration.Thispaperanalysisthevariousstressesactingonthemachinetool,usingfiniteelementanalysis.Theanalyzeddatahelpstounderstandthebehaviourofthemachinetool;ithelpstoredesignthemachinetoolstructures

Keywords:machinetool,finite elementanalysis,ansys.

I. INTRODUCTION

Alatheisamachinetoolthatrotatestheworkpieceonitsaxistoperformvariousoperationssuchas,cutting,knurling,drilling,ordeformation,facing,turning,withtoolsthatareappliedtotheworkpiecetocreateanobjectwithsymmetryabout an axis of rotation.Lathesareusedinwoodturningmetalworking,metalspinning,thermalspraying,partsreclamation,andglass-working.Lathescanbeusedtoshapepottery.Mostsuitablyequippedmetalworkinglathescanalsobeusedtoproducemostsolidsofrevolutionscrewthreadsor helices.Ornamentallathes canproducethree-dimensionalsolidsofincredible complexity. Theworkpieceisusuallyheldinplacebyeitheroneortwocentres,atleastoneofwhichcantypicallybemovedhorizontallytoaccommodatevaryingworkpiecelengths.Otherwork-holdingmethodsincludeclampingtheworkabouttheaxisofrotationusingachuckorcollect,ortoafaceplate,usingclamps.

A) CUTTINGTOOL

Inthecontextofmachining,a**cuttingtool**or**cutter**isanytoolthat isusedtoremovematerial from theworkpiecebymeansofsheardeformation.Cuttingmaybeaccomplishedbysingle-pointormultipointtools.Single-pointtoolsare used inturning,shaping,planningandsimilaroperations,andremovematerialbymeansofonecuttingedge.Millinganddrillingtoolsareoftenmultipointtools.Grindingtoolsarealsomultipointtools.Eachgrainofabrasivefunctionsasamicroscopicsingle-pointcuttingedge(althoughofhighnegativerakeangle),andshearsatinychip.

B) IntroductiontoFINITEELEMENTMETHOD

ThebasicideaintheFiniteElementMethodistofindthesolutionofcomplicatedproblemwithrelativelyeasyway.TheFiniteElementMethodhasbeenapowerfultoolforthenumericalsolutionofawiderangeofengineeringproblems.Applicationsrangefromdeformationandstress analysisofautomotive,aircraft,building,defence,missileandbridgestructurestothefieldanalysisofdynamics,stability,fracture mechanics,heatflux,fluidflow,magneticflux, seepageandotherflowproblems. With the advances incomputertechnologyandCADsystems,complexproblemscanbemodelledwithrelativeease.Severalalternateconfigurationscanbetried outona computer before the firstprototypeisbuilt.Thebasicsinengineeringfieldare musttoidealizethegivenstructurefortherequiredbehaviour.The proven knowledgein the computationalaspects oftheFiniteElementMethodisessential.IntheFiniteElementMethod,thesolutionregionisconnectedasbuiltupofmanysmall,interconnectedsubregionscalledfiniteelements.

Thestepbystepprocedureforstaticstructuralproblemcanbestatedasfollows

STEP1: Discretizationofstructure(domain)
Thefirststepinthefiniteelementmethodistodividethestructureor solutionregionintosub-divisionsorelements.

STEP2: Selectionofaproperinterpolationmodel.
Sincethedisplacement(fieldvariable)solutionofacomplexstructureunderanyspecifiedloadconditionscan'tbepredictedexactly. Weassumesomesuitablesolutionwithinanelementtoapproximatetheunknownsolution.Theassumedsolutionmustbesimplefromcomputationalpointofview,anditshouldsatisfycertainconvergencerequirements.

STEP3: Elementstiffnessmatrices(characteristicmatrices)andloadvectors.
Fromtheassumeddisplacementmodelthestiffnessmatrix[K(e)] andtheloadvectorF(e)ofelement'e'aretobederivedbyusingeitherequilibriumconditionsorasuitablevariationprinciple.

STEP4: Assemblageofelementequationstoobtaintheoverallequilibriumequations.Sincethestructureiscomposedofseveralfiniteelements,theindividualelementstiffnessmatricesandloadvectorsaretoassembledinasuitablemannerandtheoverallequilibriumequationshavetobeformulatedas

$$[K]q=F$$

[K]iscalledassembledstiffnessmatrix,qiscalled thevectorofnodaldisplacementandFisthevectorofnodalforcesofthecompletestructure.

STEP5: Solutionofsystemequationshavetobemodifiedto accountforthe boundaryconditionsofthe problem.After incorporationoftheboundaryconditions,theequilibriumcanbee xpressedas

[K]q=F

For linearproblems,thevector'q'canbesolvedveryeasily,Butfornon - linearanalysisproblems,thesolutionhastobeobtainedinasequenceofsteps,eachstepinvolvingthemodificationofthestiffnessmatrix[k]and /ortheloadvectorF.

STEP6: ComputationofElementStressesandStrains.From theknownnodal displacements, if required, theelementstressesandstrainscanbecomputedbyusingthenecessaryequationsofsolidorstructuralmechanics.

C) AdvantagesofFiniteElementMethod:

Incontrasttoothervariationsandresidualapproachesthefiniteelementmethoddoesnotrequiretrailsolutions,whichapplytotheentiremulti-dimensionalcontinuum.

- Theuseofseparatesubregionsorfiniteelementsforthetrailsolutionspermitsagreaterflexibilityinconsideringcontinuationofcomplexshape.
- Ratherthanrequiringeverytrialsolutiontosatisfytheboundaryconditions,oneprescribestheconditionsafterobtainingthealgebraicequationsfortheassemblage.
- Astheboundaryconditionsdonotenterintoequationsfortheindividualfiniteelements,onecanusethesamefieldvariableforbothinternalandboundaryelements.
- Thefieldvariablemodelsneednotbechangedwhentheboundaryconditionschange.
- Theintroductionofboundaryconditionsintoassembledequationsisarelativelyeasyprocess.Nospecialtechniquesorartificialdevicesarenecessary.
- Thefiniteelementmethodnotonlyaccommodatescomplex geometryandboundaryconditions,butalsoprovensuccessfulinrepresentingvarioustypesofcomplicatedmaterialpropertiesthataredifficulttoincorporateinothernumericalmethods.
- Thefiniteelementmethodreadilyaccountsfornon-homogeneitybythesimpletacticofassigningdifferentpropertiestodifferentelements.
- Thesimplegeneralityofthefiniteelementproceduremakesitapowerfulandversatiletoolforfiniteelementmethoda widerangeofproblems.

D) LimitationsofFiniteElementMethod:

The finiteelementmethoddoes notaccommodatefewcomplexphenomenasuchas

- CrackingandFracturebehaviour.
- Contactproblems.
- Bondfailuresofcompositematerials.
- Non-Linearmaterialbehaviourwithworksoftening.

It does notaccountfortransient,unconfinedseepageproblems.

TheFiniteElementanalysishasreachedahighlevelofdevelopmentasasolutiontechnique.However,themethodyieldsrealisticresultsonlyofthecoefficientsormaterialsparameterswhichdescribethebasicphenomenaareavailable.Themosttediousaspectoftheuseofthefiniteelementmethodisthe Basicprocessesofsubdividingthecontinuumandofgeneratingerrorfreeinputdataforthecomputer.Errorsintheinputdatamaygoundetectedanderroneousresultsobtainedmayappearacceptable.
Alargevolumeofsolutioninformationisgeneratedbyafiniteelementroutine,butthisdataisworthonly while whenitsgenerationandinterpretationaretemperedbyproperengineeringjudgment.

E) ApplicationsofFEM:

Finiteelementmethodcomesunderthecategory ofdiscretizationmethods.R.W.cloughappearsto be thefirsttousethistermoffiniteelement,sinceearly1960'sthereha sbeenmuchprogressinthismethod.Thismethodrequiresalargenumberofcomputationsrequiringacomputer.Infactdigitalcomputeradvanceshave beenresponsiblefortheexpandingusageoftheFiniteelementmethod.TheFEMwasinitiallydevelopedtosolvestructuralproblems.Itsuseoflate,hasbeenrapidly extendedtovariousfields.Thediversityofapplicationsofthemethodisexplainedinthefollowing:

a) MechanicalDesign:

Stressconcentrationproblems,stressanalysisofpressurevessels, distance,compositematerials,linkagesandgears.Naturalfrequenciesandstabilityoflinkages,gearsandmachinetools.Crackandfractureproblemsunderdynamicloads.

b) CivilEngineeringStructures:

Staticanalysisoftrusses,frames,roofs,bridgesandpre-stressedconcretestructures.Naturalfrequencies,modesandstabilityofstructures.Propagationofstresswavesandresponseofstructurestoperiodicloads.

c) AirCraftstructures:

Staticanalysisofaircraftwings,fins, rockets, spacecraft andmissilestructures.Naturalfrequencies,flutterandstabilityof aircraftandmissilestructures.Responseofaircraftstructurestorandomloads,dynamicresponseofaircraftandspacecrafttoperiodicloads.

d) Heatconduction:

Steadystatetemperaturedistributioninsolidsandfluids.Transientheatflowinrocketnozzles.internalcombustionengines,turbineblades,finsandbuildingstructures.

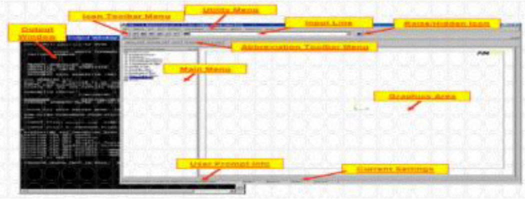
e) NuclearEngineering:

Analysisnuclearpressurevesselssteadyandunsteadystatetemperaturedistributioninreactorcomponents.Naturalfrequenciesandstabilitiesofcontainmentstructures.Responseofreactorcontainmentstructurestodynamicloads.Thermalandviscouselasticanalysisofreactorstructures.

II.INTRODUCTIONTOANSYS

ANSYSiscommercialfinite-elementanalysissoftwarewiththecapability toanalyzeawiderange ofdifferentproblems.ANSYSrunsunderavarietyofenvironments,includingIRIX,Solaris,andWindowsNT.Likeanyfinite-elementsoftware,ANSYSsolvesgoverningdifferentialequationsbybreakingtheproblemintosmallelements.Thegoverningequationsofelasticity,fluidflow,heattransfer,andelectro-magnetismcanallbesolvedbytheFiniteelementmethodinANSYS.ANSYScansolvetransientproblemsaswellasnonlinearproblems.
ThisdocumentwillfocusonthebasicsofANSYSusingprimarily structuralexamples.

A) LAYOUTOFANSYS



B) DATABASEANDFILES

ThetermANSYSdatabasereferstothedataANSYSmaintainsinmemoryasyoubuild,solve,andpostprocessyourmodel.Thedatabasestoresbothyourinputdataand ANSYSresultsdata:

–Inputdata--informationyoumustenter,suchasdimensions,materialproperties,andloaddata.

–Resultsdata--quantitiesthatANSYScalculates,suchasdisplacements,stressesandtemperature.

C) DEFININGTHEJOBNAME

UtilityMenu>File>ChangeJobname

ThejobnameisanameupTo32charactersthatidentifiestheANSYSjob.Whenyoudefineajobnameforananalysis,thejobnamebecomesthefirstpartofthenameofallfilestheanalysiscreates.(Theextensionorsuffixforthesefiles' names isa fileidentifiersuchas.DB.)

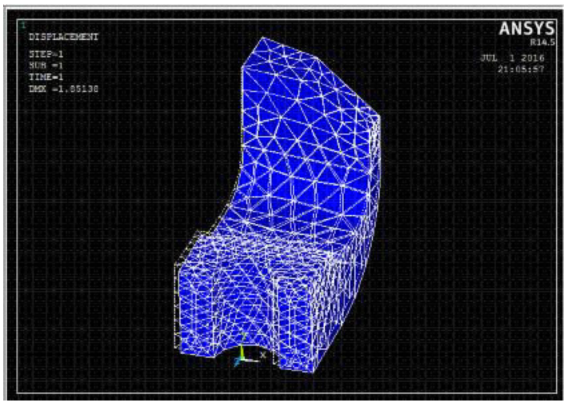
Byusingajobnameforeachanalysis,youensurethatnofilesareoverwritten.

Typicalfiles inAnsysjobname.db, .dbb: Database file,binary.Compatibleacrossallsupportedplatforms.jobname.log:Logfile,ASCII.Containsa logof everycommandissuedduringthesession.Ifyoustartasecondsession withthe samejobnamein thesameworkingdirectory,ANSYSwillappendtothepreviouslogfile(withatimestamp).

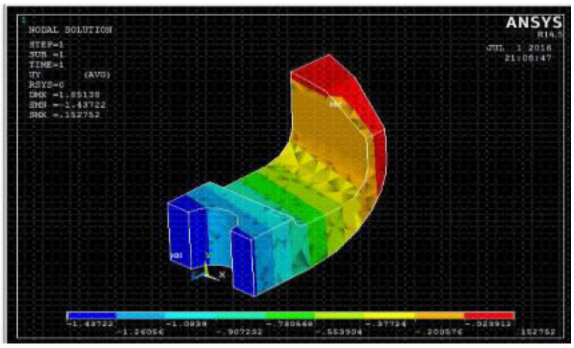
jobname.err:Errorfile,ASCII.Containsallerrorsandwarningsencounteredduringthesession.ANSYSwillalsoappendtoanexistingerrorfile.

jobname.rst,.rth,.rmg,.rfl:Resultsfiles,binary.ContainsresultsdatacalculatedbyANSYSduringsolution.Compatibleacrossallsupportedplatforms.

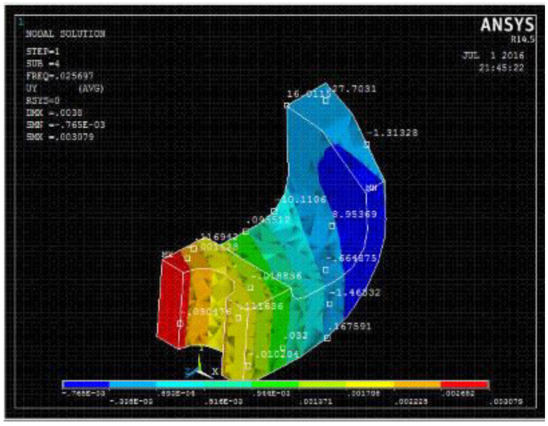
IV.RESULTSPOST PROCEDURE–PLOTRESULTS DEFORMEDSHAPE



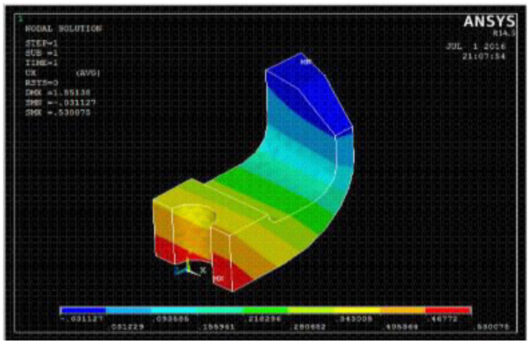
PLOTRESULTS-CONTOUREDPLOT DEFORMATIONAT YCOMPONENT



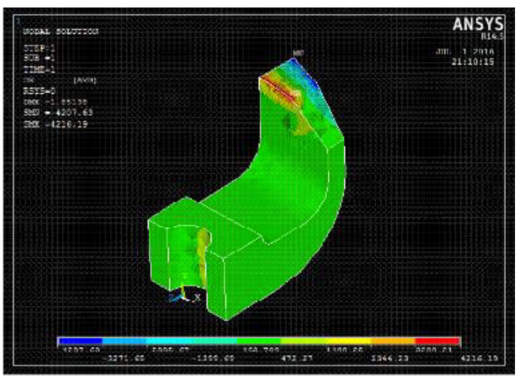
POSTPROCEDURE–QUERYRESULTS SUBGRIDSOLUTION STRESS



PLOTRESULTS-CONTOUREDPLOT STRESS ATXCOMPONENT



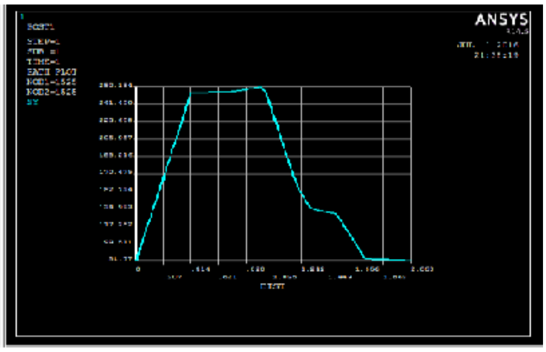
PLOTRESULTS-CONTOUREDPLOT STRESS ATYCOMPONENT



PLOT–NODES

POSTPROCEDURE–PATHOPERATIONS

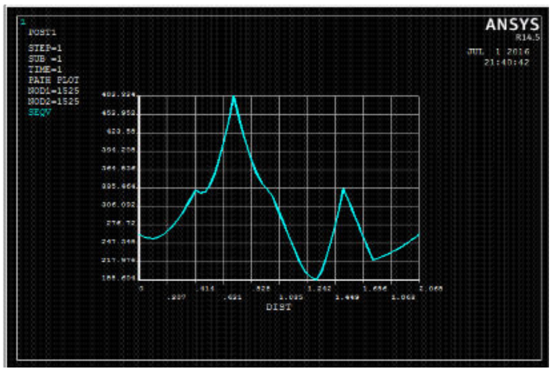
DEFINEPATHSELECT
NODES–
OKMAPONTOPATH
SELECTSTRESSATY-
OKPLOTPATHITEM
ONGRAPHSELECT
SY



PLOT–NODES

POSTPROCEDURE–PATHOPERATIONS

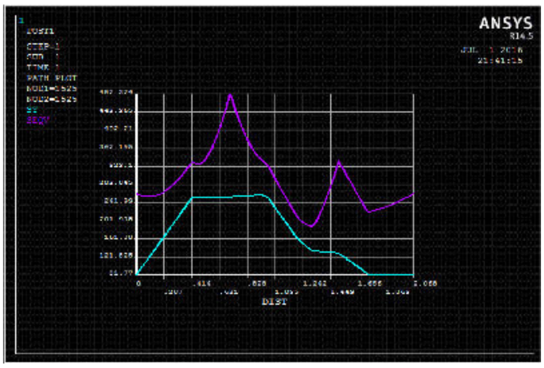
DEFINEPATHSELECT
NODES–
OKMAPONTOPATH
SELECTVONMISES-
OKPLOTPATHITEM
ONGRAPHSELECT
SEQY



PLOT–NODES

POSTPROCEDURE–PATHOPERATIONS

DEFINEPATHSELECT
NODES–
OKMAPONTOPATH
SELECTVONMISES-
OKPLOTPATHITEM
ONGRAPH
SELECTSEQYANDSY



V.CONCLUSION

Lathesareusedinwoodturningmetalworking,metalspinningthermalspraying,partsreclamation,andglass-working.Lathescanbeusedtoshapepottery.Mostsuitablyequippedmetalworkinglathescanalsobeusedtoproducemostsolidsofrevolutionscrewthreadsorhelices.InthisprojecttheLathecutteris modelledwiththerespectivedimensionsandimportedintoAnsys inIGESformatanddonethestaticanalysis.Foundoutthedeformationsofthebody,withrespectivedimensionsandcontouredalong withVonmisesstressesincomponentsandgraphswereplottedinsomeimportantcomponentaxesinStaticanalysis.

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Design and Analysis of Portable Gantry Hoist

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DepartmentOfMechanicalEngineering,MRCESecunderabad

***Abstract-* DuringGantryHoist,engineershavetomanuallyevaluatevarioustoolssuchasCADandCAEtools.Thisprocesstakesconsiderableamountoftimeandeffort.Furthermore,theprocessofFEMsimulationssuchasmeshingandpostprocessingisveryiterativeandtimeconsuming.Inthiswork,an alternativeway to performFEAwillbepresented.Themainobjectiveofthisapproachistoreliefengineers fromtimeconsuminganditerative work**

Beforeperformingthetopologyoptimization,thestructuralmodelingoftheGantryHoistneedstobedevelopedbyusingCATIA software.Thestructuralmodelingthenimportedintothecomputer-aidedengineering(CAE)andbeganthemeshingontheGantryHoist.Thefiniteelementmodeling(FEM)processeswereperformedbyusingAnsys15.Theboundarycondition(BC)andloadingselectedandpl aceattheGantryHoist.Thefiniteelementanalysis(FEA)thencarriedoutattheGantryHoist.TheAnsys15usedtosolvetheanalysisequationthus,producingtheresultofstress,strainanddisplacementwhere itwillbeusedtoanalyzethecriticalareaoftheGantryHoist.FinallyResultsdescriptionintermsoffactor of safety, stiffens,deformationandstress

Key words-CATIA, FEM, ANSYS

I. INTRODUCTION

Therearecurrentlymanydifferentcranes.Gantrycranesareoneofthem.Gantrycranesarebuilttomovelarge loads, forexample,filledcontainersfromshipstoshore.Gantrycranesareavailableindifferentsizeandstructuredependingonthetaskthe ydo.Insomelinesofworkitisnecessarytohavetheloadsmovedquickly.Forexampleharborcranes,whereeachminuteittakestoemptyorloadashipcanbeextremelycostly.Thefirstgantrycranes were built over 40years ago andsincethentheyhaveundergone amajor development. In2009 theworld's largestgantrycranewasbuiltinSouthKorea.

Gantrycranesareatypeof crane builtatopagantry,whichis astructureusedtostraddlean objectorworkspace.Theyarealsocalledportalcranes,the"portal "beingtheemptyspacestraddledbythegantry. Theterms gantrycraneand overheadcrane (orbridgecrane)areoftenusedinterchangeably,asbothtypesofcranestraddletheirworkload.Theusualdistinctiondrawnbetweenthetwoisthatwithgantrycranes,theentirestructure(includinggantry)isusuallywheeled(oftenon rails).Bycontrast,thesupportingstructureofanoverheadcraneisfixedinlocation,oftenintheformofthewallsorceilingofabuilding, towhichisattachedamovablehoistrunningoverheadalongarailorbeam(whichmayitselfmove).Furtherconfusingtheissueisthat gantrycranesmayalsoincorporateamovablebeam-mountedhoistinadditionto theentire structure being wheeled,andsome overheadcranesaresuspendedfromafreestandinggantry.

Gantrycranesintheformofcontainercranesareprominentfeaturesofmostcontainerterminals,usedtoloadintermodalcontainersonandoffcontainerships.Theycanrangefromenormous"full "gantrycranes,capableoflifting someoftheheaviest loadsin theworld,tosmall shopcranes,usedfortaskssuchasliftingautomobileenginesoutof vehicles.

A. Background

Portableliftingequipmentisalargecomponentofanymechanicalshop.Thiscanbeachievedthroughtheuseofforklifts,chainlifts,etc.Whilemotor-poweredequipmentisexpensiveandrequiresmaintenanceandfuel,manuallyoperatedliftsareinexpensiveanddonotrequiremuch oranymaintenance.Easeofmaneuverabilityisabigissueformost shopsalongwithvariableterrain.

B. Justification

Theplanforthisprojectistodesignandvalidationofoverhead liftwitha chainhoistthatcanbebrokendown andeasilymovedtodifferentjobsitesandhavea2tonliftingcapacity.Usingmaterialsthatarealreadyavailablewillcutdownoncosts andallowformoremoneytobeputintoahigherqualityhoist.Thecasterwheelswillbeahighstrengthsolidrubberwheelsotherearenoproblemswithflattireswhileitstillhastheabilitytobemaneuvered inmorehostileterrainssuchassoftsoilandgraveldriveways.They willalsohavetohaveahigherloadratingthanthe2tonratedcapacitytoaccountfortheextraweightoftheframe,hoist,andtrolley.Buildingacustomhoistwillallowforplentyofcustomizationandpersonaladditionstothebasicoverheadhoistdesignsuchasracksfortools,parts,andotheritemscouldbeusefulinthe workarea.

C. VARIANTS:

Containercrane

Aship-to-shorerailmountedgantrycraneisaspecialisedversionofthegantrycraneinwhichthehorizontalgantry rails and theirsupporting beamarecantileveredoutfrombetweenframeuprightsspacedtosuitthelengthofastandardfreightcontainer,sothatthebeamsupportingtherailsprojectsoveraquaysideandoverthewidthofanadjacentshipallowingthehoisttoliftcontainersfromthequayandmove outalongtherailstoplacethecontainersontheship.Theuprightsh avewheels whichrunintracksallowingthecranetomovealongthequaytopositionthecontainersatanypointonthelengthoftheship. Thefirstquaysidecontainergantrycranewasdevelopedin1959byPaceco,Inc.[1]Paceco'snamefortheirlineofquaysidecranes,"Portainer",hassincebecomesomethingofagenericisedtrademark, usedtorefertoanyquaysidecontainergantrycrane.

D. Fullgantrycrane

Taisun,theworld'sstrongestgantry crane,atYantaiRafflesShipyard,Yantai,China

"Full"gantrycranes(wheretheloadremainsbeneaththegantrystructure,supportedfromabeam)arewellsuitedto lifting massive objectssuch as ships'engines, asthe entirestructurecan resist thetorquecreated by theload,and counterweightsaregenerallynotrequired.Forexample,Samson andGoliath,twofullgantrycraneslocatedintheHarlandandWolffshipyard inBelfast havespansof140metresandcanliftloadsofupto840tonnestoaheightof70metres.

In2008,theworld'sstrongestgantrycrane,Taisun,whichcan lift20,000metrictons,wasinstalledin Yantai,ChinaattheYantaiRafflesShipyard.

E. Workstationgantrycrane

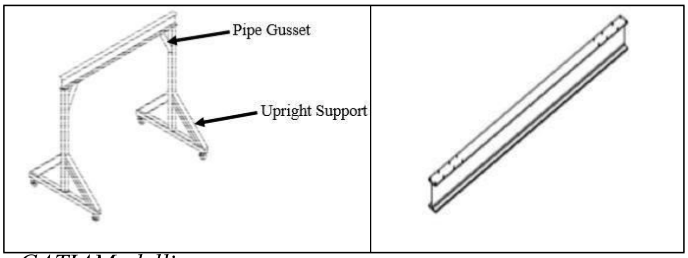
Workstationgantrycranesareusedtoliftandtransportsmalleritems aroundaworking area in afactoryormachineshop.Someworkstationgantrycranesareequippedwithanenclosedtrack,whileothersuseanI-beam,orotherextrudedshapes,fortherunningsurface.Mostworkstationgantrycranes areintendedtobe stationary when loaded, andmobilewhenunloaded.WorkstationGantryCranescanbeoutfittedwitheitheraWireRopehoistoralowercapacityChainHoist.

F. Rubbertyredgantrycrane

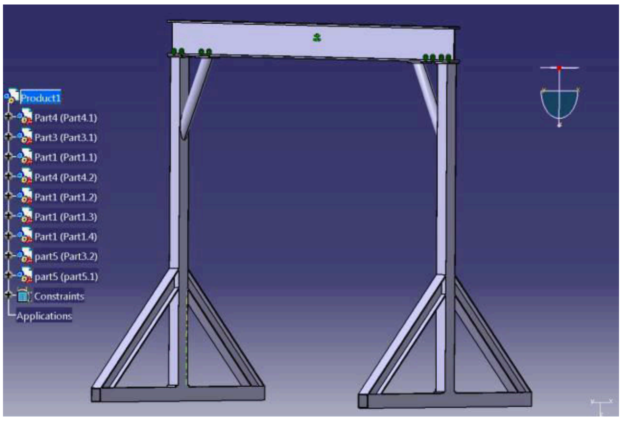
Smallergantrycranesarealsoavailablerunningonrubbertyressothattracksarenotneeded.Rubbertyredgantrycranesareused incontainerterminalstostraddlemultiplelanesofrail/roadandcontainerstorage;straddlecarriersareused whenmovingindividual

II. DESIGNANDANALYSIS

Thedesignwasbasedoffofpreviouslybuiltgantryhoists.The RoseFloathoistwasusedasadesigntoavoidespeciallythe“A”framesectionusedforthesupports.Thematerialusedwasbasedonwhatwasavailableandwhatwouldbeastrongbutnotoverkilltoavoidaddingtoomuchweightonthecasters.The uprightsupportswere madetobecutat45degreestomakeiteasytocut.Thepipegussetsweremadeatasharperanglebecausethatallowedthetrolleytohavea widerdistanceto movebackand forth.Thespecificationsforthemembers canbefound inAppendixA.Thematerialthatwasavailable wastheS10X25.4.



CATIAModelling:



FEAnalysis

Inthissection,thestepstakentoperformastructuralanalysisinANSYSareexplained.Itisnecessarytoidentifythetediousandtimeconsumingstepsandtrytoautomatethemtoreducethe FEsimulationtimeandtoavoidtheconstantinteractionoftheuserwiththeFEtool.Followingthelistofstepsarepresented.

*Geometry.*Thefirststeptotakeinordertoperformtheanalysisisto definethegeometrytobeevaluated.ThisgeometryisnormallydoneinCADsoftwareandlaterimportedintoadedicatedFE-program.

*Material.*After havingthegeometrydefined,the nextstepistoassignamaterial tothisgeometry.Dependingonthetypeofanalysissomepropertieshavemoreimportancethanothers.ForastructuralanalysistheYoung’smodulusandthePoissonratioarethemostimportant.Theimportanceofautomatingthisstepistoavoidtheneedofmanuallyselectingtherequiredmaterialfromalonglistlocatedin ANSYS,especiallywhentheuserknowsbeforehandthenameofthematerial.

*Meshing.*OneofthemostrelevantstepsintheFiniteElementAnalysisisthemeshing.Thespeedandtheaccuracyoftheresultshavea directconnectioninhowthispart isdone.Thehigherthenumbers of nodesarethehighertheaccuracyoftheresults,howeverthespeedofthesimulationdecreases.

Tetrahedronssecondordermeshisusedforthestructure.Bodysizingof20mmusedforthestructure.

TotalNoofNodes:158255TotalN

oofElements:74717

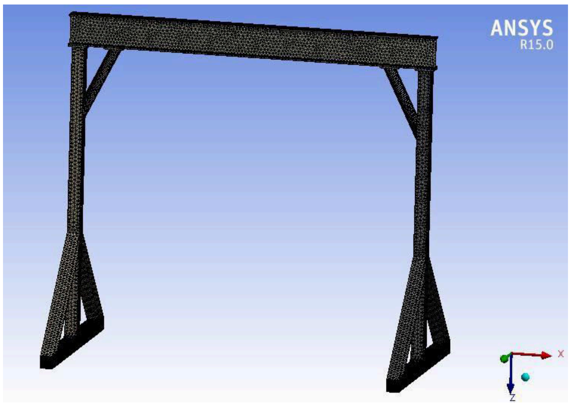


Fig:Meshofthestructure

Pre-processing.Aftermeshingthestructure,theBoundaryConditionshavetobeappliedinthemodel.Forobtainingthestressthealgorithmfirstcalculatesthedisplacements,hencethenecessitytofixthe model.
Furthermore,afterfixingthemodeltheloadconditionsthatinfluencethestructurearegivenasinputstotheanalysis.InFigure6itispossibletoobservehowtheseboundaryconditionsareplacedinthestructure.

Loads:

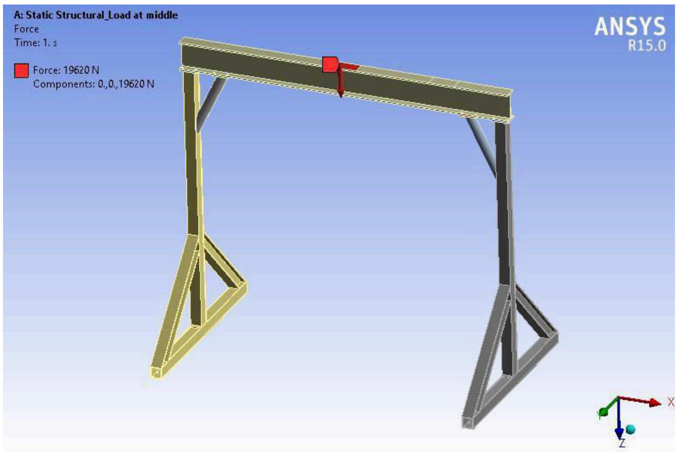
Thestructureisdesignedforthe 2toncapacity,sothattheloadwillbeappliedis2000kg.

Appliedis=2000*9.81NTotalap

pliedload=19620N

Oneloadcasesconsideredinthepresentanalysis.Case1:

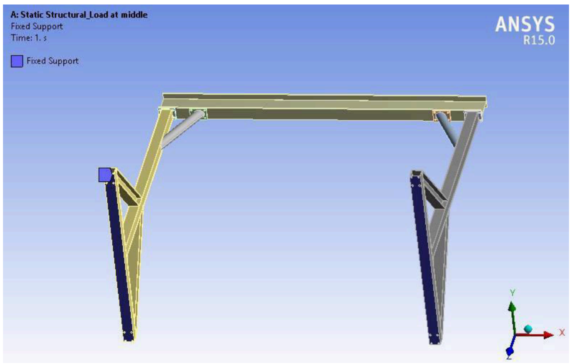
LoadactingatthecentreofthestructureCase1:



FigLoadappliedincase1

Boundaryconditions:

Thestructurebottomisfixedinalldegreesoffreedom(Ux,Uy&Uz=0mm)



FigBoundaryconditionappliedinthestructure

Postprocessing.

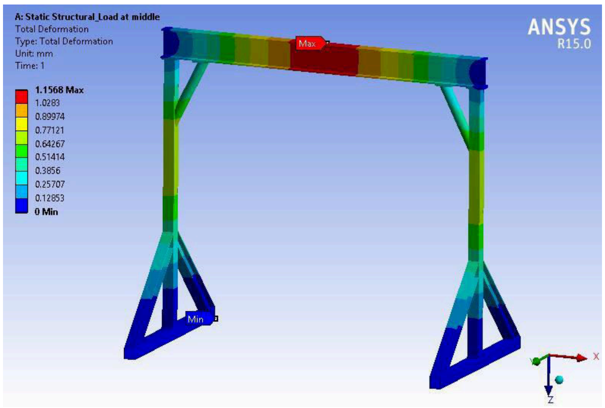
Thefinalstepistorunthesimulations,butbeforeithastobespecifiedwhichresultsarerequiredbytheuser.Inordertodetermineif themodelcanresisttheloadsappliedtoit,itisnecessarytoknow,e.g.theMaximumVonMisesstressandthedisplacement.Knowing theseresultstheusercancomparewiththedatafromthematerialusedandapplyingthesafetyfactoritcanbedeterminedifthestructureisstiffenough.Anotheruseis being abletoextracttheresultsautomaticallyforthepossibilitytooptimizethestructure.

III. RESULTSANDDISCUSSIONS

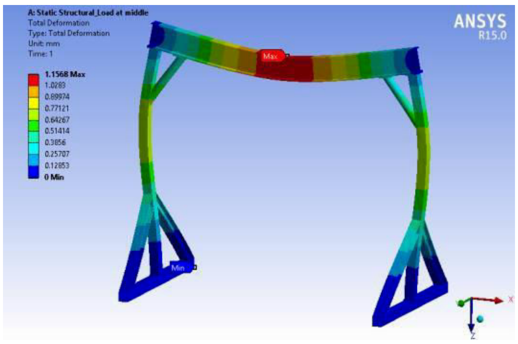
ANALYSISRESULTS

Thischapterisintendedforpresentingtheresultsobtainedafterlearningthetheoriesandapplyingthemethoddescribedinthetwopreviouschapters.Itstartswiththevalidationofthemodel.

Case1:Results



FigTotaldeformation_Truescale



FigTotaldeformation_Autoscale

Totaldeformationobservedinthestructureis1.15mm.

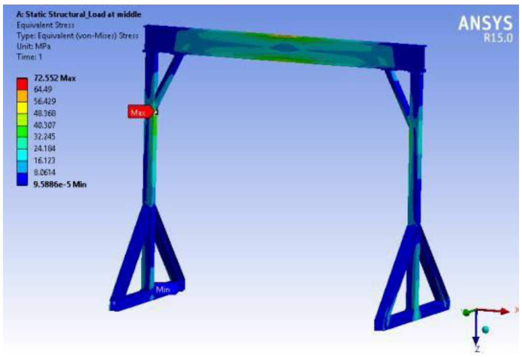


Fig:vonMisesstress_case1

MaximumvonMisesstressobservedinthestructureis72MPa.

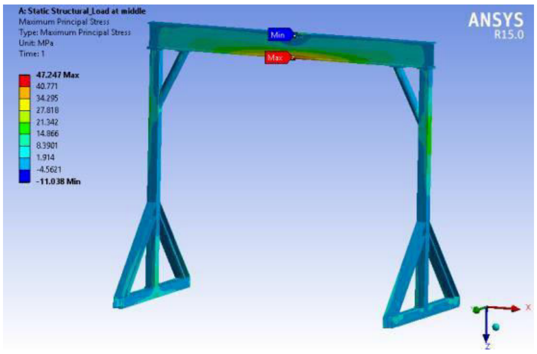


Fig:Maximumprincipalstress_case1

Maximumprincipalstressobservedinthestructureis47MPa

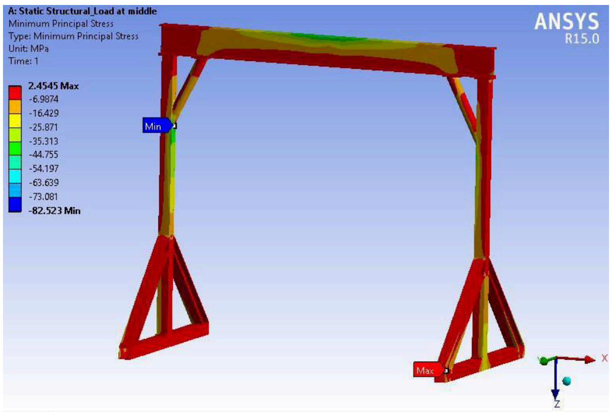


Fig:Minimumprincipalstress_case1

Minimumprincipalstressobservedinthestructureis82 MPa

CONCLUSION

Themaxstresswasabout75MPawhichisbelowthemaxbendingstressof317MPa.Amoreindepthstructuralanalysisshouldbeperformedtofindareasthatcouldbemadecheaperandlighterifthematerialswouldhavetobepurchasedinordertosavemoney.Thepipegussetsweremadewithsucha sharp angleto allowforthe trolleytohavemoretravelsidetoside.Thedownsidewascuttingtheanglewithagrinderinsteadofabandsawbutitstillcameoutcloseenoughtogetastrongweldonit.Thebeamwas abletolifttheweightitwasratedfor.Thelimitingfactorfortheweightratingturnedouttobethecasters,ifthehoistwastoberatedfor3tonstheywouldnothold125%oftheratedweightalongwiththehoist weight.

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Determination of Stress Intensity Factors Under Mode-I Fracture of C45 Steel

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Abstract—
Thefocusofthispaperistoinvestigatehowacrackpropagatesandgrowsinarectangularplatewithanellipticalcrackthroughthecentre. ThefiniteElementAnalysistoolAnsysisusedtopropagatethefailure criteriaandtocomputestressesandStressIntensityfactorSIF(K).A specificobjectwascreatedandcentralcrackwasinvestigated.Thisconfigurationwasintroducedsincetheengineersoftendetect Mode1 Opentypecrackinobject.TheStressIntensityFactorobtainedtheoreticallyiscomparedagainstsamebyAnsys17.2tool.Bothofthemobtainedandalsomaximumstresszoneislocatedat the cracktipinAnsys.

Keywords-
FractureMechanics,ANSYS,CentralCrack,CrackPropagation,LinearElasticFractureMechanics(LEFM),FiniteElementMethod, StressIntensityFactor,HighGrade Steel C45. I.

I.INTRODUCTION

Failureoftheengineeringstructuresiscausedbycracks,whichisdependingonthedesignandoperatingconditionsthat extendbeyondasafesize.Cracks presentto someextentinallstructures,eitherasaresultofmanufacturingdefectsorlocalized damagein service[2].Thecrackgrowthleadstoadecreaseinthestructuralstrength.Fracture,thefinalcatastrophiceventtakesplaceveryrapidlyandisprecededbycrackgrowth.DamageTolerance(DT)assessmentisaprocedurethatdefineswhetheracrackcanbesustainedsafelyduringtheprojectedservicelifeofthestructure.Thefundamentalassumptionoflinearelasticfracturemechanicsisthatthecrackbehaviorisdeterminedsolelybythe valuesofthestressintensityfactorswhichareafunctionoftheappliedload and thegeometryofthecrackedstructure.Fracturemechanicsdealswiththestudyofhowacrackinastructurepropagatesunderappliedloadspropagationandfailurewithexperimentalresults[5].Calculatingfractureparameterssuchasstressintensityfactorinthecrack region[1],whichisusedtoestimatethecrackgrowth,makestheanalyticalpredictions.Sometypicalparametersare:Stressintensity factors(Openmode
(a) KI,Shearmode(b)KII,Tearmode(c)KIII

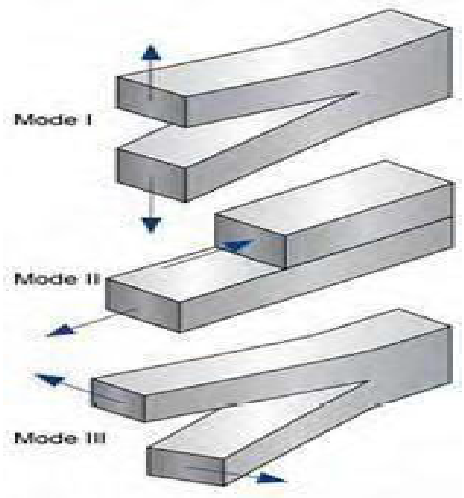


Figure1:ThreeTypesOfLoadingOnACrackedBody; (A) ModeI;(B)Mode IIAnd(C)ModeIII

II.REVIEW

DayalR.ParhiandSasankaChoudhuryacantileverbeamwithasinglecrackhasbeentakenintoconsideration.Finiteelementmethodisusedtofindoutthe naturalfrequenciesofthefaultycantileverbeam.Afuzzycontrollerhasbeendesignedusingtrapezoidal,Gaussianaswellastriangularmembershipfunctiontofindoutthecrackdepthandcracklocation[5,7]

D.K.Agarwallaconcludescrackdetectionandlocalizationisthe maintopicofdiscussionforvariousresearchersacrosstheglobe.Itisconcludedthatresultsobtainedfromexperimenthaveaverygoodagreementwiththeresultsobtainedfrom FEMandthestructure vibrateswithmorefrequencyinthepresenceofacrackawayfromthefixedend.

AnanalyticalandexperimentalapproachbyH.Nahviand M. Jabbarietal.tothecrackdetectionincantileverbeamsby vibrationanalysis.Sensibilityanalysisoftheinverseproblemofthecrackparameters(locationanddepth)determinedbyM.B.Rosales,CPFilipichandFSBuezasetal.Anefficient numerical techniqueisnecessarytoobtainsignificantresults.

III.PROBLEMSTATEMENT

Cracksoftendevelopinthecornersofastructuralmemberduetohighstressconcentrationfactorinthoseareas.Ifonecancalculatetherateofcrackgrowth, anengineercanscheduleinspectionaccordinglyandrepairorreplacethepartbeforefailurehappens.Moreover,beingabletopredictthepathofacrackhelpsadesignertoincorporateadequategeometrictoleranceinstructuraldesigntoincreasethepartlife[11].Whileproducingdurable,reliableandsafestructuresarethegoalsofeveryaerospacecomponentmanufacturer,there aretechnical challenges thatare noteasytobesolved.Givenlimitedenginedesignspace,engineersstrivetooptimizeusingmaterialgeometrytoproducehighefficientandhighperformanceenginesthatwilloperateatminimumweightandcost[6].Engineersoftenlooktohavematerialsfromcomponentanddesignthethinnestpossiblecomponents.Benefitsfrom thisapproachincludereducedweight, and smallerprobabilityofencounteringbrittlenessinducingmicrostructuraldefects.Thefocusofthispaperistoinvestigatethecornercrackgrowthinasteelalloyplate.Thispaperwillexaminethestressesnearthecracktip,computethestressintensityfactorsandcompareitagainstmaterialtoughnesstodeterminetheinfluenceofthecrackontheplate.

IVMETHODOLOGY

Engineersstrivetooptimizepartgeometryby designingthethinnestpossiblecomponentsbecausethisapproach notonlyreduceengineweightbutalsoreducetheriskofbrittlestructureoftenfoundinbulkmaterials[9].Beingabletodeterminetherateofcrackgrowth,anengineercanscheduleinspectionaccordinglyandrepairorreplacethepartbefore failure happens.Beingabletopredictthepathofacrackhelpsadesignertoincorporateadequategeometrictoleranceinstructuraldesigntoincreasethepartlife[10].Themethodologyusedtoinvestigatethemechanicsofcrackpropagationconsistsofthefollowingsteps:

- Modelcreation
- Elasticstressanalysisoftheuncrackedbody
- Flawimplementation
- Crackpropagation
- Elasticstressanalysisofthecrackedbody
- Calculationofstressintensityfactor
- Interpretationofresults

V.EXPERIMENTSANDRESULTS

Modelishavingwiththedimensionsof0.1minheight,0.1minwidth,andcracklengthis0.02m.Inaddition,thesymmetryboundaryconditionsofsteelplateasshowninbellowfig2.

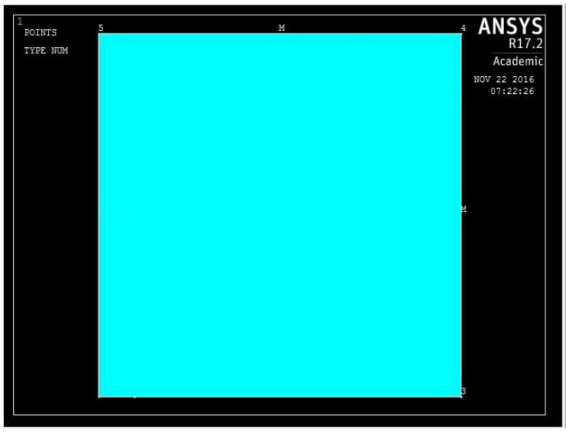


Figure2:Basicmodel

Amongallthesteelbasedalloys,accordingtoImmarigeonetal[3] , highgradesteelc45 isbyfar themostwidely used,accountingforalmosthalfofallsteelusedinaircraftbecausethematerialcanincreasethestrength-to-weightratioinstructuresandprovideheatresistancewithweightsavings.However,thesignificantweightsavingspermittedbythesesteelapplicationdevelopmentsgeneratespecificdrawbacksthatneedparticulartechnologicaldevelopments.Amongthemostimportantconcernsarebrittleinclusions,whicharedifficulttodetectbynon-destructivetesting,caninitiatecracksand produceearlyfailure ofthe structures[2].Materialsimperfectionsduetomanufacturingprocess,forexample,voidsandimpuritiescandevelopflawsthatmaycausethematerialtobecomeweak.Forthosereasons,thematerial chosen inthisstudyis highgradesteelC45andthepropertiesaresummarizedinTable1

QUANTITY	MAX	MIN	UNITS
Density	7850	7850	Kg/m3
Young’s modulus	210000	210000	Mpa
Poisons ratio	0.27	0.3	
Tensile srength	600	800	Mpa
Yield strength	340	400	Mpa

THEORITICALSTRESSINTENSITYFACTOR(K1):

1.Stressintensityfactor**(K1)=Cσ√πa**2.C =(1-0.1+0.96)√1/COS(πη)WhereCisaconstant.

3. η=a/b

UsingthenumericalpackageAnsys17.2,wealsodeterminedthevalueofthestressintensityfactorKIforthesame geometry. This wascomputedusingfiniteelementsonameshwithquadratictriangularelementsonthevicinityofthecracktip,andquadraticrectangularelementseverywhereelse.Quarterpointelements,formedby placingthemid-sidenodenearthecracktipatthequarterpoint,wereusedtoaccountforthecracksingularity.

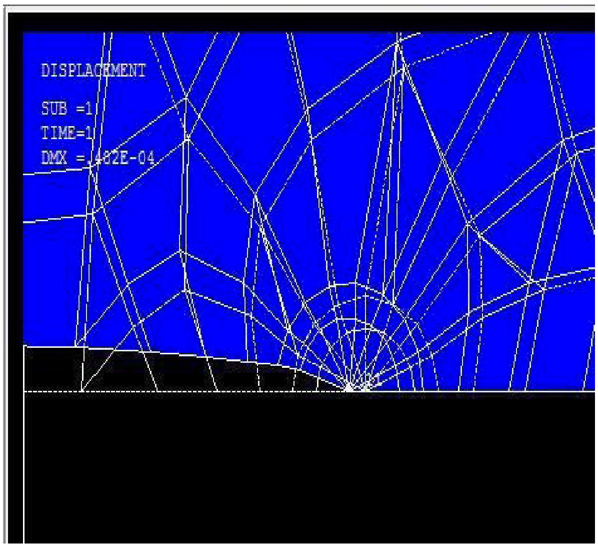
STRESSINTENSITYFACTORK1	THEORITICAL	ANSYS
	27.785	23.433

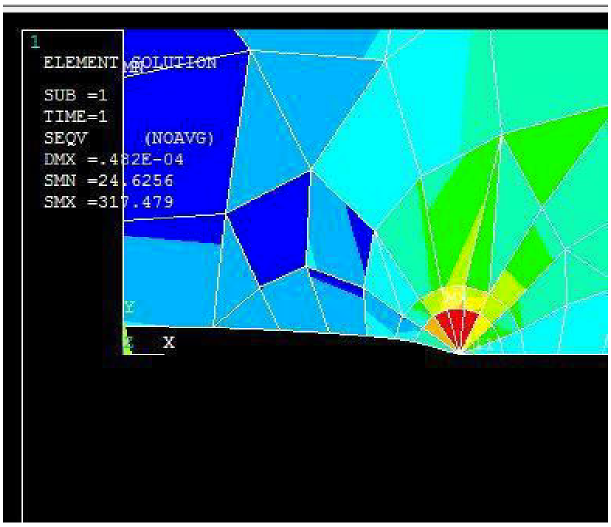
ANALYSISOFFAILURECRITERIAAstatic fractureanalysiswasperformed,wherethegoalwasmerelytocomputethestressintensityfactors.

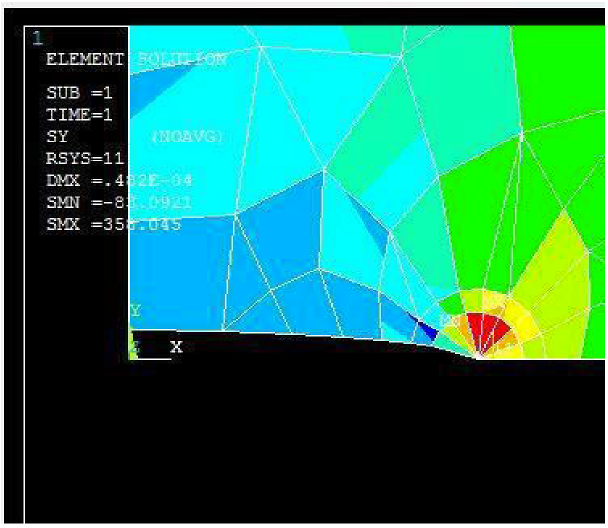
StepsinAnalysisProcedure:

- Pre-processing
- Give thejob name
- DefineElementType
- 3DefineMaterialProperties
- DefineKeyPoints
- DefineLineSegments
- DiscretizeLinesL3,L4&L5
- CreatetheConcentrationKeypoint(CrackTip)
- CreatetheArea
- ApplyBoundaryConditions
- ApplyLoads
- MeshtheModel
    - Processing(SolvingtheSolution)
    - PostProcessing
- ZoomtheCrack-TipRegion
- DefineCrack-FacePath
- DefineLocalCrack-TipCoordinateSystem
- ActivatetheLocalCrack-TipCoordinateSystem
- DefinetheModel-1crackdeformationDefinetheModel-1StressIntensityFactorusingKCALC
- Definethemodel-1failurecriteriaFromthesefiguresitseemsthattherestressintensityfactor&failurecriteriaofcrackpropagationtooccurmainlyinmode1,duringcontinuedfracture.

VI.CONCLUSIONS







Fromtheabove figuresthestressintensityfactor&failurecriteriaofcrackpropagationtooccurmainlyinmode1,duringcontinuedfracture.

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THERMAL ANALYSIS ON HEAT EXCHANGER

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Abstract**—**
aHeatExchangerisadevicebuiltfortheefficientheattransferfromonefluidtoanother,whetherthefluidsareseparatedbyasolidwallsothattheynevermix,orthefluidsaredirectlyincontact.AnobjectiveofthepresentdissertationworkistodesignanddevelopaTubeintubetypeHeatexchanger.TheDissertationisaboutpreparingthemodelandperformingexperimentonanexperimentalsetupoftubeintubeheatexchangeranduseofdifferentinputsfortheestimationofheattransfer.Analyticalcalculationsweremadetoanalyzethetemperaturedropsasafunctionofbothinletvelocityandinlettemperatureandhoweachvarieswiththeotherinheatexchangermodels.TheCFDanalysisisdonewithCFDpackage, ANSYS 15.0.

Keywords: ANSYS, FEA, HeatExchanger etc…

*I*INTRODUCTION

Theheatexchangerisadevicewhichtransferstheheatfromhotmediumtocoldmediumwithoutmixingbothofmediumsincebothmediumsareseparatedwithasolidwallgenerally.Thereare manytypesofheatexchanger thatusedbasedontheapplication.Forexample,doublepipeheatexchangerisusedinchemicalprocesslikecondensingthevaportotheliquid.Whentoconstructthistypeofheatexchanger,thesizeofmaterialthatwanttousesmustbeconsideredsinceitaffectedtheoverallheattransfercoefficient.Forthistypeofheatexchanger,theoutlettemperatureforbothhotandcoldfluidsthatproducedisestimated byusingthe bestdesignofthistypeofheatexchanger.etc.Thepurposeofconstructingaheatexchangeristogetanefficientmethodofheattransferfromonefluidtoanother,bydirectcontactorbyindirectcontact.

Heat exchangebetween flowingfluids is oneofthemostimportantphysicalprocessofconcern,andavarietyofheatexchangersareusedindifferenttypeofinstallations,asinprocessindustries,compactheatexchangersnuclearpowerplant,HVACs, foodprocessing,refrigeration.The heattransferoccursbythreeprinciples:conduction,convectionand radiation.Inaheatexchangertheheattransferthroughradiationisnottakenintoaccountasitisnegligibleincomparisontoconductionand convection.

1.1 ScopesofResearch

Thescopesofthisresearchareasfollows:
i. Studyonheattransferforheatexchangersspecifictodoublepipeheatexchangertypes.
ii. DesignthedoublepipeheatexchangerbyusingGAMBIT.
iii. SimulationindoublepipeheatexchangerbyusingFLUENTsoftware.
iv. Analysistheheatexchanger specificto flowrateofhot andcoldfluid.
v. TosimulateheattransferinconcentrictubeheatexchangerbyusingCFD-Fluentsoftware.
vi. Toanalyzetheheattransferinconcentrictubeheatexchangerby comparingthesimulationresulttotheAnalyticalcalculations.ValidatesimulationresultstotheAnalyticalcalculationswithin5%error.

1.2 Heatexchanger

Itisapieceofequipmentbuiltforefficientheattransferfromonemediumtoanother.Themediamaybeseparatedbyasolidwalltoprevent mixingortheymaybeindirectcontact.They are widely used inspaceheating,refrigeration,airconditioning,powerplants,chemicalplants,petrochemicalplants,petroleumrefineries,naturalgasprocessing,andsewagetreatment.Theclassicexampleofaheatexchangerisfoundinaninternalcombustionengineinwhichacirculatingfluidknownasenginecoolantflowsthroughradiatorcoilsandairflowspastthecoils,whichcoolsthecoolantandheatstheincomingair.

Therearethreeprimaryclassificationsofheatexchangersaccordingtotheirflowarrangement.In parallel-flowheatexchangers,thetwofluidsentertheexchangeratthesameend,andtravelinparalleltooneanothertotheotherside.Incounter-flowheatexchangers thefluidsentertheexchangerfromoppositeends.Thecountercurrentdesignisthemostefficient,inthatitcantransferthemostheatfromtheheat(transfer)mediumperunitmassduetothefactthattheaveragetemperaturedifferencealonganyunitlengthishigher.Seecountercurrentexchange.Inacross-flowheatexchanger,thefluidstravelroughlyperpendiculartooneanotherthroughtheexchanger.

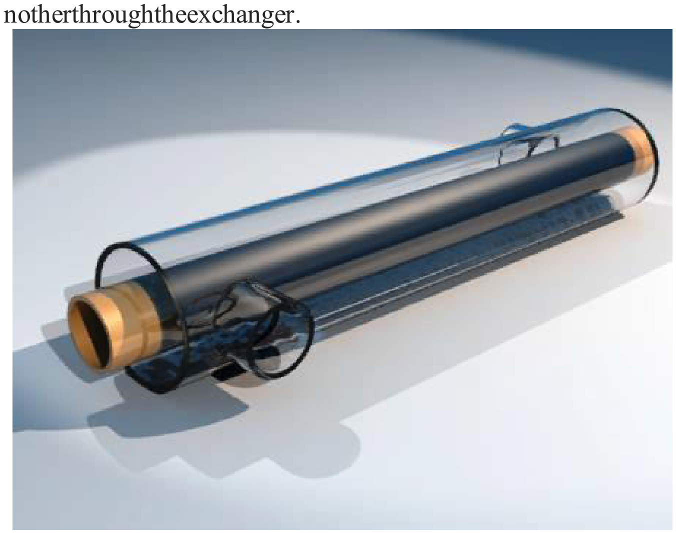

Figure-1.1 Doublepipeheatexchanger

Doublepipeheatexchangersarethesimplestexchangersusedinindustries.Ononehand,theseheatexchangersarecheapforbothdesignandmaintenance,makingthemagoodchoiceforsmallindustries.Ontheotherhand,theirlowefficiency coupledwiththehighspaceoccupiedinlargescales,hasledmoderni ndustriestousemoreefficientheatexchangerslikeshellandtubeorp late.However,sincedoublepipeheatexchangersaresimple,theyar eusedtoteachheatexchangerdesignbasicstostudentsasthefundam entalrulesforallheatexchangersarethesame.Tostartthedesignofa doublepipeheatexchanger,the first stepistocalculatethe heatdutyoftheheatexchanger.Itmustbenotedthatforeasierdesign,i t'sbettertoignoreheatlosstotheenvironmentforinitialdesign.Theh eatdutycanbedefinedastheheatgainedbycoldfluidwhichisequalt otheheatlossofthehotfluid.

1.2.1 Shellandtubeheatexchanger

Shellandtubeheatexchangersconsistofseriesoftubes.Onesetofthe setubescontainsthefluidthatmustbeeitherheatedorcooled.Thesec ondfluidrunsoverthetubesthatarebeingheatedorcooledsothatitca neitherprovidethe heatorabsorbtheheatrequired.A setoftubesiscalledthetubebundleandcanbemadeupofseveraltype softubes:plain,longitudinallyfinned,etc.Shellandtubeheatexcha ngersaretypicallyusedforhigh-pressureapplications(withpressuresgreaterthan30barandtemper aturesgreaterthan260°C).Thisisbecausetheshellandtubeheatexc hangersarerobustduetotheirshape.Severalthermaldesignfeatures mustbeconsideredwhendesigningthetubesintheshellandtubeheat exchangers:Therecanbemanyvariationsontheshellandtubedesig n.Typically,theendsofeachtubeareconnectedtoplenums(sometim escalledwaterboxes)throughholesintubesheets.Thetubesmaybes traightorbentintheshapeofaU,calledU-tubes.

- **Tubediameter:**Usingasmalltubediametermakestheheatex changerbotheconomicalandcompact.However,itismorelike lyfortheheatexchangertofoulupfasterandthesmallsizemakes mechanicalcleaningof thefoulingdifficult.Toprevailoverthefoulingandcleaningpr oblems,larger tubediameterscanbeused.Thus todeterminethetube diameter,the availablespace, costandfoulingnatureofthefluidsmustbeconsidered.
- **Tubethickness:**Thethicknessofthewallofthetubesisusually determinedtoensure:
  - Thereisenoughroomforcorrosion
  - Thatflow-inducedvibrationhasresistance
  - Axialstrength
  - Availabilityofspareparts
  - Hoopstrength(towithstandinternaltubepressure)
  - Bucklingstrength(towithstandoverpressureintheshell)
- **Tubelength:**heatexchangersareusuallycheaperwhenthey haveasmallershell diameterandalongtubelength.Thus,typicallythereisanaimto maketheheatexchangeraslongasphysicallypossiblewhilstn otexceedingproductioncapabilities.However,therearemanylimitationsforthis,includingspaceavailableattheinstallatio nsiteandtheneedtoensuretubesareavailableinlengthsthatare twicetherequiredlength(sotheycanbewithdrawnandreplace d).Also,long,thintubesaredifficulttotakeoutandreplace.
- **Tubepitch:**whendesigningthetubes,itispracticaltoensureth atthetubepitch(i.e.,thecentre-centredistanceofadjoiningtubes)isnotlessthan1.25timesthe tubes'outsidediameter.Alargertubepitchleadstoalargerover allshelldiameter,whichleadstoamoreexpensiveheatexchan ger.
- **Tubecorrugation:**thistype oftubes,mainlyused fortheinnertubes,increasestheturbulenceofthefluidsandthee ffectis veryimportant intheheat transfergivingabetterperformance.
- **TubeLayout:**referstohowtubesarepositionedwithintheshel l.Therearefourmaintypesoftubelayout,whichare, triangular (30°), rotatedtriangular (60°), square (90°)androtatedsquare(45°).Thetriangularpatternsareempl oyedtogivegreaterheattransferastheyforcethefluidtoflowin amoreturbulentfashionaroundthepiping.Squarepatternsaree mployedwherehighfoulingisexperiencedandcleaningismor eregular.

1.2.2 Plateheatexchanger

Anothertypeofheatexchangeristheplateheatexchanger.Oneisco mposedofmultiple,thin,slightlyseparatedplatesthathaveverylarg esurfaceareasandsmallfluidflowpassagesforheattransfer.Thissta cked-platearrangementtypicallyhaslowervolumeandcostthantheshella ndtubeheatexchanger.Advancesingasketandbrazingtechnologyh avemadetheplate-typeheatexchangerincreasinglypractical.InHVACapplications,l argeheatexchangersofthistypearecalled plate-and-frame;whenusedinopen loops,theseheatexchangersarenormallyof thegaskettypetoallowperiodicdisassembly,cleaning,andinspecti on.Therearemany typesof permanentlybondedplateheatexchangers,suchasdip-brazed,vacuum-brazed,andweldedplatevarieties,andtheyareoftenspecifiedforclo sed-loopapplicationssuchasrefrigeration.Plateheatexchangersalsodi fferinthetypesofplatesthatareused,andintheconfigurationsofthos eplates.Someplatesmaybestampedwith"chevron",dimpled,oroth erpatterns,whereothersmayhavemachinedfinsand/orgrooves.

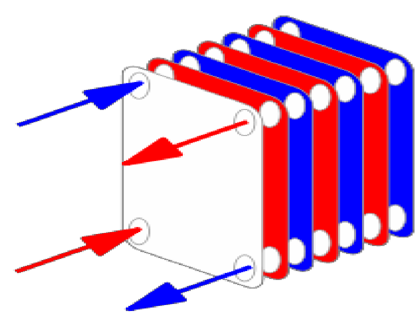

Figure-1.2: Conceptualdiagramof aplateandframeheatexchanger

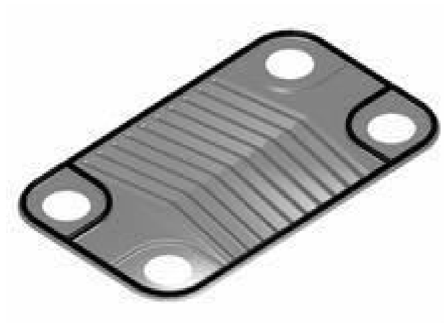

Figure-1.3: Singleplateheatexchanger

1.2.3 Plateandshellheatexchanger

Athirdtypeofheatexchangerisaplateandshellheatexchanger,whichcombinesplateheatexchangerwithshellandtubeheatexchangertechnologies.Theheartoftheheatexchangercontains afullyweldedcircularplate packmadebypressingandcuttingroundplatesandweldingthemtogether.Nozzlescarryflowin and outofthe plate pack(the'Plate side'flowpath).Thefullyweldedplatepackisassembledintoanoutershellthatcreatesasecondflowpath(the'Shellside').Plateandshelltechnologyoffershighheattransfer,highpressure,highoperatingtemperature,compactsize,lowfoulingandcloseapproachtemperature.Inparticular,itdoescompletelywithoutgaskets,whichprovidessecurityagainstleakageathighpressuresandtemperatures.

Phase-changeheatexchangers

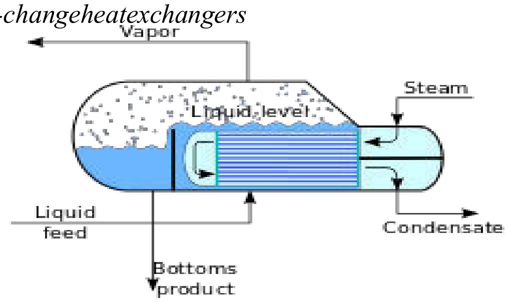

Figure-1.4: Typicalkettlereboilerusedforindustrialdistillationtowers

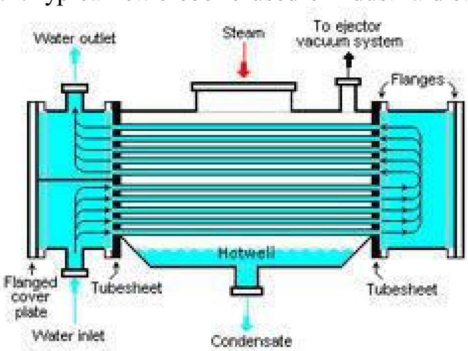

Figure-1.5: Typicalwater-cooledsurfacecondenser

Inadditiontoheatingupорcoolingdownfluidsinjustasingle phase, heatexchangers can be used eitherto heataliquid toevaporate(orboil)itorusedas condenserstocoolavaporandcondense it to a liquid.In chemical plantsandrefineries,reboilersusedtoheatincomingfeedfordistillationtowersareoftenheatexchangers.

Distillationset-upstypicallyusecondenserstocondensedistillatevapoursback into liquid.Powerplantsthatusesteam-driventurbinescommonlyuseheatexchangerstoboilwater intosteam.Heatexchangersorsimilarunitsforproducingsteamfromwaterareoftencalledboilersorsteamgenerators.

Inthenuclearpowerplantscalledpressurizedwaterreactors,speciallargeheatexchangerspassheatfromtheprimary(reactorplant)systemtothesecondary(steamplant)system,producingsteamfromwaterintheprocess.Thesearecalledsteamgenerators.Allfossil-fueledandnuclearpowerplantsusingsteam-driventurbineshave surfacecondenserstoconverttheexhauststeamfromtheturbinesintocondensate(water)forre-use.

Toconserveenergyandcoolingcapacityinchemical andotherplants,regenerativeheatexchangerscantransferheatfrom astreamthatmustbecooledtoanotherstreamthatmustbeheated,suchasdistillatecoolingandreboilerfeedpre-heating.

Thistermcanalsorefertoheatexchangersthatcontainamaterialwithintheirstructurethathasachangeofphase. Thisisusuallyasolidtoliquidphaseduetothesmallvolumedifferencebetweenthesestates. Thischangeofphaseeffectivelyactsasabufferbecauseitoccursataconstanttemperaturebutstillallowsfortheheatexchangertoacceptadditionalheat.Oneexamplewherethishasbeeninvestigatedisforuseinhighpoweraircraftelectronics.

1.3OPTIMIZATION

Therearethreegoalsthatarenormallyconsideredintheoptimaldesignofheatexchangers:(1)Minimizingthepressuredrop(pumpingpower),(2)Maximizingthethermalperformanceand(3)Minimizing theentropygeneration(thermodynamic).

*II*METHODS

2.1 ComputationalFluidDynamics

CFDisusefulforstudyingfluidflow,heattransfer;chemicalreactionsetcbysolvingmathematicalequationswiththehelpofnumericalanalysis.CFDresolvetheentiresysteminsmallcellsandapplygoverningequationsonthesediscreteelementstofindnumericalsolutions regardingpressuredistribution,temperaturegradients.Thissoftwarecanalsobuildavirtualprototypeofthesystemordevicebeforecan beapplytoreal-world physicstothe model, and thesoftwarewillprovidewithimagesanddata, whichpredicttheperformanceofthatdesign.Morerecentlythemethodshavebeenappliedtothedesignofinternalcombustionengine,combustionchambersofgasturbineandfurnaces,alsofluidflowsandheattransferinheatexchanger.ThedevelopmentintheCFDfieldprovidesacapabilitycomparabletootherComputerAidedEngineering (CAE)toolssuchasstressanalysiscodes.BasicApproachtousingCFD

a) Pre-processor:Establishingthemodel

- Identify theprocessorequipmenttobeevaluated.

∟ Represent the geometry of interest using CAD tools.

∟ Use the CAD representation to create a volume flow domainaround theequipmentcontainingthe criticalflowphenomena.

∟ Create a computational mesh intheflowdomain.

b) Solver:

∟ Identify and apply conditions at the domain boundary.

∟ Solve the governing equations on the computational mesh usinganalysissoftware.

c) Postprocessor:Interpretingtheresults

∟ Post-

∟ Interpret the prediction to determine design iterations or processthecompletedsolutionstohighlightfindings.possiblesolut

ions,ifneeded

2.2 FLUENT/GAMBITFluidsAnalysis

Beloware step-by-step instructionsonhowtocreatea mesh inGambit,howtosaveandexportthemesh,howtoimportthemeshfr omwithinFluentand finally, howto solve theproblemusingthesolversandmodelscontainedinFluent.Youwi llthenbegivenaproblemthatyouaretoinvestigateandreporton.

GAMBIT

Takecaretoinsurethatyouareinthecorrectdirectory.Fireupgambit fromthecommandpromptbytypinggambitfilename.Thefirstthin gthatyoushoulddoistospecifywhichsolveryouneedfromtheSolve rmenu.Choose'Fluent5/6'.This will determinewhattype ofmenupopupthroughout yoursession.

Generateagrid. Therearetwowaysofgeneratingamesh.Gambitca llsthem'topdown'or'bottom-up'intheusermanuals.Theseinstructionsarebottom-up.Youwillcreateverticesuponwhichtheedgeswillbebuiltupon.C onnectingedgeswillcreatea face.Connectingfaceswillcreateavolume(3D).Oncethefaceorvol umeiscreated,a meshcanbegeneratedonit.Forthisexample,wewillsticktо2D,nod e->edge->face-> mesh.Remembertosaveandsaveoften.

Vertex:Therearefourbuttonsunder thewordOPERATIONSinthetoprightcornerofGambit.Theyare,f romlefttoright,thegeometry,mesh,zonesandtoolscommand.Atth istime,clickonthegeometrybutton.Note:mostofthebuttonsinGa mbittoggleoffandon.Theblankspaceunderthebuttonsontherighth andsideisnowshowingmorebuttonsandwindows.Directlyunder OPERATIONSisGEOMETRYwith5buttons:vertex,edge,face,v olume,andgroups.Clickon thevertex button. Bythistime,you willhavenoticedthatasyoumovethemouseoverthefunctionbutton sa windownearthebottomofGambittellsyouwhatthatbuttondoes. Use thisfunctionto familiarizeyourselfwith the variousbuttonsinGambit.Once youhaveclickedonthevertexbuttonmorebuttonsappearbelow.re medythis,clickontheFittoWindowbutton,thetopleftbigbuttonint heGRAPHICS/WINDOWSCONTROLarea(nearbottomright).I fatanytimeyouwishtoundothecommandyoujustdid,lookforthebu ttonthathasthearrowthatis'spinning'fromrighttoleft.TheUndoco mmandcanundomorethanonecommand,justkeepclicking.

Formorecomplicatedgeometry,suchasanairfoil,thevertexdataca nbeimported.GotoFile->Import->VertexData.Enterthepathtothefileorusthebrowser.Thedatafile Gambitcanreadhastohavethefileextension.dat.

Edges: Oncetheverticesarecreated,youwanttocreateedgesconne cting them.UnderGEOMETRY,clickon theedgebutton(secondfromleft).WhentheEDGEbuttonspopup,ri ghtclickonthefirstbuttonontheleft.Adropdownlistwillappeargivi ngdifferentoptionsfortheedgetype.Whenoneoftheseoptionsissel ectedafloatingwindowwillbedisplayed.Tocreatesmoothcurvede dgesusetheNURBSoption.Therearetwo methodsfortheNURBS,interpolateandapproximate.The approximatemethodwithatoleranceofzerowillgiveasmoothcurve .ToselecttheverticesfortheNURBSlineleftclicktheuparrowonthe rightsideoftheyellowverticesbox.Selecttheverticeswiththemous e and clickonthe ---> button. Once thevertices areselected, thefinalonewillturnredandtheotherswillturnpink.Iftheverticesar etheonesyouwanttoconnectwithanedgethenclickApplyinthefloa tingwindow.Anedgewillappearinyellow.Usethisproceduretocre ateanedgeforthetopandbottomoftheairfoilandthecontrolvolume.

Face: UnderGEOMETRY,clickonthefacebutton(thirdfromleft). WhentheFACEbuttonspopupclickonthefirstbuttonontheleft:Cre ateFace.AfloatingwindowcalledCreate FaceFromWireframewill appear. Selectinganedgeisthesameasselectingavertex.Holdtheshiftkeyd ownandleftclickontheedge.Theedgewillturnred.Selectaseconde dge:the firstwillturnpinkandthe secondwillturnred.SelectalledgescomprisingthefaceandclickAp ply in thewindow.Afacewillbecreated,itscolorislightblue.Tocreateasin glefacefromtwofacesusetheBooleanOperationsSubtractoption.

Mesh: Ameshcannowbecreatedontheface.UndertheOPERATIO N button, clickon MeshCommandbutton. WherethewordGEOMETRYusedtobe,thewordMESHwillappea rwithfivebuttons:boundary-layer,edge,face,volumeandgroup.Youwanttomeshthefacethatyo uhavejustcreated,soclickonface.ClickonthetopleftbuttonintheF ACEmenuarea,thebuttoniscalled: MeshFaces.ThiswillcausetheMeshFacesfloatingwindowtopop up. Leteverythingstayatitsdefault, select theface andclickApply.Gambitmayhesitatewhileit'sthinkingandthenyou willseethemeshinyellow.Youcanplayaroundwithmeshspacingb utkeeptheelementsandtypeatGambitsdefaultsetting.

BoundaryConditions: Youcansetorchangetheboundaryconditi onsinFluentbutyoucanalsodoitinGambit,infact,it'salittlebiteasie r.UpintheOPERATIONSmenu;clickontheZonesbutton.Underth ewordZONEStwobuttonswillappear:SpecifyBoundaryTypesan dSpecifyContinuum.ClickontheSpecifyBoundaryTypesbutton. AfloatingwindowcalledSpecifyBoundary Typeswillappear.Makesurethatatthetopofthiswindowthesolvern ame'Fluent5/6'appears,ifnotgotothesolvermenuandchoose'Flue nt5/6'.Youmusthavethiscorrectas differentsolversspecifyBC'sdifferently.ChangetheEntitypopdownmenutoedges.SelecttheedgethatwillbethevelocityinletandundertheTypepopdownmenuchooseVelocityInlet.Itisrecommendedthatyoulabelthedifferentedges.ThiswillhelpyoukeeptrackoftheminthFluentoutputreports.Thelabelsmustbeoneword,i.e.nospacesortabs.TofinishcreatingtheBCclickApply.NowselecttheedgethatwillbetheoutletandchooseOutflow.ThetopandbottomedgesoftheairfoilandcontrolvolumeareWalls.ThereisalistatthetopofthiswindowthatshouldreflectthetwoBC'sthatyouhavecreated.

SaveandExport: ThefilethatyouhavebeensavingtothroughoutthesessionisaGambitfileandisdifferentfromamesh file.TocreatethemeshfileforFluentto importclick onFile->Export->Mesh.Thenextpopupwindowwillhavefiletype(UNS/RAMPANT/FLUENT5)andfilename.Typeinthenameasyoupleasebutkeepthe.mshfilenameextension.Ifthegeometryis2D,thenchecktthebox“Export2dMesh”.YoumaynowquitGambit.FLUENTOnceFluentisloaded,type2datthecommandprompt.Theinstructionsbelowshouldbefollowedroughlyintheorderthattheyarewritten.Achoiceinonemenumayalterchoicesinanothermenu. Notethatinthe titlebarofthe Fluentwindow, therearethedescriptors:[2d,segregated,lam].Thesewillhelpyoukeeptrackofwhatmodels/solversyouareusing.

Readinthegrid. ThearetwofilesthatcontaindatathatFluentneedstosolveproblems.ThefirstistheCasefile,whichstoresalloftheinformationonboundaryconditions,whatsolversandmodelswereused,etc.ThesecondistheDatafile,whichstoresthesolution.Eventhoughthemeshisnotatruecasefile,readinthemeshusingtheFile->Read->Casecommand.Youwillhavetonavigatetoyourworkingdirectory.Fluentwilltellyouwhatitisdoing asitreads inthemesh.Besuretofollowthisdialogandspotanyerrors.

Check,DisplayandScaletheGrid. Fluentassumesthatthegridunitsareinmeters(SIunits).IfyoucreatedyourmeshinGambitinanythingotherthanmetersyouwillneedtoscalethegrid.GotoGrid->Scale.Inthepopupwindow,changethepulldownmenu"GridWasCreatedIn"towhateverunitsyouusedinGambit(ft).ClickonScale,theXmaxandYmaxfieldsshould nowreflect the propervalues. Close the window.Thepropervaluesshouldalsobeshownwhenyouchecktthe grid. Go toGrid->Check.Alist ofstatisticswillappear in theactivitywindow.To displaythegrid,gotoDisplay->Grid.Adisplaywindowwillshowthegrid.Theinletwillbeblue,theoutletred,wallswhiteandthemeshgreen.Thiswillgiveavisualcheckontheboundaryconditions.TherearetwowaystofixincorrectlyspecifiedBC's.Onewayistofire upGambit,redotheBC's,exportthecorrectmeshandre-importthemeshintoFluent.AnotherquickerwayistofixthemwithinFluent.ThiswillbeexplainedintheBoundaryConditionssection.

DefinitionofProperties: Oncethegridiscorrect,youcandefinethepropertiesofyourproblem.ThethreecrucialcategoriesunderDefineareModels,MaterialsandBoundaryConditions.Itisagoodhabittospecifytheseinorder;for example,changesintheModelsmenuwillchangethemenusinBoundaryConditions.

Models->Solver: Youwillnotchangeanythinghere,however,takealookaroundandfamiliarizeyourselfwiththevariousoptionsavailableforsolvers.

Models->Energy: Turntheenergyequationonoroff(default).

Models->Viscous: Therearevariousassumptions used whennumericallysolvingthegoverningequations.Thefirstistoassumethattheflowisinviscid.Thesecondistoassumelaminarflow(default),noturbulence.Andthethirdistoturnonaturbulencemodel,forexample,thek-epsilonturbulencemodel.Howwilleachoftheseassumptionsaffectyoursolution?Whichturbulencemodeliscorrectforyourflowconfiguration?Doyouhavetoworryaboutwalleffects?

Materials: Thedefaultfluidisair.Ifyou'dliketochangethematerialthenclickontheDatabasebutton,choosethematerialthatyouneedandclickonCopy.ThiscopiesthematerialpropertiesfromthedatabaseintoFluent.Oncethisisdone,make surethatthe materialthat youwanttouseisintheNamefield.ClosetheMaterialswindow.

BoundaryConditions: ThconditionforthevelocityinletistheonlyBCthatneedstobeset.Changethevelocitymagnitude (m/s)anddirectionto the desiredvalues. To settheconditionsattheinlet,clickonthewordvelocity_inletintheZonearea.TheTypeareashouldadjusttoreflect"velocity-inlet".Ifyouwantedtochangethisinlettosomethingelse,intheTypelistclickontheboundaryconditionneeded.Awindowwillpopuptomakesurethatthischangeiswhatyouwant,clickyesorno.Ifthespecificationiscorrect,clickontheSetbutton.EnterthevelocityandclickOKinthepopupwindow.ClosetheBoundaryConditionswindow.

Solve: Youcannowsolvetheproblem.Goto Solve->Iterate.Awindowappearsthathasafieldwhereyoucanspecifyhowmanyiterationstoperform.Itisalwaysgoodtochooseasmallnumberatfirsttoseeifthesolutionisgoingwild(i.e.incorrectBC's)orseemstosettledown.Enterasmallnumber,say20andclick on Iterate.You'llseetheresidualsprintedintheactivityareaandtheplotofresidualsdisplayedintheplotwindow. Ifeverythingisokay,thenputinahigher number,say100, andclickIterate. Do thisuntilFluentsays"SolutionConverged".

DisplaytheSolution: Isyoursolutioncorrect?You'llwanttoviewvector,contourandXYplotsofyourdata.UndertheDisplaymenu,you'llseeContours,VelocityVectors,PathLinesandParticleTracksamongothers.Thesewillplotthevariousquantitiesforyou.Ifyou'dliketoseeanXYplotof,forexample,thetemperaturealongawall,gotoPlot->XYPlot.

Hardcopy: Fluentdoesnothavethecapabilityofprintingtheplotsthatit generates.Itdoeshowever,let yousavetheseplotsaspostscript,tiff,EPS,PICT,etc.,files.Todothis,displaythe plotthatyouwanttosaveinthedisplaywindow.ThengotoFile->Hardcopy.Awindowwillappearwhich haveall oftheformatslisted.ForyourreportchooseTIFF.Choosecolororgrayscale.DONOTchangetheresolutionfield.Iknowitsays "0"but itwillworkoutok. Click onSave andnavigatetoyourworkingdirectory.

SavingCaseandDatafiles: You'vedonealotbynowsoitwouldbegoodtosaveboththecaseanddatafiles.GotoFile->Write->Case&Data.Navigatetowhereyouwanttobeandclickokay.Since youhavealreadysavedthecasefile,itwillaskyouifyouwanttooverwrite.Ifyoudon't,clickcancelandsavethedatafileseparatelyusing File->Write->Data.YoumaynowquitFluentandalloftheinformationissafelystoredinthecaseanddatafiles.Whenyouwanttorevieworchangethis simulationjustfireupFluentandreadinthecaseanddatafiles,File->Read->Case&Data.Youcanchangeinlet conditions and recalculateadifferentsolution,or trynewmodelsandsavethemasdifferentcaseanddatafiles.

Overthepasthalf-century,wehavewitnessedtheriseinthe new methodologyforattackingcomplexprobleminfluidmechanics,heattransferandcombustion.Ithascometothestatethatwhereverthere isaflow,computercanhelptounderstandandanalyzethesame.This newmethodologyofsolvingaflowproblemusingacomputerisgiventhenameCFD.ComputationalFluidDynamicsorCFDistheanalysisofsystemsinvolvingfluidflow,heattransferandassociatedphenomenasuchas chemicalreactions by means ofcomputer-basednumericalapproach,Inthisnumericalapproach,theequations(usuallyinpartialdifferentialform)thatgovernaprocessofinterest aresolvednumerically.Thetechniqueisverypowerfulandspansawiderangeofindustrialandnon-industrialapplicationareas.

3.2 Analysationofafluidflowproblem

Therearethree methodstoanalyzeafluidflowproblem.

1. Experimental
2. Theoretical
3. Computational(CFD)

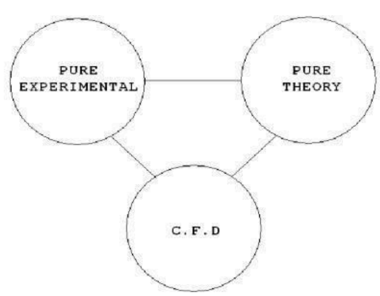

Fig2.1: The“threedimensions”offluiddynamics

CFDsynergisticallycomplementstheotherapproachesbutwillneverreplaceeitherofthem.Thefutureadvancementoffluiddynamicswillrestuponaproperbalanceofallthreeapproaches,with CFDtointerpretandunderstandtheoryandexperimentandviceversa.

Experimentalapproach

- Mostreliableinformation
- Fullscaletestsareprohibitivelyexpensiveandoftenimpossible
- Thegeneralrulesformodelingandextrapolationtofullscaleareoftenunavailable
- Simulationofallthefeaturessuchascombustionorboiling areoftenomittedfrommodelstests
- Serious difficulties of measurement in manysituations
- Measuringinstrumentshaveuncertainlyerrors

TheoreticalorAnalyticalapproach

- Solvemathematicalmodels ratherthan physicalmodels
- Analyticalmethodscannotpredictmanyphenomena
- Analyticalorexactsolutionsarepossibleonlyforverysimpleandidealsituationswithmanyassumptions Examples:ideal flows(potential flows),Couetteflow,Blassinsflowetc.

2.3 COMPUTATIONALFLUIDDYNAMICS:

Advantages

- Lowcost,highspeed
- Completeinformationatanyinaccessiblepoint
- Abilitytosimulaterealisticconditionsandalsoidealconditions
- Canhandleanycomplexgeometry

Disadvantages

- Propermathematicalmodelmaynotbeavailable
- Validationofcomputerresultsneedsexperimentaldata

Pre-RequisitesforCFD

- Fluidmechanics
- Heattransfer
- Partialdifferentialequations
- Numericalmethods

2.4 Mathematical behaviour of governing equations incomputationalfluiddynamics

ThedevelopmentofthehighspeeddigitalcomputercombinedwiththedevelopmentofaaccuratenumericalalgorithmsforsolvingproblemsonthesecomputershashadagreatimpactonthewayprinciplesfromthescienceofFluidMechanicsareappliedtoproblems ofdesigninmodernengineeringpractice

Thephysicalaspectsofanyfluidflowaregovernedbythreefundamentalprinciples:conservationofmass,conservationofmomentum,conservationofenergyandthesecanbeexpressedintermsofbasicmathematicalequationswhichintheirmoregeneralformareeitherintegralequationsorpartialdifferentialequationincomputationalapproach;theseequationsthatgovernaprocessaresolvednumerically.

Thesepartialdifferentialequationshavecertainmathematicalbehavior.Thisbehaviorisnotfixedandvariesfromonecircumstancetoanother,dependingonthemagnitudeofthedimensionlessflowparametersgoverning, thesituation,theequationsgoverningtheflowandthesteadyorunsteadynatureoftheflow.

2.5.Discretization

The word "discretization" requires someexplanation.Obviously,itcomesfrom"discrete,"definedin *TheAmericanHeritageDictionaryoftheEnglishLanguage* as "constitutingaseparatething;individual;distinct;consisting of unconnected distinct parts." However, the word "discretization"cannotbefoundinthesamedictionary;it cannotbefoundin*Webster'sNewWorldDictionary*either. Thefactthatitdoesnotappearintwoofthemostpopulardictionaries oftodayimplies,attheveryleast,thatitisarathernewandesotericword.Indeed,itseemstobeuniquetotheliteratureofnumericalanalysis,firstbeingintroducedintheGermanliteraturein1955by"W.R.Wasow",carriedon byAmesin1965inhisclassicbookonpartialdifferential equations,andrecentlyembracedbytheCFDcommunityas closed-formathematicalexpression,suchasafunctionoradifferentialorintegralequation involvingfunctions,allofwhichareviewedashavinganinfinitecontinuumofvaluesthroughoutsomedomain,isapproximatedbyanalogouspointsorvolumesinthedomain.Thismaysoundabit mysterious,solet uselaborateforthesakeofclarity.Also,wewillsingleoutpartialdifferentialequationsforthepurposesofdiscussion.Therefore, theremainderofthisintroductorysectiondwellsonthemeaningof"discretization".

2.5.1.INTRODUCTIONTOFINITEDIFFERENCES

Here,weareinterestedinreplacingapartialderivativewithasuitablealgebraicdifferencequotient,i.e.,a*finitedifference.*Mostcommonfinite-differencerepresentationsof derivatives are based onTaylor'sseries expansions.Forexample,if $u_{i,j}$ denotesthexcomponentof velocityatpoint(i,j),thenthevelocity$u_{i+1,j}$ atpoint(i+1,j) canbeexpressedintermsofaTaylorseriesexpandedaboutpoint(i,j) asfollows

$$u_{i+1,j} = u_{i,j} + \left(\frac{\partial u}{\partial x}\right)_{i,j} \Delta x + \left(\frac{\partial^2 u}{\partial x^2}\right)_{i,j} \frac{(\Delta x)^2}{2} + \left(\frac{\partial^3 u}{\partial x^3}\right)_{i,j} \frac{(\Delta x)^3}{6} + \ldots \quad \text{....(2.1)}$$

Equation(2.1)ismathematicallyanexactexpression for $u_{i+1,j}$ ifthenumberoftermsisinfiniteandtheseries convergesand /or$\Delta x \to 0$.

SolvingEq.(2.1)for $\left(\frac{\partial u}{\partial x}\right)_{i,j}$ weobtain

$$\left(\frac{\partial u}{\partial x}\right)_{i,j} = \frac{u_{i+1,j} - u_{i,j}}{\Delta x} - \left(\frac{\partial^2 u}{\partial x^2}\right)_{i,j} \frac{(\Delta x)^2}{2} + \left(\frac{\partial^3 u}{\partial x^3}\right)_{i,j} \frac{(\Delta x)^3}{6} + \ldots\ldots\ldots \quad \text{.....(2.2)}$$

InEq.(2.2)theactualpartialderivativeevaluatedat point(i,j)isgivenontheleftside.Thefirsttermontheright side, namely $\frac{(u_{i+1,j} - u_{i,j})}{\Delta x}$ is a finite-difference representationofthepartialderivative.Theremainingtermsontherightsideconstitutethe*truncationerror*.Thatis,ifwewishto*approximate*thepartialderivativewiththeabovealgebraicfinite-differencequotient,

$$\left(\frac{\partial u}{\partial x}\right)_{i,j} \approx \frac{u_{i+1,j} - u_{i,j}}{\Delta x} \quad \text{....(2.3)}$$

ThenthetruncationerrorinEq.(3.2)tellsuswhatis beingneglectedinthisapproximation.InEq.(3.2),thelowest-ordertermin thetruncationerrorinvolvesΔxtothefirstpower;hence,thefinite-differenceexpressioninEq.(3.3)iscalled*first-order-accurate.* WecanmoreformallywriteEq.(2.2)as

$$\left(\frac{\partial u}{\partial x}\right)_{i,j} = \frac{u_{i+1,j} - u_{i,j}}{\Delta x} + O(\Delta x) \quad \text{.....(2.4)}$$

2.6Explicitandimplicitapproaches:

2.6.1DefinitionsandContrasts:

Wehavediscussedsomebasicelementsofthefinite – differencemethod.Wehavedonenothingmorethanjustcreatesome numericaltoolsforfutureuse;wehavenotyetdescribedhowthesetoolscanbeputto use forthesolutionsofCFDproblems.The*way*thatthesetoolsareputtogetherandusedforagivensolutioncanbecalledaCFD*technique*,and wehavenotyetdiscussedanyspecifictechniques.However,onceyouchooseaspecific techniquetosolve yourgivenproblem,youwillfindthatthetechniquefallsintooneortheotheroftwodifferent general approaches,an*explicit*approachoran*implicit*approach.Itisappropriatetointroduceand definethesetwogeneralapproachesnow;theyrepresentafundamental distinction between various numerical techniques,adistinctionforwhichweneedtohavesome appreciationatthisstageofourdiscussion. Forsimplicity,letusreturntotheone-dimensionalequation givenbyEq.(2.5)repeatedbelow.

$$\frac{\partial V}{\partial t} = \alpha \frac{\partial^2 V}{\partial x^2} \quad \text{.....(2.5)}$$

We willtreat Eq. (2.5)as a "modelequation" forour discussioninthissection;allthenecessarypointsconcerning explicitandimplicitapproachescanbemadeusingthismodelequation withoutgoingto theextra complexity of the governingflow equations. Above,weusedEq. (3.a) toillustratewhatwasmeantby a differenceequation.In particular,inthatsectionwechoosetorepresent $\frac{\partial V}{\partial t}$ witha forwarddifferenceand $\frac{\partial^2 V}{\partial x^2}$ withacentralseconddifference, leadingtotheparticularformofthedifferenceequationgivenbyEq.(2.6)repeatedbelow:

$$\frac{V_i^{n+1} - V_i^n}{\Delta t} = \alpha \frac{V_{i+1}^n - 2V_i^n + V_{i-1}^n}{(\Delta x)^2} \quad \text{.....(2.6)}$$

Withsomerearrangement,thisequationcanbewrittenas

$$V_i^{n+1} = V_i^n + \alpha\Delta t \frac{V_{i+1}^n - 2V_i^n + V_{i-1}^n}{(\Delta x)^2} \quad .....(2.7)$$

$$AV_{i-1}^{n+1} - BV_i^{n+1} + AV_{i+1}^{n+1} = K_i \quad .....(2.8)$$

Notethat'K_i'inEq.(3.24)consistsofpropertiesattimelevel'n',whichareknown.Hence,'K_i'isaknownnumberinEq.(3.24) Returningtofig.(3.a2),wenowapplyEq.(2.8)sequentiallytogridpoints'2'through'6'.

Atgridpoint2:

$$AV_1 - BV_2 + AV_3 = K_2 \quad .....(2.9)$$

Here, we have dropped the superscript for convenience;itiseasytoremememberthat V_1, V_2, V_3 represent threevalues at timelevel'n+1', and'K_2'isaknown number asstatedbefore.Moreover,because ofthestipulatedboundary conditionsatgridpoints'1'and'7', V_1 inEq.(3.25)isa knownnumber.Hence,inEq.(3.25)theterminvolvingthe known V_1 canbetransferredtotheright-handside,resulting in

$$-BV_2 + AV_3 = K_2 - AV_1 \quad .....(2.10)$$

Denoting $K_2 - AT_1$by $K_2^{|}$, where$K_2^{|}$ isaknown number,Eq.(2.10)iswrittenas

$$-BV_2 + AV_3 = K_2^{|} \quad .....(2.11)$$

Atgridpoint3:

$$AV_2 - BV_3 + AV_4 = K_3 \quad .....(2.12)$$

Atgridpoint4:

$$AV_3 - BV_4 + AV_5 = K_4 \quad .....(2.13)$$

Atgridpoint5:

$$AV_4 - BV_5 + AV_6 = K_5 \quad .....(2.14)$$

Atgridpoint6:

$$AV_5 - BV_6 + AV_7 = K_6 \quad .....(2.15)$$

2.7FiniteVolume:

Finitevolumemethodisoneof theverypopularapproximatemethodstosolvethe governingequationsoriginatedfromfluiddynamics.Thegoverning equationsdiscretizedusingthismethodmayresemblesimilartotheequationsdiscretizedwithfinitedifferencemethodbutthebasicideabehindthesetwoschemesisverydifferent.Ingeneral,infinitedifferencemethod,themathematicallymodeleddifferentialorintegralequationsaretakenasthecorrectandappropriateformoftheconservationprinciplesgoverningthephysicalproblemandthenmakinguseofTaylorseries or integralmethodsthedifferential orintegralequationsareconvertedintoalgebraicform.However,infinitevolumemethod,afterdiscretizingthedomainunderconsiderationassub-domainscalled controlvolumes,theconservationstatementsareappliedineachofthesecontrolvolumes.Thatis,theconservationprinciplesaremadetosatisfyineach of the controlvolumes.The generationofcontrolvolumescanbedoneintwoways

1. *Cell-Centeredmethod:* In this method, thecontrolvolumesareidentifiedfirstandthengridpoints willbeplacedatthecenterofeachcell.
2. *Cell-Vertexmethod:* Incellvertexmethodthegridpointswillbeidentifiedfirst andthentheboundaries ofthecontrolvolumearefixedathalfwaybetweenthe gridpoints.If thegrid points areidentifiednon-uniformlyinthisschemethenthesepointsneednotbeatthegeometriccentreofthecontrolvolumes.

2.8Maccormack'stechnique

MacCormack'stechniqueis a variantof the lax-Wendroffapproachbutismuchsimplerinitsapplication. LiketheLax-Wendroffmethod,theMacCormackmethodis alsoanexplicitfinite-differencetechniquewhichissecond orderaccurateinbothspaceandtime.Firstintroducedin 1969,itbecamethemostpopularexplicitfinitedifferencemethodforsolvingfluidflowsforthenext15years.Today,the MacCormack method has been mostlysupplanted bymore sophisticatedapproaches. However,theunderstandand program. Moreover, the results obtained by using MacCormack's methodare perfectlysatisfactoryformany fluidflowapplications.

3Designandanalysisofconcentrictubeheatexchanger

3.1Concentrictubeheatexchanger:

ConcentricTube(orPipe)HeatExchangersareusedinavarietyofindustriesforpurposessuchasmaterialprocessing,foodpreparationandair-conditioning.Theycreateatemperaturedrivingforcebypassingfluidstreamsofdifferenttemperaturesparalleltoeachother,separatedbyaphysicalboundaryintheformofapipe.Thisinducesforcedconvection,transferringheatto/fromtheproduct.

Theprimaryadvantageofaconcentricconfiguration,asopposedtoaplateorshellandtubeheatexchanger,isthesimplicityoftheir design.Assuch, the insidesofbothsurfacesareeasytocleanandmaintain,makingitidealforfluidsthatcausefouling.Additionally,theirrobustbuildmeansththeycanwithstandhighpressureoperations.Theyalsoproduceturbulentconditionsat lowflowrates, increasingthe heat transfercoefficient,andhencetherateofheattransfers.There aresignificantdisadvantageshowever,thetwomostnoticeablebeingtheirhighcostinproportiontoheattransferareaandtheimpracticallengthsrequiredforhighheatduties.Theyalsosufferfromcomparativelyhighheatlossesviatheirlarge,outershells.

Thesimplestformiscomposedofstraightsectionsoftubingencasedwithintheoutershell,howeveralternativessuchascorrugatedorcurvedtubingconservespacewhilemaximizingheattransferareaperunitvolume.Theycanbearrangedinseriesorinparalleldependingontheheatingrequirements.Typicallyconstructedfromstainlesssteel,spacers areinsertedtoretainconcentricity, whilethetubesaresealedwithO-rings,packing,orweldeddependingontheoperatingpressure.

Whilebothcoand counter configurationsare possible,thecountercurrentmethodismorecommon.Thepreferenceis topassthehotfluidthroughtheinnertubetoreduceheatlosses,whilethe annulusisreservedforthehigh viscositystreamtolimitthepressuredrop.Beyonddoublestreamheatexchangers,designsinvolvingtriple(ormore)streamsarecommon;alternatingbetweenhotandcoolstreams,thusheating/coolingtheproductfrombothsides.

3.2Problemdescriptionandmodeling:
3.2.1 Concentric Tubeparallel Flow Heat ExchangerwithoutThickness:
3.2.1(a): ModelinginGAMBIT

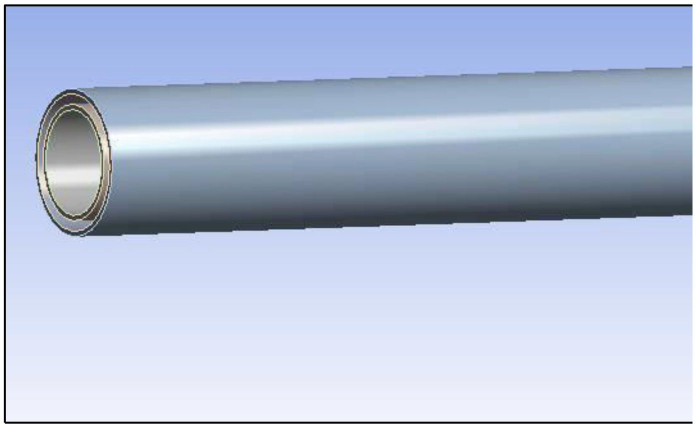

Figure-3.1: ModellinginAnsysfluent

3.2.1 (b):MESHING

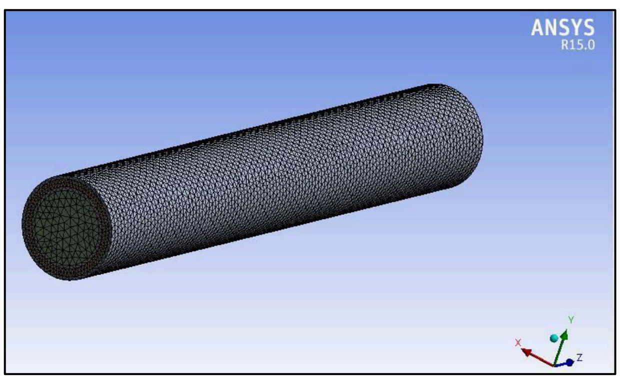

Figure-3.2:MESHING

3.2.2 Problemresults

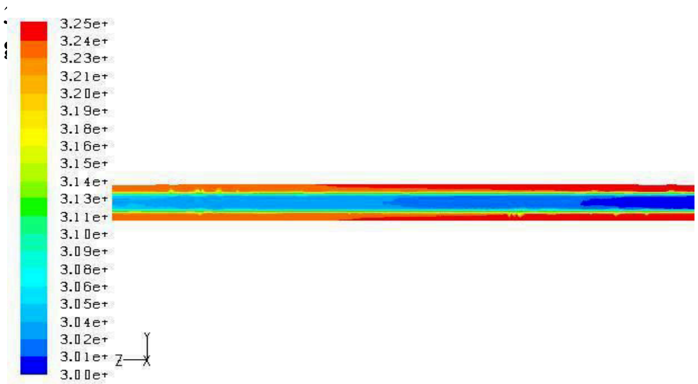

Figure-3.3: TemperatureprofileofConcentricTubeHeatExchanger

3.2.2(b):VelocityprofileofConcentricTubeHeatExchanger

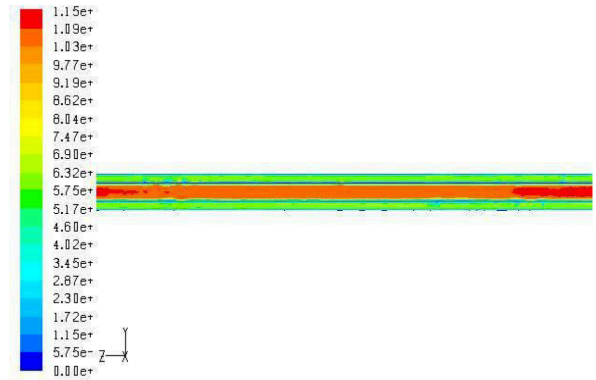

Figure-3.4: VelocityprofileofConcentricTubeHeatExchanger

3.2.2(c)Figure-14:PressurevariationofConcentricTubeHeatExchanger

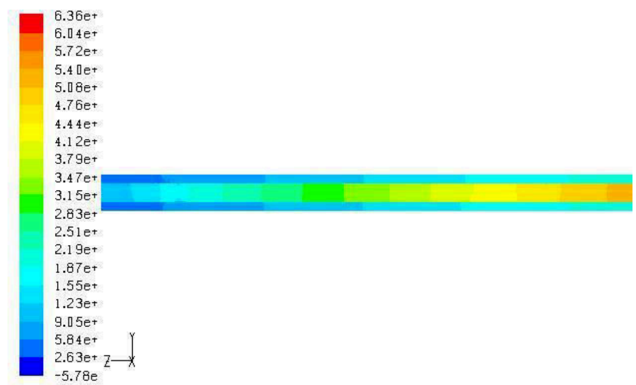

Figure-3.5:PressurevariationofConcentricTubeHeatExchanger

3.3GeometryModelingOfActualProblem:

ThegeometryismadeinAnsysfluent.Thegeometryconsistsofalengthof1m.Concentrictubeofinnertubeinnerdiameter 0.012m andinnertubeouterdiameter0.015m andoutertubediameteris0.025 m.Forthis project,fullydevelopedturbulentincompressiblefluidflowwillbeanalyzedintwoheatexchangercases:parallelflowandcounterflowheatexchanger.Theresultingtemperaturedifferencewillbecomparedandbedeterminedas afunction oftheinletvelocityandinlettemperatures.Theoverallobjectiveistodeterminethemaximumtemperaturedifference.Thetypeofheatexchangerusedwillbeofconcentrictubedesign.Wateristhecoolingmediumandtheworkingfluid.

3.3.1:PARAMETERS

Table-3.1: Parameters

S.no	Dimensions	Values
1	LengthL	1m
2	InnertubeInnerdiameterdi	0.012m
3	InnertubeOuterdiameterdo	0.015m
4	OutertubeDiameter D	0.025m
5	MassflowinletofcoldwaterMc	0.04545m/sec
6	MassflowinletofhotwaterMh	0.02272m/sec
7	Hot waterinlettemperatureTh	52°=325kelvin
8	ColdwaterinlettemperatureTc	27°=300kelvin

4.3.2 BoundaryConditions

Boundaryconditionsareusedaccordingtotheneedofthemodel.Theinletandoutletconditionsaredefinedasvelocityinletandpressure outlet.Asthisisacounter-flowwithtwotubessotherearetwoinletsandtwooutlets.Thewallsareseparatelyspecifiedwithrespectiveboundaryconditions.Noslipconditionisconsideredforeachwall.Exceptthetubewallseachwallissettozeroheatfluxcondition.Thedetailsaboutallboundaryconditionscanbeseeninthetable2asgivenbelow.

Table3.2: Namingofvariouspartsofthebodywithstatetype

S.no	Partofthemodel	Statetype
1	HotInlet	Fluid
2	Coldinlet	Fluid
3	Innertubes	Solid
4	Outertube	Solid

*IV*CONCLUSIONS

CFDanalysiswasdoneonconcentrictubeheatexchanger.Theconclusionsofthisinvestigatingareasfollows.

- Themainobjectiveofthisprojectwastoanalysethefluidflowinconcentrictubeheatexchangers.
- ACFD package(ANSYS15.0)wasusedforthenumericalstudyofheattransfercharacteristicsofaconcentrictubeheatexchanger.
- Characteristicsofthefluidflowwerealsostudiedfortheconstanttemperature
- FromthestudiesCFDcanbeconsideredasapowerfultoolforanalysisfluidandheattransferproblems.

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Design and modal analysis of an excavator arm

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***Abstract-*Anexcavatorisatypicalhydraulicheavy-dutyhuman-operatedmachineusedingeneralversatileconstructionoperations,suchasdigging,groundleveling,carryingloads,dumpingloadsandstraighttraction.Theseoperationsrequirecoordinatedmovementofboom,armandbucketinordertocontrolthebuckettippositiontofollowadesiredtrajectory.Anexcavatoriscomprisedofthreeplanarimplementsconnectedthroughrevolute jointsknownas the boom,arm,andbucket,andoneverticalrevolutejointknownastheswingjoint.Itwillbringbiggerdynamicstressbecauseofimpactandvibrancyofthehydraulicexcavatorwhenitis working, whichmaybeleadstothedamageofitsstructure.Themodelofthearmofsmall-scaledhydraulicexcavatorisbuiltbyusingPro-engineer.The3DSimulationAnalysisofarmofexcavatoriscarriedoutinANSYS.ThenaturalfrequenciesandmodeshapesofexcavatorarmaredeterminedusingANSYS.**

Key words:CATIA,ANYSYS,Excavator etc..

IINTRODUCTION

a) Excavator

Anexcavatorisatypicalhydraulicheavy-dutyhuman-operatedmachineusedingeneralversatileconstructionoperations, suchasdigging,groundleveling,carryingloads,dumpingloadsand straighttraction.Theseoperationsrequirecoordinatedmovementofboom,armandbucketinordertocontrolthebuckettippositiontofollowadesiredtrajectory.Anexcavatoriscomprisedofthreeplanarimplementsconnectedthroughrevolutejointsknownastheboom,arm,andbucket,andone verticalrevolutejointknownastheswingjoint.Anexcavatorhasaboom,stick,bucketandcabona rotatingplatformknown asthehouse. The housesitsatopanundercarriagewithtracksorwheels.Acable-operatedexcavatoruseswinchesandsteelropestoaccomplishthemovements.Theyareanaturalprogressionfromthesteamshovelsand oftencalledpowershovels**.**Allmovementandfunctionsofahydraulicexcavatorareaccomplishedthroughtheuseofhydraulicfluid,withhydrauliccylindersandhydraulicmotors.Due tothe linearactuation ofhydrauliccylinders,theirmodeofoperationisfundamentallydifferentfromcable-operatedexcavators.

Excavatorsarealsocalleddiggersandmechanicalshovels.Tracked excavatorsaresometimescalled"trackhoes"byanalogytothebackhoe.IntheUK,wheeledexcavatorsaresometimesknownas"rubberducks."

b) Compactexcavator

A**compact**or**miniexcavator**isatrackedorwheeled vehiclewith anapproximateoperatingweightfrom0.7to8.5tones.Itgenerallyincludesastandardbackfillbladeandfeaturesindependentboomswing.HydraulicExcavatorsaresomewhat differentfromotherconstructionequipmentinthatallmovementand functionsofthemachine areaccomplishedthroughthetransferofhydraulicfluid.Thecompactexcavator'sworkgroupandbladeareactivatedbyhydraulicfluidactinguponhydrauliccylinders.Theexcavator'sslew(rotation)andtravelfunctionsarealsoactivatedbyhydraulicfluidpoweringhydraulicmotors.

c) Draglineexcavator:

Adraglineexcavatorisa pieceofheavyequipmentusedincivil engineeringandsurfacemining.Draglinesusedincivilengineering arealmostalwaysofthissmaller,cranetype.Thesearеusedforroad, portconstruction,pondandcanaldredging,andaspiledrivingrigs.Thesetypesarebuiltbycranemanufacturerssuchas LinkbeltandHyster.

Themuchlargertypewhichisbuiltonsiteiscommonlyusedinstrip-miningoperationstoremoveoverburdenabovecoalandmorerecentlyfortar-sandmining.Thelargestheavydraglinesare amongthe largestmobile landmachineseverbuilt.Thesmallest andmostcommonoftheheavy typeweigharound8,000tonswhilethelargestbuiltweighedaround 13,000tons.

Adraglinebucketsystemconsistsofalargebucketwhichissuspendedfromaboom(alargetruss-likestructure)withwireropes.Thebucketismaneuveredbymeansofanumberofropesandchains.The hoistrope,poweredbylarge dieselorelectricmotors,supportsthebucketandhoist-couplerassemblyfromtheboom.Thedragropeisusedtodrawthebucketassembly horizontally.Byskillfulmaneuverof thehoistandthedragropesthebucketiscontrolledforvariousoperations

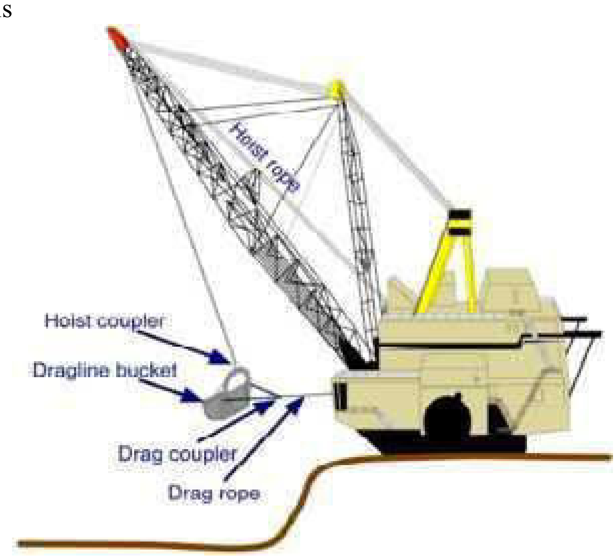


Fig.1Draglineexcavator

d) Longreachexcavator:

Thelong reach excavatororhigh reach excavatoris a developmentoftheexcavatorwithanespeciallylongboom armthat isprimarily usedfordemolition. Instead ofexcavatingditches,thelongreachexcavatoris designedtoreachtheupperstorey'sofbuildingsthatare beingdemolishedandpulldownthestructurein acontrolledfashion.It has largelyreplacedthewrecking ballasthe primarytool for demolition.Alsousingsomespecialpurposeworks.

Fig.2Longreachexcavator

e) Whatisanexcavatorarm?

Thehydraulicexcavatoroperatesondifferentlevels.Thefirst isthearmofthevehicle.Thearmiscomprised oftwo hydrauliccylinders,abucketanda boom, whichis on the upperpartofthearm.Thearmmovesintwopartsjustlikea humanarmwould:atthe wristandtheelbow.Insideofthe hydrauliccylinderisa rod,which istheinnerpart of the cylinder,and apiston, whichis at theendof thecylinder and1. thearmto move withthehelpofoil.Ifthere wereno oilinthecylinder,thepistonwoulddroptothebottom,but becauseof thenatureof oil,itsvolume always stays thesame.2. Oil is pumped through theendofthe piston and in turn pushes3. therodthroughthecylinder,thuscreatingmovementofoneor bothparts ofthe arm.Bycontrollingthe amountofoilis pumpedthroughthe valve,theaccuracyofthearmcanbe easilymanipulated.This movementisactivated bytheuseof4. controlvalvesthat arepositionedinsidethecabwherethe5. driverseatis

Fig.3Excavatorarm

IIMETHODS

a) IntroductiontoPro/E:

Pro/ENGINEERwasdevelopedbyparametrictechnologycorporation(PTC),USA.Pro/ENGINEERisaCAD/CAMsystemintegration3Dmodelingsoftwarepackageusedforvariousengineeringdesign services,includingstructural analysis,Process simulationand evaluationaswellasfor productandprocessdesigndocumentation.

Pro-eisasuiteofprogramsthatareusedin thedesign,analysis,andmanufacturingofavirtuallyunlimitedrangeofproduct.InPRO-Ewe willbedealingonlywiththe majorfront–endmoduleusedforpanandassemblydesignandmodelcreation,andproductionofengineeringdrawings**Schamtickoo(4)**.Therearewiderangesofadditionalmodulesavailabletohandletasksrangingfromsheetmetaloperations,pipinglayoutmolddesign,wiringharness design,NCmachiningandotheroperations.

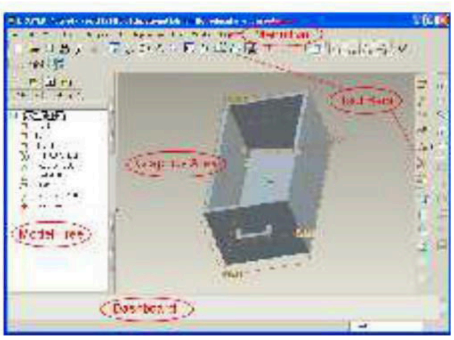
Inanutshell,PRO-ENGINEERisaparametric,feature-basedsolidmodelingsystem,**"Featurebased"**meansthatyoucancreatepartandassemblybydefiningfeaturelikeextrusions,sweep,cuts,holes,slots,rounds,andsoon,insteadofspecifyinglow-levelgeometry likelines,arcs,andcircle&featuresarespecifyingbysettingvaluesandattributesofelementsuchasreferenceplanesor surfacesdirectionof creation, patternparameters,shape, dimensionsandothers.

"Parametric"meansthatthephysicalshape ofthepartorassemblyisdrivenbythe valuesassignedtothe attributes(primarilydimensions)ofitsfeatures.Parametric maydefineor modifyafeature'sdimensions orother attributesatanytime.

Hidethebrowserbyclickingonthearrowsattherightoftheenables screen,asshowninthefigure.You shouldnowseethe graphicsareawherepartswillbedisplayed.

Select[File]->[SetWorkingDirectory]fromthemenubar, andselectthefolderinwhichyoudownloadedthepart.All workyoudo willbesavedtothefolder yousetasthe working directory.

Select[File]->[Open]fromthe menubar,andselectthepart youdownloaded.



b) CapabilitiesandBenefits:

1. Complete3Dmodeling capabilitiesenableyoutoexceedqualityaridtimetoaridtimeto marketgoals.
2. MaximumproductionefficiencythroughautomatedgenerationofassociativeCtoolingdesign,assemblyinstructions,andmachinecode.
3. Abilitytosimulateandanalysisvirtualprototypetoimproveproductionperformanceandoptimizedproductdesign.
4. Abilitytosharedigitalproductdataseamlesslyamongallappropriateteammembers
5. CompatibilitywithmyriadCADtools-includingassociativedataexchangeandindustrystandarddataformats.

c) FeaturesofPro-Engineering:

Pro/engineeringisaone-stopforanymanufacturingindustry.Itofferseffectivefeature,incorporatedforawidevarietyofpurpose.Someoftheimportantfeatures areasfollows:

- Simpleandpowerfultool
- Parametricdesign
- Feature-basedapproach
- Parentchildrelationship
- Associativeandmodelcentric

Twoselectedsurfacesbecomeco-planarandfacein***oppositedirections***.Thisconstrains3degreesoffreedom(tworotationsandonetranslation)

MateOffset

Twosurfacesaremadeparallelwithaspecifiedoffsetdistance.

AlignCoincident

Twoselectedsurfacesbecomeco-planarandfaceinthesamedirection.Canalsobeappliedtorevolvedsurfaces.Thisconstrains3degreesoffreedom(tworotationsandonetranslation).WhenAlignisusedonrevolvedsurfaces,theybecomecoaxial(axesthroughthecentersalign).

AlignOffset

Thiscanbeappliedtoplanarsurfacesonly;surfacesaremadeparallelwithaspecifiedoffsetdistance.

AlignOrient

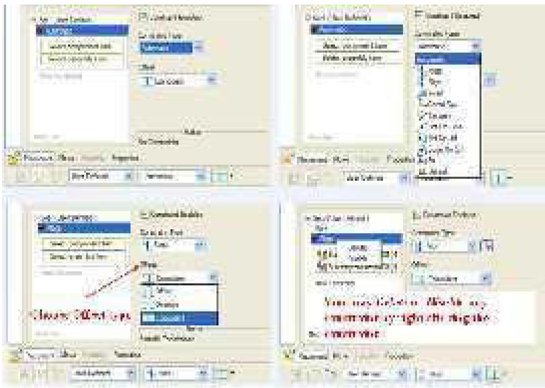
Twoplanarsurfacesaremadeparallel,notnecessarilyco-planar,andfacethesamedirection(similartoAlignOffsetexceptwithoutthespecifieddistance).

Insert

Thisconstraincanonlybeappliedtotworevolvedsurfacesinordertomakethemcoaxial(coincident).

AddingComponents:

Inthepull-downmenu,select*Insert>Component>Assemble*orpickthe***AddComponent***buttonintherighttoolbar.Browseandopenthe fileforthefirstcomponent.



d) IntroductiontoAnsys:

ANSYS isageneral-purposefinite element-modelingpackagefornumericallysolvingawidevarietyofmechanicalproblems.Theseproblemsinclude:static/dynamicstructuralanalysis(bothlinearandnon-linear),heattransferandfluidproblems,aswellasacousticandelectro-magneticproblems.Itenablesengineerstoperformthefollowingtasks-buildcomputer modelsortransfercadmodelsofstructures,products,componentsorsystem,applyoperatingloads orotherdesignperformanceconditions,studyphysicalresponsessuchasstresslevels,temperaturedistributionsorelectromagneticfields,optimizeadesignearlyinthedevelopmentprocesstoreduceproductioncosts,carryoutprototypetestinginenvironmentwhereitotherwisewouldbeundesirableorimpossible.

e) FiniteElementAnalysis:

Thefiniteelementisamathematicalmethodforsolvingordinaryandpartialdifferentialequations.Becauseitisanumericalmethod,ithas theabilitytosolvecomplexproblems thatcanberepresentedindifferential equationform.Asthesetypesofequationsoccurnaturally.InvirtuallyallfieldsofthephysicalSciences,theapplicationsoftheFiniteelementmethodarelimitlessasregardsthesolutionofpracticalDesignproblems.

Duetothehighcostofcomputingpowerofyearsgoneby,FEAhasahistoryofbeingusedtosolvecomplexandcostcriticalproblems.Inrecentyears,FEAhasbeenusedalmostuniversallytosolvestructuralengineeringproblems.OnedisciplinethathasreliedheavilyonthistechnologyistheAutomotiveandAerospaceindustry.Duetotheneedtomeettheextremedemandsforfaster,stronger,efficientandlightweightAutomobilesandAircrafts,manufactureshavetorelyontheTechniquetostaycomponentsandthehigh mediacoveragethattheIndustryisexposedto,AutomotiveandAircraftcompaniesneedtoensurethatnoneoftheircomponentsfail,thatistoceaseprovidingtheServicethatthe

f) Meshing:

A. Meshingthesolidmodel:

Theprocedureforgeneratinga meshofnodesandelementconsistsofthreemainsteps:

Setmeshcontrols(optimal).ANSYSoffersalargenumber ofmeshcontrols,whichwecanchoosefromtosuitourneeds.Generatethemesh(DescribedinMeshingYourSolidModel).Thesecondstep,settingmeshcontrols,isnotalwaysnecessarybecausethedefault meshcontrolsareappropriateformanymodels.Ifnocontrolsarespecified,theprogramwillusethedefaultsettingsontheDESIZEcommandtoproduceafreemesh.Asanalternative,youcanusetheSmartSizefeaturetoproduceabetterqualityfreemesh.Beforemeshingthemodel,andevenbeforebuildingthemodel,itisimportanttothinkabout whetherafreemeshoramappedmeshisappropriatefortheanalysis. Afreemeshhasnorestrictionsintermsofelementshapes,andhasnospecifiedpatternappliedtoit.

Comparedtoafreemesh,amappedmeshisrestrictedinterms ofelementshapeitcontainsandthepatternofthemesh.A mappedareamesh containseitheronlyquadrilateralor onlytriangularelements,whileamappedvolumemeshcontainsonlyhexahedronelements.Inaddition,amappedmeshtypicallyhasa regularpattern,withobviousrowofelements.Ifwewantthistypeof meshbuildthegeometryasaseriesoffairlyregularvolumesand/orareasthatcanacceptamappedmesh.

Whentheeffectoffrictionistakenintoaccount,the vibrationissaidtobe“DampedVibration”. Thus,therearefourdistinctcasesofvibrationpossible:

a) Freevibrationswithoutdamping
b) Freevibrationswithdamping
c) Forcedvibrationswithoutdamping
d) Forcedvibrationswithdamping.

Thefrequencyassociatedwith anyvibration is callednaturalfrequency.While vibrating,ifthe frequencyofvibrationcoincideswiththenaturalfrequency,theamplitudeof vibration increases. This phenomenon is called“Resonance”.The consequences ofResonanceare veryominousasitleadstothefailureofthe machineasa whole.

Thedecayofvibrationwithtimeduetoresistancetothemotionofthevibratingbodyiscalled“Damping”.Itprovidesaneffectivemeans ofreducingvibrationsinanymachine.

g) Forcedvibration

Vibrationthattakesplaceundertheexcitationofexternal forcesiscalled forcedvibrations.Whentheexcitationisoscillatory,thesystemisforcedtovibrateattheexcitationfrequency. Ifthe frequencyof excitationcoincideswithoneofthe natural frequenciesofthe system, a conditionofresonanceisencountered.

h) Designofanexcavatorarmbyusingpro-e

Step1:

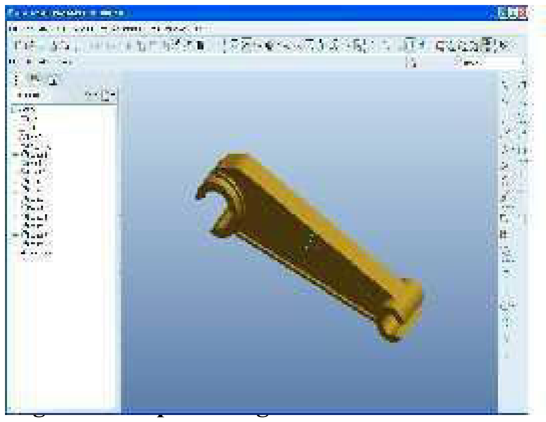
Thefirststepinpro-eistoselectthatpartoptionsincethedesignofanycomponentcanbedoneinpartdrawing.Thenameoftheparttobedrawnshouldbegivenbelowinthe name box. Andthe subtype should be selected assolidsince wearedesigningasolid model.

Step2: Thesecondstepistoselecttheplaneinwhichviewthecomponenthas tobedesigned.The figis representedbelow.Wecanselectanyoneamongthethreeplanesshownabovetodesignthecomponent.

Step3:

Weselecttheoptionnamedextrudewhichisoneamongmanyoptionsandweproceedourdesign.Thecompletedesignoftheexcavatorisdonebyusingextrudeandoffsetoption.

Thedimensionsforthedesignofanexcavatorarmaretakenasaroughfigureinorderthegeneraldesignofanexcavatorarm.Afterallthepreceduresweﬁnallyobtainanexcavatorarmwhich is shownbelowand we paintitindull yellowsincemostoftheexcavatorarm’sarelikethat.



i) Modalandstructuralanalysisof anexcavatorarmbyusingansys:

Modalanalysisisperformedontheexcavatorarmtodeterminethenaturalfrequenciesandmodeshapes.Bydeterminingthenaturalfrequenciesandmodeshapeswefinallycalculatethevibrationcharacteristicsofanexcavatorarmandalsotheinternaldeflection.

Procedureofmodalanalysis:-

1. ImportmodelfromIGESfile.
2. Giveelementtype,materialproperties.
3. Meshthedomain.
4. Giveboundarycondition(alldof)only.(notedon’tapply pressure)
6. Solution---analysis type----analysis---options------takeblocklonzesmethod.
7. Enternoofmodestoextract = 3Noofmodestoexpand =3.Enterok.
8. Solve----currentL.S

Analysisprocess:
ImporttheIGESfileintoANSYSSoftware.

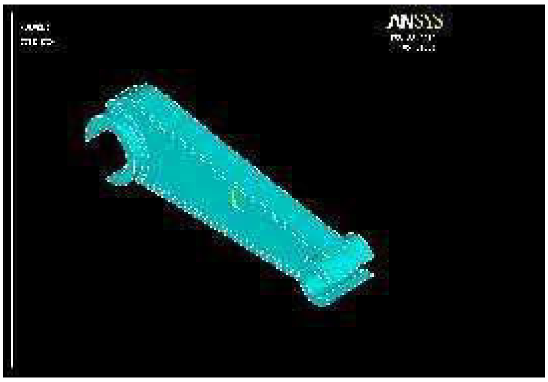


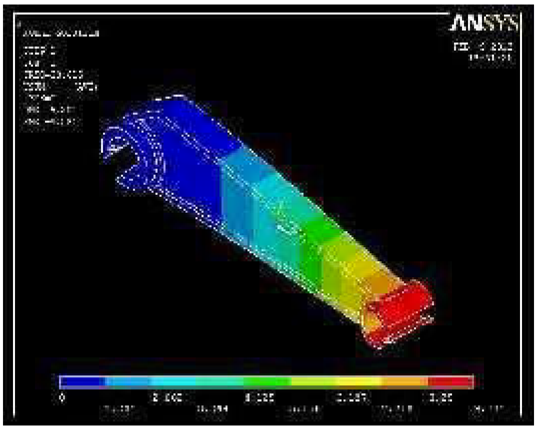
Fig.4ImportingIGESfileintoansysIII

RESULTS

a) Todeterminethevibrationfrequency:

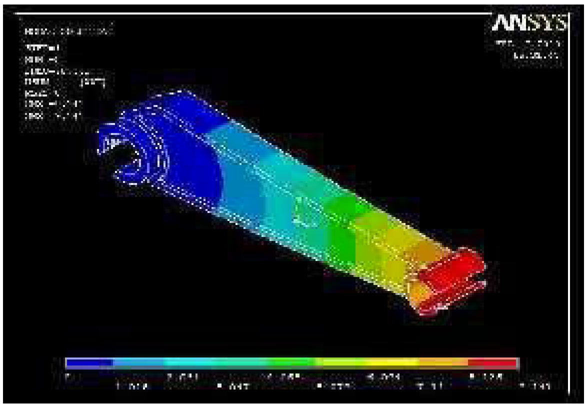
Inordertodeterminethevibrationfrequency,wemustfindoutthenaturalfrequenciesatdifferentmodes.Thevibrationfrequencycanbedeterminedonlywithoutapplyingloadsandthefrequencyisselfactingfrequency.

1.Mode1



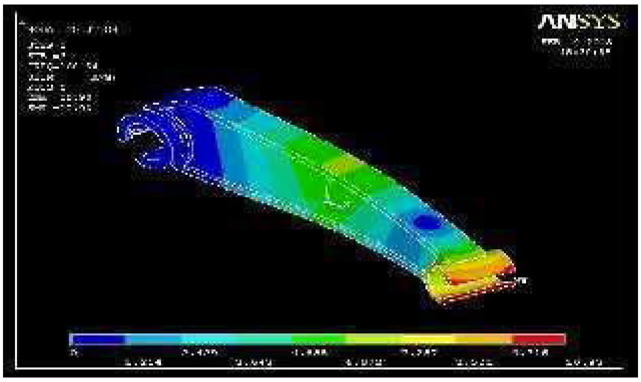
Formode1(SUB1)thefrequencyobtainedis30.615HZ2.M

ode2



Fornode2(SUB2)thefrequencyobtainedis78.332HZ

3. Mode3



Formode3(SUB3)thefrequencyobtainedis160.51HZTabl

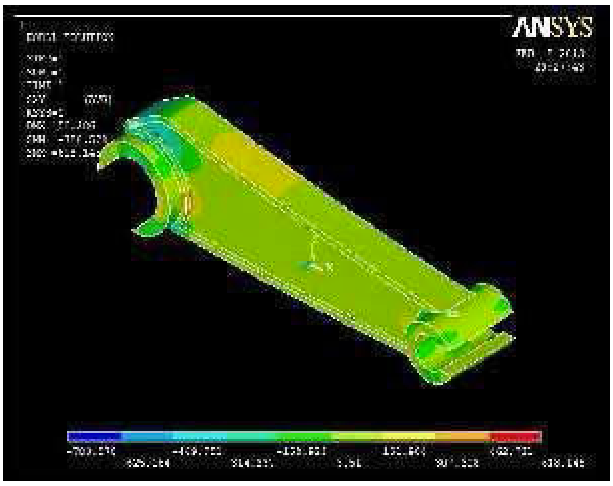
e1ModeandfrequencyafterAnsys

Mode	**Frequency**
Mode1	30.615HZ
Mode2	78.332HZ
Mode3	160.54HZ

Fromthe aboveanalysis,itisnoted thatthe excavatorarmcanwithstandthefrequencyuptoamaximumof160.54HZwiththedeflectionof10.93mm,beyondthatwillleadtofailureoftheexcavatorarm.

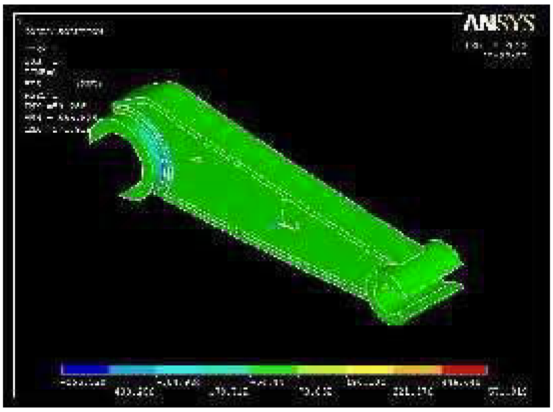
Tocalculatetheshearstressataloadof1000n(internaldeflection) Theshearstressiscalculatedonthememberwhenthestaticloadappliedis1000N.TheshearstresscalculatedinXY,YZandZXdirection.

1. Shearstressinxydirection:



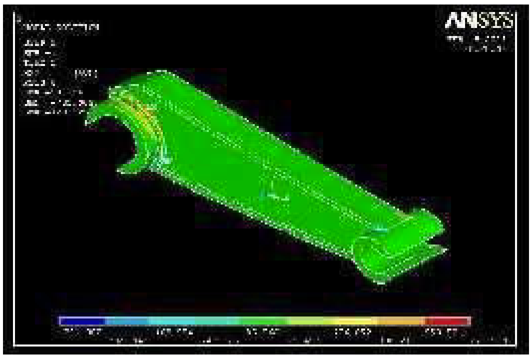
TheshearstressisappliedinXYdirectionwithavalueof 618.145MPA

2. Shearstressinyzdirection:



TheshearstressisappliedinYZdirectionwithavalueof571.919 MPA

3. Shearstressinxzdirection:



TheshearstressisappliedinXZdirectionwithavalueof720.929 MPA

Table1.4DirectionandshearstressafterAnsys

DIRECTION	SHEARSTRESS
XY	618.145MPA
YZ	571.919MPA
XZ	720.929MPA

FromtheaboveAnalysis,itisnotedthattheexcavatorarmhasashear stressdistributedin3directions.ThemaximumshearstressisobtainedinXZdirectionandminimumshearstressisobtainedinYZdirection.

IVCONCLUSION

Theexcavatorarmwassuccessfullydesignedbyusing Pro-Eandbyperformingmodalanalysisonanexcavatorarmwehavedeterminedthenaturalfrequencies,modesshapesandalsothedeflectiononthememberinoveralldirections.Itisobtained thatamongthe 3modesoffrequencies, in mode 3weare getting amaximumfrequency of160.51HZwiththedeflectionof10.93MM.Andalsothemodeshapeat160.51HZisvaryinglittlebitfromtheoriginalshapeoftheexcavatorarm.

The shearstress on theexcavatorarmis alsocalculatedwhenastaticloadof1000NisappliedinalldirectionsXY,YZ,XZrespectively.TheshearstressinYZdirection is minimumwithavalue of571.919 MPAand inXZdirectionthemaximumvalue isobtainedwhichis720.29MPA.It isconsideredthatinZ-directionwearegetting alargerfrequencywithmodedeflectionandhighshearstress.

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MODELLING AND ANALYSIS OF PULSATING HEAT PIPE

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Abstract— Thermal management in different fields of technology like aerospace, electronics etc. has become an important criterion and many devices have come up for this purpose. One among them is a heat pipe. A simple pipe consists of a tube with a suitable working fluid, an evaporator and a con-denser side. The transfer of heat takes place by absorption of heat from the evaporator side by the working fluid and dissipating it at the condenser side through latent heat. An improvement in the heat pipes is pulsating heat pipe which is also called as PHP. Pulsating heat pipe s have emerged as alternatives to conventional heat transfer technologies. Pulsating heat pipe (PHP) is a heat transfer device which is a combination of mechanisms like bubble nucleation, agglomeration and collapse, change of flow regimes, perturbations of pressure and temperatures etc. The working phenomenon of pulsating heat pipe differs from that of a regular heat pipe. The PHP has a lot of thermo-hydrodynamic characteristics which define its performance. The two phase flow which includes evaporation and condensation of the working fluid causes the transfer of heat. The various factors that affect the performance of the PHP's are the diameter of the pipe, volume fractions of fluids, different working fluids , , heat flux as an input, orientation etc. The present paper describes the detailed experimental analysis and working principle of PHP with water as working fluid and the results are compared with thermal analysis.
Index Terms: Pulsating Heat Pipe (PHP), heat transfer, working fluid, thermal analysis.

1. INTRODUCTION

Heat pipes are heat transfer devices which have a very good efficiency. These pipes absorb heat from a hot source and release it at a colder sink with the help of a working fluid. The phase change from liquid to vapor occurs in the evaporator and the vapor changes to liquid in the condenser. These heat transfer devices were developed in the 1960's and since then have been constantly studied. Today there are many classifications in heat pipes. One such simple and intriguing device is the pulsating heat pipe (PHP) .The pulsating heat pipe belongs to the family of two phase heat transfer devices. Pulsating heat pipe consists of a tube wound in a serpentine manner. Before partially filling with working fluid the PHP's are initially evacuated.

COMPARISON BETWEEN CONVENTIONAL AND PULSATING HEAT PIPE

A heat pipe consists of a small tube with evaporator and condenser at both its ends.. A PHP consists of a tube which is structured in a serpentine manner with a number of turns. The detailed comparison is given below.

CONVENTIONAL HEAT PIPE	**PULSATING HEAT PIPE**
Wick structure for fluid transfer	Slug- plug formation of fluid for fluid transfer
Conduction and phase transfer are responsible for heat transfer	Conduction and pulsating action are responsible for phase transfer
Gravity force acts as main driving force for fluid flow	Vapor bubbles formed acts as driving force for fluid flow
Heat pipe can be a single pipe with a Condenser and an evaporator	A pulsating heat pipe must have few number of turns for pulsating action to occur
Counter flow of liquid and vapor occurs	Counter flow of liquid and vapor does not occur as there is no wick structure

TABLE1 COMPARISION OF HEAT PIPES

2. LITERATURE REVIEW

In the 1990's, Akachi *proposed* the pulsating heat pipe. According to Akachi, [7]PHP is- "when one end of the bundle of turns of the undulating capillary tube is subjected to high temperature, the working fluid inside temperature increases the vapor pressure which causes the bubble in the evaporator zone to grow. This pushes the liquid column towards the low temperature end.

The condensation at the low temperature end will further increase the pressure difference between the two ends. Because of interconnection of tubes, motion of the fluid slug and the vapor bubbles at one end section of tube towards the condenser also leads to the motion of slugs and bubbles in the next section to the high temperature end. This works as a restoring force. The interplay between the driving force and restoring force leads to oscillation of the vapor bubbles and liquid slugs in the axial direction. Khandekar and Groll studied effect of number of turns on the performance of the device [1]. Their study states that gravity effects in systems with low number of turns. Khandekar and Groll also observed the stop over phenomenon and came to the conclusion that a minimum number of turns are mandatory for the PHP device to work [6].
Akachi. Studied the closed loop PHP and proposed that a closed loop PHP with check valves is the most effective heat transfer device [7]. It has a simple structure and fast thermal response.

3 CLASSIFICATION

Pulsating heat pipes can be classified into two types [1]

- open loop pulsating heat pipe (OLPHP)
- closed loop pulsating heat pipe (CLPHP

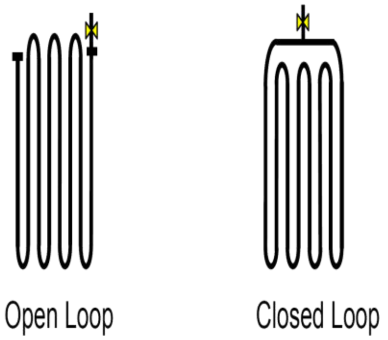

FIG1 CLASSIFICATION OF PHP

4.0 STRUCTURE OF CLPHP

PHP's consists of one evaporator zone, one condenser zone and an optional adiabatic zone. Sealed pipe or tube of a small internal diameter is taken. The material of the CLPHP should have high thermal conductivity such as copper, aluminum etc. This sealed tube is evacuated and then partially filled with the working fluid. The working fluid distributes itself into liquid plugs and vapor slugs inside the tube due to the heatflux provided at the evaporator.

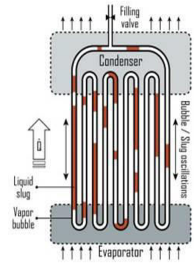

FIG 2 STRUCTURE OF CLPHP

4.1 PRINCIPLE OF HEAT TRANSFER

Performance of a PHP depends on the continuous maintenance of non-equilibrium conditions within the system. Due to the heat absorbed at the evaporator end, a temperature gradient is formed between both the evaporator and condenser zone[6]. The boiling and condensation heat transfer takes place towards the bubbles and plugs motion of the flow. As the liquid plugs move back and forth in the pipe sensible heat transfer take place between the wall and the fluid along with latent heat transfer. [5][3] There exists an asymmetric and different volumetric distribution of working fluid in each tube. This leads to imbalances in pressure resulting in a two phase flow of liquid-vapor plugs and slugs. The generating and collapsing bubbles act as the pumping elements for transporting the liquid plugs. This flow ultimately helps in the thermo fluidic transport and the heat transfer becomes a combination of sensible and latent heat portions. Continual generation of vapor bubbles from the evaporator and the condensation at the other end help in the formation of a sustained non-equilibrium oscillating state.

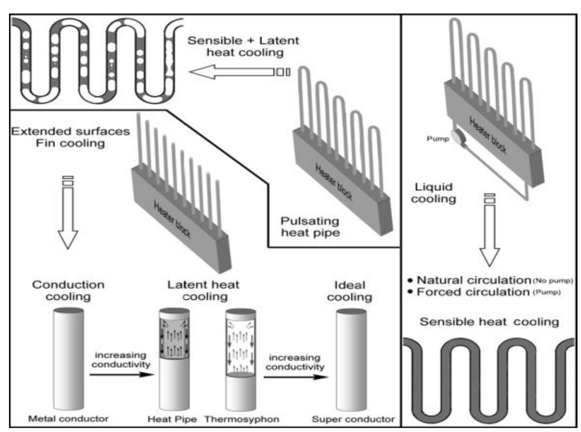

FIG3 COMPARISION OF VARIOUS HEAT TRANSFER TECHNOLOGIES

4.2 FLOW REGIMES

As the vapor pressure builds up in the evaporator zone due to the formation of tiny bubbles, the liquid above the bubbles gets pushed above. More amount of vapour is formed due to the continuously increasing heat input given to the evaporator. These small vapour bubbles start coming together to form larger bubbles and these bubbles, in turn, acquiesce and form into vapour slugs. Thus the flow regime changes from bubble to slug flow[10] . In this flow, both the liquid and the vapour phase co-exist with a definite interface between them. These liquid plugs and vapour slugs keep moving towards the condenser due to increasing pressure. This acts as the primary and driving force. The same mechanism takes place in the adjacent turns of the loop. This acts as the restoring force for the first tube. The simultaneous occurrence of the driving and restoring force leads to the pulsating or oscillating motion of the liquid-vapor plugs and slugs. This slug flow slowly transitions into a semi-annular/annular flow where the vapour slugs reduce in size and the velocity of the liquid plugs increases. The pressure drop in a slug flow is divided into

- Drop in liquid slug
- Drop around the ends of the bubble
- Drop along the body of the bubble

4.3 FACTORS AFFECTING THE PERFORMANCE OF CLPHP

- Internal diameter of PHP
- Input heat flux
- Working fluid
- Filling ratio
- Orientation of tubes
- Number of turns

4.3.1 DIAMETER AS PARAMETER

The pulsating action in the CLPHP is possible only to a certain range of internal diameter values [6]. The design rule is given by the critical bond number criterion.

$D_{cri} = 2\,(\sigma/g\,(\rho_l-\rho_v))^{0.5}$

$Bo = D_{cri} * (g\,(\rho_l-\rho_v)/\,\sigma)^{0.5}$

$Eö = [Bo]^2$

Eö: Eötvös Number
Bo: Bond Number
D: Internal diameter of tube
g: Acceleration due to gravity
ρ: Density
σ: Surface Tension

By following this criterion, there is no possibility of agglomeration of vapor bubbles. So the liquid plugs and vapor slugs are continually maintained. If diameter is increased beyond the critical diameter, the device will start acting like an interconnected array of two phase thermo syphon. If diameter is reduced below the critical diameter, dissipative losses increase and lead to poor performance.

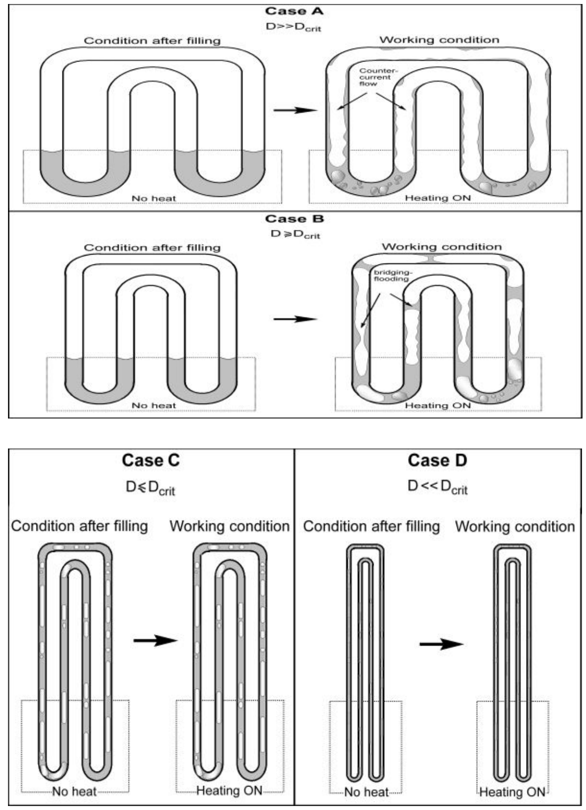

FIG4 EFFECT OF DIAMETER ON FLUID DISTRIBTION N TUBES

4.3.2 INPUT HEAT FLUX:

PHP's require high heat flux for good operation. The Heat flux applied effects the dynamics of the bubble growth and its sizes, flow perturbations and instabilities and also flow pattern in slug, annular and semiannual flows.

4.3.3 WORKING FLUID:

The properties of working fluid affect the formation of two phase flow and thus have to be considered as an important parameter [4, 9].

- High thermal conductivity.
- Low latent heat.
- High specific heat-.
- Low dynamic viscosity

The working fluids that are generally preferred are water, methanol, ethanol, Ethyl Alcohol etc.

4.3.4 FILLING RATIO:

For the CLPHP to work, the tube should be only partially filled with the working fluid. The volumetric filling ratio affects the performance of the PHP.. Therefore, the proper range of filling ratio is within 40% to 60%.

4.3.5 ORIENTATION OF TUBES:

Horizontal orientation of tubes does not give as good a performance as vertical orientation. Large number of turns supported by a high input heat flux tends to improve the performance of horizontal orientation of tubes in a CLPHP. The tubes may be inclined to 0 degrees, 30,45,60,90 and 180 degrees.

4.3.6 NUMBER OF TURNS:

There is a certain critical value for the number of turns below which stop over phenomenon occurs in a PHP.Therefore an optimum number of turns is necessary so that the level of perturbations and the pulsating motion inside the device increases. In general 5 to 23 turns can be used.

5.0 EXPERIMENTAL SETUP

5.1 MODELLING OF PHP

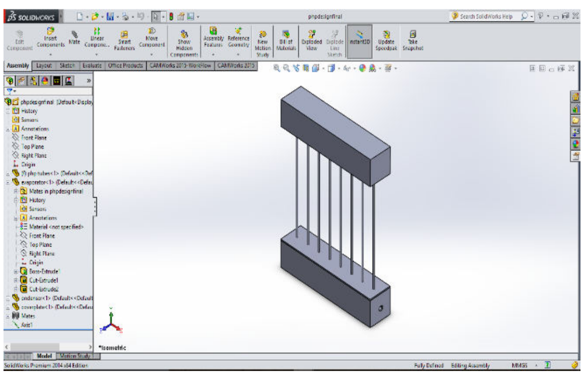

FIG5 DEIGN OF PHP IN SOLIDWORKS

The modelling is done by using solid works.
In this experiment we are first winding a tube of 4.7m length in a serpentine manner of four turns. The tube has an inner diameter of 4mm and an outer diameter of 6mm.This tube is then attached to the evaporator and condenser through suitable manufacturing process. The evaporator and condenser both are made up of stainless steel and have a dimension of 100x140x450.

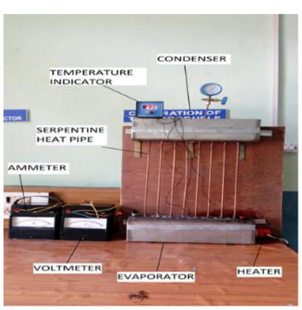

FIG6 EXPERIMENTAL SETUPOF PHP

Experiment is carried out to study the heat transfer performance of a Closed Loop Pulsating Heat pipe [CLPHP] and to study the temperature profile and the heat transfer rate at different sections [11]

Experiment is carried out for a number of iterations and a model calculation is given below

S.No	VOLTAGE	CURRENT	T_1	T_2	T_3	T_4	T_5	T_6
1	230	9.5	82	81	72	65	66	66

TABLE 2 EXPERIMENTAL READINGS

6.0 THERMAL ANALYSIS

The analysis of the project is done in ANSYS.

6.1 STEADY STATE THERMAL ANALYSIS

The feature that was used for analyzing the pulsating heat pipe is “Thermal Analysis” [5].
The analysis component system we used is Steady state – Thermal. A steady state thermal analysis calculates the effects of steady thermal loads on a system or component and can be used to determine temperatures, thermal gradients, heat flow rates and heat fluxes in an object that are caused by thermal loads which do not vary much with time. Such loads include convection, radiation, constant temperature boundaries etc.

The tasks involved in performing a steady state thermal analysis are

1. Building the model.
2. Applying loads and obtaining solution.
3. Reviewing the results.

6.2 BUILDING THE MODEL

The model is already built in the Solid works software. So it is simply imported into the workspace of Ansys steady state thermal.

6.3 Applying loads and obtaining solution

Then the model needs to be meshed for loading.. The tetrahedron 10 node element has been chosen as it is default for thermal analysis of solids. The meshing is performed on the object with fine sizing and high smoothing

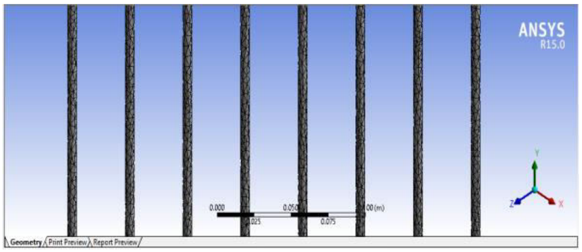

FIG6 MESHING OF PHP

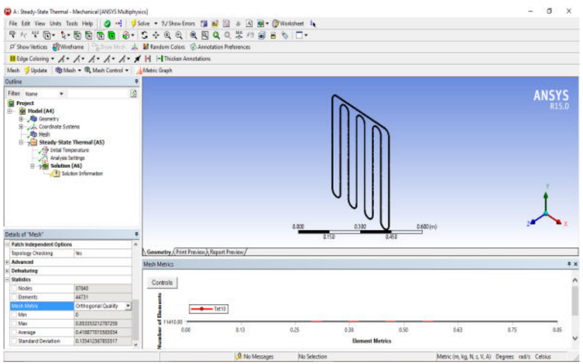

FIG7 NODES AND ELEMENTS AFTER MESHING

The number of nodes and elements formed are 87840 and 44731 respectively.

7.0 RESULTS

Apply boundary conditions and loads after meshing is done. The boundary conditions of 100°c in the evaporator zone and 30°c in the condenser zone are given along with the calculated value of heat flow due to convection which is 31.29W. These loads are applied to the given solid material made of copper material. After mentioning all boundary conditions required, the software is asked to solve the problem with the above constraints.

Reviewing the results

Once the solver gives the results, they can be checked by clicking on solution information. The solution of temperature distribution was found out. The temperature distribution contours are formed in the pipe.

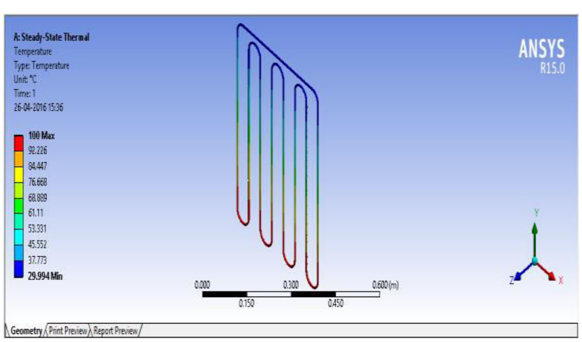

FIG8 CONTOURS OF TEMPERATURE DISTRIBUTION

As steady state was formed at a condenser zone temperature of 50°c, the temperature distribution contours are found for that too

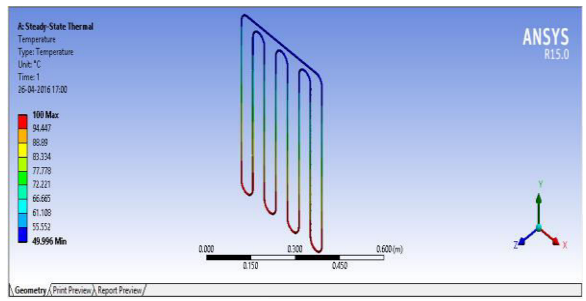

FIG9 TEMPERATURE DISTRIBUTION FOR 50°C

7.1 COMPARISON OF TEMPERATURE DISTRIBUTIONS

The temperature distributions that were achieved in various analyses of experimental, finite element and ansys are to be compared to validate the behavior and working of a pulsating heat pipe.

The temperature range from condenser to evaporator when steady state was achieved at a condenser zone temperature of 50°c is 66°c at the condenser part of PHP and 82°c at the evaporator zone of PHP. Steady state thermal analysis performed at 50°c gave the temperature contours ranging from 100°c to 50°c from evaporator to condenser.

	EXPERIMENTAL ANALYSIS	ANSYS THERMAL ANALYSIS
TEMPERATURE DISTRIBUTION RANGE FROM CONDENSER TO EVAPORATOR	66°c to 82°c	50°c to 100°c

TABLE4 COMPARISON OF ANALYSES RESULTS

7.2 COMPARISON OF EXPERIMENTAL RESULTS WITH LITERATURE SURVEY

In the paper,[8] “Thermal characteristics of an alumunum closed-loop pulsating heat pipe charged with ammonia” by Md Shahidul Haque and in “Thermal simulation of a pulsating heat pipe” by M.Mamelli, M.Marengo and S. Zinna, the behavior of temperature with time has been established under various differing factors and values[3]. It was observed that the evaporator temperature and condenser temperature increase with time. It can be observed in our experimental results and graphs that the evaporator and condenser temperature increase per every time step

PROPERTIES	WICKED HEAT PIPE (LITERATURE)	PULSATING HEAT PIPE (LITERATURE)	PULSATING HEAT PIPE (EXPERIMENTAL)
TEMPERATURE RANGE	Range of 30°c to 120°c	Range of 50°c to 160°c	56°c to 82°c
TOTAL POWER	Up to 200 W	Up to 3000 W	2160 W

TABLE5 COMPARISON WITH LITERATURE

8.0 CONCLUSIONS

1. PHP is a device which is comparatively a simpler and efficient heat transfer device.
2. By controlling the various factors affecting its performance, their performance can be improved.
3. The mathematical representation of the working of a PHP is not easily understandable due to its complex thermo hydrodynamic behavior.
4. PHP are useful in control of electronic and electrical devices and they are one of the best option in the thermal management.
5. PHP are having more efficiency than conventional heat pipes they are highly used in space applications.

9.0 FUTURE SCOPE

1. The experiments can be carried out with different working fluids such as ethanol, methanol, ethyl alcohol etc.
2. By changing amount of heat supplied value effective performance of PHP can be obtained.
3. The heat source can also be obtained from sun's radiation by using solar collector.
4. The number of tubes can be increased for better flow and efficiency.
5. The change in the tubes orientation is also used to improve efficiency of thermal systems.
6. The length of evaporator, condenser and adiabatic zones can be changed.

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A Review on Computer Aided Process Planning Technique in Casting Industries

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Abstract: *The cost reduction with High quality of product design based on CAD made by casting is very important task in the up to date competitive global market trends. This research represents an approach of Computer Aided Process Planning technique for reducing cost minimization and High quality improvement of casting based products in the Computer Integrated Manufacturing (CIM) environment area. Computer aided Process planning involves materials and machines for different steps, requirement of trained skilled labours & making the right process plan sheets used in casting process.*

This research will show an offline control of designing layout, production based & decision making process plans at the initial stages and thus enables starting prediction and prevention of manufacturing processes associated with the product design for reducing the cost of the designed products with improved High quality.

Keywords: *MCU, NC, Stereo- lithography, CAPP, CAD, CAM, CIM, FEM, Off-line control sheets,.*

1. INTRODUCTION

CAD/CAM (computer-aided design and computer aided manufacturing) refers to computer software that is used to both design and manufacture products.CAD is the use of computer technology for design and design documentation. CAD/CAM applications are used to both design a product and program manufacturing processes, specifically, CNC machining. CAM software uses the models and assemblies created in CAD software to generate tool paths that drive the machines that turn the designs into physical parts. CAD/CAM software is most often used for machining of prototypes and finished parts.

The current standard to program NC machine tools has had no significant change since the early 1950's when the first NC (numerical control) machine was developed at M.I.T. (Massachusetts Institute of Technology), U.S.A. These early NC machines and today's NC machines continue to use the same standard for programming namely G & M codes based on the ISO 6893 standard. Industrial world has witnessed significant improvements in product design and manufacturing since the advent of computer aided design (CAD) and computer aided manufacturing (CAM) technologies. Although CAD and CAM have been significantly developed over the last three decades, they have traditionally been treated as separate activities.

CAPP is a highly effective technology for discrete manufacturers with a significant number of products and process steps. The first step is the implementation of FT classification and coding. Commercially available software exists to support both GT and CAPP. As a result, many companies can achieve the benefits of GT and CAPP with minimum cost and risks.

***Parametric Design**:* In 1989 T-FLEX and later Pro/ENGINEER introduced CADs based on parametric engines. Parametric modeling means that the model is defined by parameters. A change of dimension values in one place also changes other dimensions to preserve relation of all elements in the design. MCAD systems introduced the concept of constraints that enable you to define relations between parts in assembly. Designers started to use a bottom-up approach when parts are created first and then assembled together. Modeling is more intuitive, precise and later analysis, especially kinematics easier.

Effective use of these tools can improve a manufacturer's competitive advantage too. Technological advances are reshaping the face of manufacturing, creating paperless manufacturing environments in which computer automated process planning (CAPP) will play a preeminent role. The two reasons for this effect are: costs are declining, which encourages partnerships between CAD and CAPP developers and access to manufacturing data is becoming easier to accomplish in multivendor environments. With the introduction of computers in design and manufacturing, the process planning part needed to be automated.

The shop trained people who were familiar with the details of machining and other processes were gradually retiring and these people would be unavailable in the future to do process planning. An alternative way of accomplishing this function was needed and Computer Aided Process Planning (CAPP) is an alternative. Computer aided process planning is usually considered to be a part of CAD.

However computer aided manufacturing is a standalone system. In fact a synergy results when CAM is combined with CAD to create a CAD/CAM system. In such a system CAPP becomes the direct connection between design and manufacturing. The goal is to find a useful reliable solution to a real manufacturing problem in a safer environment. If alternate plans exist, rating including safer conditions is used to select the best plans.

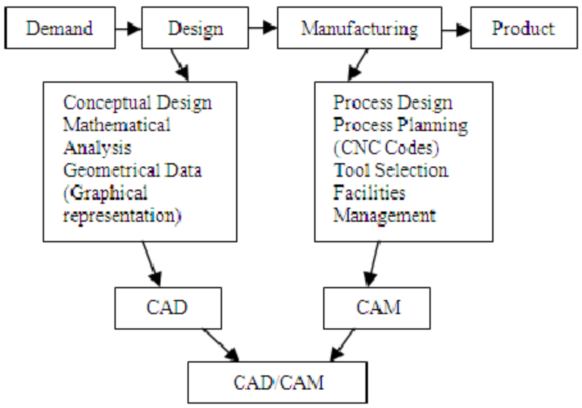

Figure: Structure of CAD/CAM

2. BACKGROUND

2.1 Computer Aided Design *(CAD)*:

A product must be defined before it can be casted. Computer Aided Design involves any type of design activity that makes use of the computer to develop, analyze or modify an engineering design. There are a number of fundamental reasons for implementing a computer aided design system, which may be proven as a better design.

- Increase the productivity of the designer: This is accomplished by helping the designer to visualize the product and its component subassemblies and parts; and by reducing the time required in synthesizing, analyzing, and documenting the design.
- This productivity improvement translates not only into lower design cost but also into shorter project completion times.
- To improve the quality of the design: A CAD system permits a more thorough engineering analysis and a larger number of design alternatives can be investigated.
- Design errors are also reduced through the greater accuracy provided by the system.

Figure: Machine Design

The following speculations are separated into strong probability of adoption, medium, and weak.

- CAD format standardization based on XML (Strong)
- Full virtual prototypes (strong)
- CAD specialization (strong)
- Real time ray tracing (strong)
- Development of open source CAD (medium)
- Small scale and rapid manufacturing (medium)
- Dynamic Physical Rendering (weak)
- CAD based on genetic programming (weak)

Some of the applications of this technology are:

- Production of drawings and design documents
- Visualization tool for generating shaded images and animated displays
- Engineering analysis of the geometric models
- Process planning and generation of NC part programs.

2.2 Computer Aided Manufacturing *(CAM):*

By the time computer use in design began, numerical control technology (NC technology) had matured to become cost effective for applications in casting and machining. An important aspect in numerical control is part-programming. A part-program is simply a set of statements comprehensible to the machine control unit (MCU) that oversees slide and tool movements and other auxiliary functions. In the case of components with complex geometries, many part programs had to carry out lengthy calculations for which it is logical to use computers.

This gave rise to machine control units (MCU) with built in microprocessors- the building blocks of computers. The use of computers in extending the applications of NC technology, especially to part-programming was earlier termed Computer Aided Machining (CAM) and the associated technology was called Computer Numerical Control (CNC). Later Computer Aided Machining became an acronym for Computer Aided Manufacturing (CAM). Earlier Computer Aided Manufacturing used to denote computer use in part-programming only. Today it means any non design function of manufacturing that is computer aided. In figure, CNC welding machine assisting in casting products.

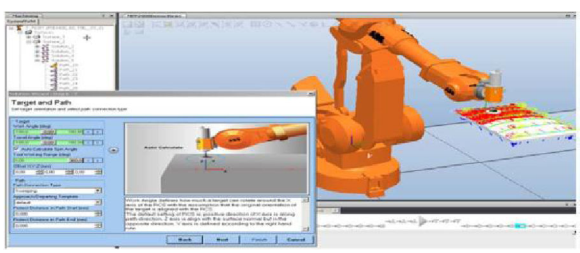

Figure: Design pattern using CAD/CAM

3. EXISTING SYSTEM

Computer Aided Process Planning *(CAPP):*

A number of cost reducing with estimation approaches are available today for estimating product cost at design stage with the reduction of cost. These include intuitive, analogical (Duverline and Castelain 1999, Wang et al. 2003) , analytical (Feng and Zhang 1999), feature based (Feng et al. 1996, Ou-Yang and Lin 1997) and parametric (DoD 1999, Farineau et al. 2001). The intuitive method is based on the experience of the estimator. Process planning translates design information into the process steps with instructions to efficiently and effectively manufacturing the products (figure: 3). As the design process is supported by many computer-aided tools, computer-aided process planning (CAPP) has evolved to simplify the process planning and achieve more effective use of manufacturing resources.

Process planning is concerned with determining the sequence of individual manufacturing operations needed to produce a given part or product. The resulting operation sequence is documented on a form typically referred to as a route sheet containing a listing of the production operations and associated machine tools for a work part or assembly. Process planning in manufacturing also refers to the planning of use of blanks, spare parts, packaging material, user instructions (manuals) etc.

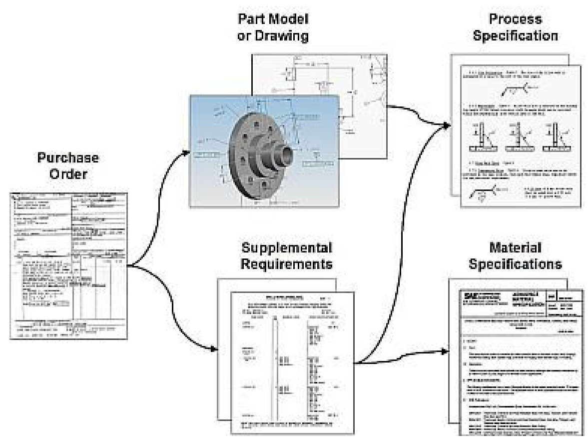

Figure: Computer Aided Process Planning

CAPP Benefits

Significant benefits can result from the implementation of CAPP. In a detailed survey of twenty-two large and small companies using generative-type CAPP systems, the following estimated cost savings were achieved:

- Reduced process planning and production Lead-time; faster response to engineering changes
- Greater process plan consistency; access to upto-Date information in a central database
- Improved cost estimating procedures and fewer Calculation errors
- More complete and detailed process plans
- Improved production scheduling and capacity Utilization

Improved ability to introduce manufacturing Technology and rapidly update process plans to

Utilize the improved technology. CAPP, thus, results to a highly effective technology for discrete manufacturers with a significant number of products and process steps. Rapid strides are being made to develop generative planning capabilities and incorporate CAPP into a computer-integrated manufacturing architecture. The first step is the implementation of GT or FT classification and coding.

Commercially-available software tools currently exist to support both GT and CAPP. As a result, many companies may achieve the benefits of GT and CAPP with minimal cost and risk. Effective use of these tools can collaborate to manufacturer's profit.

Finite Element Modeling (FEM)

FEM is a numerical technique to find out the approximate solution of partial differential equation (PDE) as well as of integral equation. The solution approach is based on eliminating the differential equation completely or rendering the PDE into an approximating system of ordinary differential equations, which are then numerically, integrated using standard techniques such as Euler's method or Runga-Kutta.

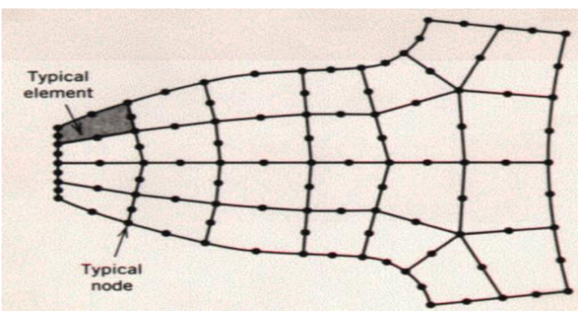

Figure: Finite Element Modeling

In FE modeling first we divide the whole structure is divided into pieces (elements and nodes) as shown in figure (4), after that behavior of physical quantities on each element is described. Further assembly of elements at the node to form an approximate system of equations for the whole structure is done. Solve the system of equations involving unknown quantities at the nodes (e.g., displacement) now at the end calculate desired quantities (e.g., strain and stresses) at selected elements.

FEM now days integrated with CAD software. FEM analysis allow user to virtually analyze or simulate the product with an actual conditions (stresses and actual forces). This will help designer to modify and optimize the design of product for the sake of increasing its reliability.

In figure Finite element analysis of a product is shown, here we can see how the stresses are generated and at hich portion stresses are maximum. By FE analysis we reached to the conclusion that the portion which has maximum stresses is most likely to fail. So we have to pay bit more attention to design this portion.

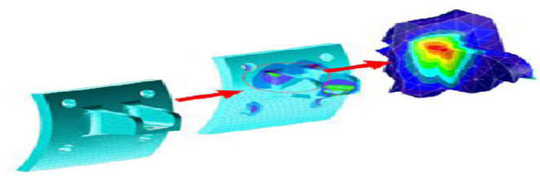

Figure: Finite Element Modeling process analysis

4. PRAPOSED SYSTEM K

Computer-aided design (CAD) involves creating computer models defined by geometrical parameters. These models typically appear on a computer monitor as a three-dimensional representation of a part or a system of parts, which can be readily altered by changing relevant parameters. CAD systems enable designers to view objects under a wide variety of representations and to test these objects by simulating real-world conditions.

Computer-aided manufacturing (CAM) uses geometrical design data to control automated machinery. CAM systems are associated with computer numerical control (CNC) or direct numerical control (DNC) systems. These systems differ from older forms of numerical control (NC) in that geometrical data are encoded mechanically. Since both CAD and CAM use computer-based methods for encoding geometrical data, it is possible for the processes of design and manufacture to be highly integrated. Computer-aided design and manufacturing systems are commonly referred to as CAD/CAM.

Commercial mechanical CAD/CAM packages provide a rather low level of automation of process planning tasks and a weak connection between their CAD and CAM/NC part programming modules. Automated process planning involves two important tasks; machining feature extraction and feature-based process planning. The CAD model of the part and the stock is exported via STEP from the commercial CAD system to an external machining feature recognition system.

The development of CAD and CAM and particularly the linkage between the two overcame traditional NC shortcomings in expense, ease of use, and speed by enabling the design and manufacture of a part to be undertaken using the same system of encoding geometrical data. This innovation greatly shortened the period between design and manufacture and greatly expanded the scope of production processes for which automated machinery could be economically used. Just as important, CAD/CAM gave the designer much more direct control over the production process, creating the possibility of completely integrated design and manufacturing processes.

The rapid growth in the use of CAD/CAM technologies after the early 1970s was made possible by the development of mass-produced silicon chips and the microprocessor, resulting in more readily affordable computers. As the price of computers continued to decline and their processing power improved, the use of CAD/CAM broadened from large firms using large-scale mass production techniques to firms of all sizes.

The scope of operations to which CAD/CAM was applied broadened as well. In addition to parts-shaping by traditional machine tool processes such as stamping, drilling, milling, and grinding, CAD/CAM has come to be used by firms involved in producing consumer electronics, electronic components, molded plastics, and a host of other products. Computers are also used to control a number of manufacturing processes (such as chemical processing) that are not strictly defined as CAM because the control data are not based on geometrical parameters

5.RESULT

Casting Methodology for improvement of Quality with Cost Reduction

For carrying out efficient solid modeling of casting process the software application would require the facetted model in stereo lithography tessellated language format. This format would make the representation to be given as input in a simpler and efficient way. The stereo lithography tessellated language format also helps in generation of mesh which further helps in the process of analyzing stresses, filling of moulds and during solidification of castings. Proper care and steps must be taken to speed up the process of analysis.

In this direction to name one could be to remove minute filets in model before transferring the stereo lithography tessellated language file. The above steps help in reducing the file size and there by helps in achieving speed in analysis with efficiency in process by reducing the errors generated during analysis.

Software Used

The complete job estimation and castings are obtained By using software "K-form Project Manager v.2.5" This software includes a complete information starting from order in and order out in any organization working in CIM environment by using CAPP technique.

This enables the cost reduction with improved quality in the limited time period and also it forms the various route sheets which will be processed in the manufacturing unit for completion of the job step by step. So by using this software the time taken in the process can be minimize and also complete information is available on a single work-station in the organization, which can be managed by a single trained person. Hence it reduces the cost of administration required which directly effects the cost of the final product. The main inputs to the software are as follows:

- Part description with quantity and time of supply.
- Raw material required in casting as well as in Machining processes.
- Processes required step by step for making the Product.
- No. of skilled workers & staff with their wages.
- Other administrative expenses & overheads.

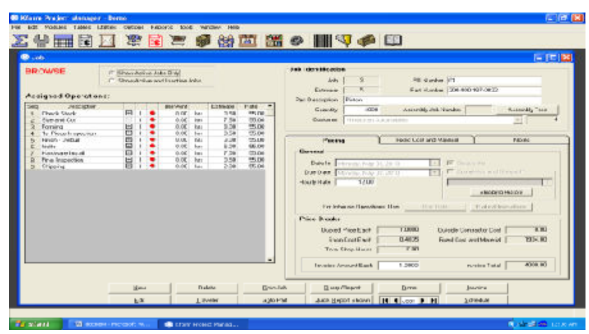

Figure: Result Analysis

By using the inputs, abovementioned, the software automatically prepares the estimate and costing of the products with the complete route sheet to be followed in the manufacturing unit at every stage of processing.

6. CONCLUSION

This research concludes that this approach to CAPP technique for cost reduction and quality improvement of casting products in the CIM environment is the requirement for the present and future competitive market for any organization. Because CAPP involves deciding the methods, materials and machines for various steps, requirement of trained labours & making the process plan sheets used in casting process at the early stage of the production of any casted product by using CAPP software at a single workstation.

Hence in this technique a very low administration is required, which directly affects the cost of the product. Also, the time taken at various products can be estimated & reduced at the early stages, so it increases the productibility of the organization with the reduction of the cost. Also at early stages, by using the casting analysis for the product to be cast reduces the cost of the product with improved quality.

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Heat Transfer design calculations in Combustion chamber of Torpedo Engine

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Abstract: *A heat transfer model has been developed that uses quasi-steady heat flux relations to calculate the heat transfer from combustion gases through the cylinder wall to the coolant in an internal combustion engine. The treatment of convective heat transfer accounts for the physical problems of rotating and impinging axial flow inside the engine cylinder. The radioactive heat transfer includes gas radiation (CO2, H20, and CO) and soot-particle radiation.*

Cylinder wall temperatures can be accurately predicted from this model for both the gas and the coolant sides. The present model's heat transfer results for the motoring case are in good agreement with results from empirical correlations based on instantaneous heat flux data. The calculated radiative heat flux and gas emissivity show reasonable agreement with data in the literature.

Keyword: *Heat, Tehrmo Dynamics, Cylinder Gas,TDC*

1.INTRODUCTION

In internal combustion (IC) engines, heat loss from combustion gases through the cylinder wall to the coolant strongly influences the thermodynamics of the engine cycle. This heat loss is an important part of the energy balance, which influences gas temperature and pressure, piston work, engine performance, and emissions.

HEAT TRANSFER MODEL

The physical system under consideration is quasi- steady, one-dimensional heat flow through the solid medium separating the cylinder gas and coolant.

The basic assumptions used with the present model are as follows:

- The coolant temperature is known.
- The cylinder wall comprises seven heat transfer areas (intake valve, exhaust valve, cylinder head, liner, piston top, cup wall, and cup bottom), each of which is at its uniform temperature and has its uniform heat flux at every instant of the cycle. (See Fig. 1.)

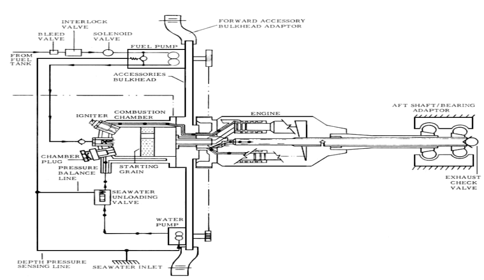


Figure.1: Schematic diagram of engine cylinder

- The convective heat transfer coefficients on both sides of the walls are uniform over each heat transfer area.
- The equivalent wall thickness at each heat transfer area is the same.

- The possible effects of surface scales or deposits on either side of the cylinder wall are not considered, and the heat losses through leaks at the valve seats or at the gap between the liner and the piston are neglected.

- The heat flow is quasi-steady, and the wall temperatures may be determined using simple network analysis.

2. EXISTING SYSTEM

The process by which heat is transferred from the cylinder gas through the wall to the coolant consists of three parts: convective and radioactive heat transfer from cylinder gas to combustion-chamber surface, conductive heat transfer through the cylinder wall, and convective heat transfer from the cylinder wall to the coolant.

Under the quasi-steady flow assumption, the heat flux is considered to be the same across each element:

$$\dot{q}/A = U\,(T_g - T_c) \quad (1)$$

$$= h_g\,(T_g - T_{wg}) \quad (2)$$

$$= k\,(T_{wg} - T_{wc})/\delta \quad (3)$$

$$= h_c\,(T_{wc} - T_c) \quad (4)$$

$$\frac{1}{U} = \frac{1}{h_g} + \frac{\delta}{k} + \frac{1}{h_c} \quad (5)$$

$$\dot{q}(\theta) = \sum_i h_{gi}\,[T_g(\theta) - T_{wgi}(\theta)]\,A_i \quad (6)$$

$$\dot{Q} = \int_0^{720^\circ} \dot{q}(\theta)\,d\theta \quad (7)$$

$$h_{gc}R/k_g = 0.0166\,Pr\,Re^{0.8} \quad (8)$$

$$h_{gc}/\rho_g CpV = 0.022\,Re^{-0.2}Pr^{-0.5}(T_g/T_{wg})^{-0.5} \quad (9)$$

where Re ($= \rho_g VD/\mu_g$) is a Reynolds number.

$$h_c D_o/k_c = (0.35 + 0.56\,Re^{0.52})\,Pr_c^{0.3} \quad (10)$$

$$h_c D_h/k_g = 1.012 \times 10^{-4}\,Re^{1.27} \quad (11)$$

$$h_c D_v/k_g = 0.54\,(Pr\,Gr)^{1/4} \text{ for } 10^4 \leq Pr\,Gr \leq 10^9 \quad (12)$$

$$h_c D_v/k_g = 0.14\,(Pr\,Gr)^{1/4} \text{ for } Pr\,Gr > 10^9 \quad (13)$$

3. PROPOSED SYSTEM

CONVECTIVE HEAT TRANSFER

Heat Transfer from Cylinder Gas to Walls:

A very fundamental rotating-disk flow and forced rotating-tube flow are considered for the calculation of heat transfer between the cylinder gas and the wall in swirl engines. For piston top and cylinder head, the turbulent flow over a disk rotating at constant speed about its axis is assumed. The analysis, based on Hartnett (6), is performed by integrating the continuity, momentum, and energy equations for the fully turbulent flow. The heat transfer coefficient, hgc , over the disk plate is written as follows:

where Re (= ρgR2ω/μg), Pr, kg and R are Reynolds number, Prandtl number, thermal conductivity of gas, and equivalent radius, respectively. For the liner and the piston-cup wall, the turbulent fluid flowing inside a pipe rotating about its longitudinal axis is assumed. The heat transfer coefficient is obtained from the results of Cannon and Kays (7):

Heat Transfer from Cylinder Wall to Coolant

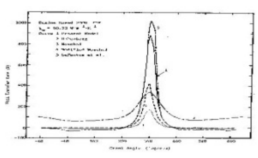
The heat transfer from the cylinder head and liner to the coolant is modeled by turbulent cross-flow forced convection. An average heat transfer over the cylindrical surface was correlated by McAdams for water and hydrocarbon oils (8).

where Prc, kc, Re (= ρcVcDO/μc), and DO are the Prandtl number of the coolant, thermal conductivity of the coolant, Reynolds number, and outside diameter of the engine cylinder, respectively. Vc is a mean velocity of the coolant.

The heat transfer from the back surface of the valve to the inlet gas is treated differently during the periods when the valves are open and closed. When the valve is open, the correlation of Kapadia and Borman is used for the heat transfer from the back surface of an open valve to the flowing air, based on steady-flow analysis and experiment (9):

where Re (= MDh/µgAe), M, Dh and Ae are Reynolds num- ber, mass flow rate, hydraulic diameter, and effective flow area, respectively. When the valve is closed, the heat transfer is treated as natural convective heat transfer over a horizontal plate facing upward. The empirical correlations to be used are given in Eqs. 12 and 13, taken from Rohsenow and Hartnett (10):where Gr and Dv are Grashof number and valve diameter, respectively.

The heat transfer from the piston wall to the lubricating oil depends on the movement of oil, the amount of oil in the cooling cavity, etc. Due to this complexity, the heat transfer coefficient in the oil side is assumed to be 2400 W•m-2•K-1, and the oil temperature is assumed to be 366 K (11, 12).



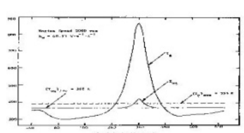


Figure.2: Comparison of Heat Transfer Rates

4.RESULTS AND DISCUSSION

In order to calculate the heat transfer in a reciprocating IC engine, an engine cycle simulation code was incorporated with the present heat transfer model.

Figure 2 shows the heat transfer rates for the motoring case calculated by the present model and under the same engine geometry and comparable conditions, using the empirical correlations available in the literature. The present (model) results are in good agreement with those of the LeFeuvre model (3), and LeFeuvre's correlation is known 4 to be good for the motoring case. LeFeuvre et al. applied Dorfman's rotational- and turbulent flow concepts (16) to correlate their instantaneous temperature and heat flux measurements with the analytical predictions.

The present results and the results using Woschni's model (1) are in reasonable agreement for the intake and exhaust periods. Woschni's model required an average wall temperature for several cycles. Although his empirical equation was based on the turbulent flow in the duct, it required several constants that were determined by the engine geometry and operating conditions.

The peak heat transfer rate of the present model is about five times higher than that of Woschni's model. This may be due to the omission of swirl, which is important in compression and expansion processes, in his equation. Woschni's equation was modified by Hiraki to consider the swirl of the gas inside the combustion chamber (17). The results are shown on curve 4 of Fig. 2, which displays a better fit to that of the present model. Hohenberg claimed that his heat transfer calculation (2) was precise due to his accurate surface temperature, combustion pressure, and heat flux measurements.

His heat transfer correlation required the mean velocity, mean wall temperature, and mean gas temperature during the cycle calculation; because of this averaging process, his results could be expected to be higher at intake and exhaust processes and to be lower at compression and expansion processes than the results obtained using the present model; these trends are observable on curve 2 of Fig. 2.

The majority of the above mentioned correlations, except LeFeuvre's, are not based on instantaneous data but on time-averaged data. Although LeFeuvre's correlation can predict the instantaneous heat flux, it is highly dependent on the engine geometry and operating conditions. The present model can also predict the instantaneous heat flux by using very physical fundamentals to calculate convection and a basic spectral absorption model to calculate radiation.

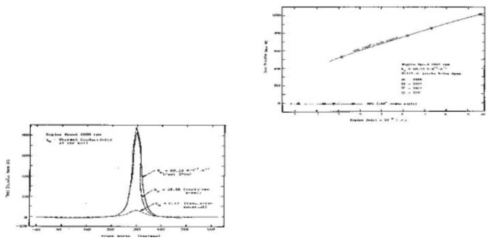


Figure. 3 Wall- and Gas-Temperature Histories

Figure 3 shows the histories of the gas and wall temperatures for the entire cycle. Note that (Twg)ave and (Tg)ave are the averaged wall and gas temperatures, respectively, over the entire cycle.

The calculated gas emissivities and radioactive heat fluxes obtained using the present model and those obtained from the measurements by Flynn et al. (5) are compared in Table 1. Flynn et al. performed a detailed investigation of radioactive heat flux in a diesel engine. They studied the radiative heat flux by varying a number of operating conditions, such as engine speed, fuel-to-air ratio, fuel- injection timing, fuel type, etc.

The radiation intensity was measured at seven wavelengths by using an infrared detector and an infrared monochromatic. Only those data obtained using No. 2 diesel oil were compared. In order to compare the present calculated radiation results with those of Flynn et al., two important parameters mean beam length and concentrations of gas species are required.

The value of the mean beam length was taken as 3.6 times the ratio of cylinder gas volume to its surface area based on Flynn's test engine at top dead center (TDC). The concentrations of the gas species and the in-cylinder pressures were obtained from the engine cycle simulation code, based on the values of peak gas temperatures and the equivalence ratios from Flynn et al.

The reported maximum wall temperatures (5), which were assumed to occur at the same time (or crank angle) as the peak gas temperatures for the present calculations, were also used for the present comparison. The calculated and measured gas emissivities were in reasonable agreement (within 10%).

The heat fluxes calculated by using the present model are also in reasonable agreement with the measured values, except for run no. 54 at an engine speed of 1010 rpm.

5. CONCLUSIONS

A heat transfer model that uses quasi-steady heat flux relations to calculate the heat transfer from combustion gases to the coolant in IC engines has been developed. The treatment of convective heat transfer accounts for the physical problems of rotating and impinging axial flow inside the engine cylinder. The radioactive heat transfer includes gas radiation (CO2 , H2O, and CO) and soot-particle radiation. The wall temperatures can be accurately predicted from this model for both the gas and coolant sides of the combustion-chamber walls.

The heat transfer results of the present model for the motoring case are in good agreement with those of LeFeuvre's empirical correlation, which was obtained from instantaneous heat flux data. The calculated radioactive heat flux and gas emissivity show reasonable agreement with those based on Flynn's measurements.

The present model is a step toward analysis of the thermal effects in engines and of cooling systems. The model can be used to study the effects of a number of parameters on heat transfer and wall temperatures for example, the effects of in-cylinder flows and of wall thickness and wall materials.

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He has 14+Years good Teaching Experience and has a good Knowledge on Robotics, Artificial Intelligence, Mechatronics, CAD/CAM, DOM, DMM and ICG.

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He is guided 90+ PG/UG Projects in various Subject concerns. He is the member of IJMET, IJMME, IJERT, and IJAME.

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About MRGI

Malla Reddy group of institutions is one of the biggest conglomerates of hi-tech professional educational institutions in the state of Telangana, established in 2001 sprawling over 200 acres of land. The group is dedicated to impart quality professional education like pharmacy, Engineering & Technology, MCA, MBA courses. Our sole objective is to turn out high caliber professionals from those students who join us.

About MRCE

Malla Reddy College of Engineering (Formerly CM Engineering College) has been established under the aegis of the Malla Reddy Group of institutions in the year 2005, a majestic empire, founded by chairman Sri. Ch. Malla Reddy Garu. He has been in the field of education for the last 22 years with the intention of spearheading quality education among children from the school level itself. Malla Reddy College of Engineering has been laid upon a very strong foundation and has ever since been excelling in every aspect. The bricks of this able institute are certainly the adept management, the experienced faculty, the selfless non-teaching staff and of course the students.

About Conference

ICTIMES started long back with its banner to promote the vision of future technologies that change the trends of life on this planet earth. Under this banner, the Department of Mechanical Engineering at MRCE organizes the ICFTME-International Conference on Future Technologies in Mechanical Engineering to provide a scholarly platform to ignite the spirit of research and bring out the latent potential in teaching fraternity and student community. ICFTME accommodates major areas like, Thermal Engineering, Design Engineering, Materials Science and Manufacturing Technology, CAD/CAM/CIM, I.C. Engines and Fluid Mechanics.

ICFTME Focuses to identify the innovations in Energy development and Conservation, innovations in new materials and their applications, creative design concepts and advanced methods of analysis of complex systems and components and research in alternate fuels for sustainability.