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EXPLICITDESIGNANDANALYSISOFEVCARBODY

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ABSTRACT:

Tominimizethedamageduringcaraccidents,thesolidityofthecarbodystructuremust be a priority for the automotive industry. An important factor used in determining thecrashworthiness of an automobile vehicle during impact is its strength. In designing, a carstructure should have the property of protecting or reducing the level of damage done to thedriver and the car body, by absorbing the impacted load and reducing the stress values. Thefrontal side of a car is more liable to high energy impact and deformation during a crash. Thispaper provides the simulation and analysis of a car body crash impact using Explicit Dynamicsin ANSYS workbench. This work aims to analyse the possibility of replacing conventionalmaterial used in car bodies by establishing the best suitable composite material in order toprovide strength, rigidity, crashworthiness, safety, lightweight, improve the fuel efficiency ofcars.Inthisproject,wewilldesignacarbody structureandsolidconcretewallbyusingCATIAV5 software and perform crash analysis on the car body in ANSYS workbench software byExplicit Dynamics module by usingdifferent materials in thecarbody atdifferent speeds ofthe car. The behaviour of automotive car structure is analysed by evaluating equivalent strain,equivalentstressandtotaldeformation. OptimizationofvariousparametersisdoneusingTaguchitechnique.

INTRODUCTION

Electric vehicles (EVs) have gained significant attention in recent years as a sustainableand Environment friendly alternative to traditional Internal Combustion Engine (ICE) vehicles.One of the critical components of an EV is it’s body, which plays a pivotal role in ensuring thevechicle’s performance, safety and efficiency. In this context, the design and material selectionforEVbodiesare ofparamount importance.

The"ExplicitDesignandAnalysisofEVCarBody"projectaimstoaddressthegrowingdemandforelectricvehicles (EVs)byfocusing onthecriticalaspectofcar bodydesignandanalysis.Withtheincreasingemphasisonsustainabilityandreducingcarbonemissions,theautomotiveindustryisexperiencingasignificantshifttowardselectricpropulsionsystems.Asaresult,thereisapressingneedforinnovativeapproachestodesignandoptimizethestructuralintegrity,aerodynamicsandoverallperformanceofEVcarbodies.Thisproject seekstoexploretheunique challenges and opportunities associated withdesigningcarbodiesspecificallytailoredforelectricvehicles.Itwillencompassvariousaspectsofthedesignprocess,includingconceptualization,modeling,simulationandanalysis,withtheultimategoalofdevelopinganoptimizedcarbodydesignthatmeetsthestringent requirementsofEVperformance,safetyandefficiency.

DISADVANTAGES:

Computational Complexity: Simulating explicit crash scenarios with varying materials andspeedscanbe computationallyintensive, requiringsignificantcomputational resourcesandtime.

Modelling Assumptions: Simplifications and assumptions made in the simulation modelmay impact the accuracy of results, requiring validation against experimental data or real-worldtests.

MaterialCharacterization: Accuratelyrepresentingmaterialbehavior,includingnonlinearities, strain rates and failure modes, requires detailed material characterization, whichcanbechallengingandtime-consuming.

SkillandExpertise: Effectiveimplementationofexplicitanalysistechniquesrequiresspecializedknowledgeandexpertiseinfiniteelementanalysis,materialscienceandcrashworthinessprinciples.

Interpretation of Results: Interpreting and translating simulation results into actionabledesign changes can be complex, requiring careful analysis and understanding of the underlyingphysicsandengineeringprinciples.

ADVANTAGES:

Enhanced Safety: Explicit design and analysis allow for detailed simulations of car bodystructures, helping engineers identify potential weak points and optimize safety features toprotectoccupantsduringcrashes.

MaterialOptimization:Bysimulatingthebehaviourofdifferentmaterialsatvariousspeeds

, engineers can identify the most suitable materials for specific components of the carbody,balancingfactorssuchasweight,strengthandcost.

Performance Prediction: Explicit analysis provides insights into how the car body willbehave under different collision scenarios, enabling engineers to predict performance metricssuchasdeformation,stressdistributionandenergyabsorption.

Iterative Design Process: The ability to quickly iterate on design variations and simulatetheir performance accelerates the development process,allowing for rapid prototyping andoptimizationofcarbodystructures.

Cost Savings: By identifying potential issues and optimizing designs through simulation,explicit analysis can lead to cost savings by reducing the need for physical prototypes andminimizingmaterialwaste**.**

LITERATURE SURVEY

Usama Idrees et. al. : In this paper the work is mainly based on Researchers haveproposedanoptimalmaterialforautoframes,usinglightermaterial'AL-7075T6'.Thealuminium alloy has a higher strength-to-weight ratio, affecting fuel consumption. Simulationsshowed that the deformation in the passenger zone increases with impact velocity but does notexceed the critical limit to harm the passenger. The alloy is 40% lighter by weight and moreeffectiveinstrengthandimpactsenergyabsorption.

Soniya Patil et.al.: In this paper the work is mainly based on the study shows that vehicledeformation is linked to collision time, with dynamic cars experiencing higher deformation.Optimizing aluminium sheet design is crucial for high stress and deformation. Composite carsare lighter, while stainless steel cars have better crash withstand values. Future research shouldusehybridmaterials.

Saumyaa Sinha et.al.: In this paper the work is mainly based on the results of this analysisprove why Composites are a better choice when it comes to selection of low weight and highstrength materials. The comparison between the three materials taken in this study- AMMC,Aluminium Alloy 6061and AISI 1045, shows that Al Alloy and AMMC are superior to AISI1045intermsoftheirstructuralstrengthanddeformationresistance. AMMCsupersedesAluminium Alloy because it is more lightweight and it can thus be inferred that AMMC is themostsuitable material for the frontal structure ofa car for theprotection of the vehicle itselfanditsinternalcomponents,passengersinsideandpedestrians.

Babalu Kumar et.al.: In this paper the work is mainly based on the crash analysis showsthat at 60 km/hr., carbon fiber reinforced polypropylene has the highest equivalent stress andleast strain among all materials. At 90 km/hr., GFRP, glass fiber reinforced polypropylene andpolyester show similar deformation. At 120 km/hr., CFRP provides more safety, reduces fuelconsumptionandhashighstrengthatleast weight. **Aisha Muhammad et.al.:** In these journal highlights is the study reveals that hybrid andelectric vehicles demand lighter bodyweights. A frontal crash simulation at 35m/s shows carbodies experience moreimpactwhen collidingwithmovingcars,static vehiclesandstaticwalls.Optimizingaluminiumsheetsdesignforhighstressanddeformationisrecommended.

L Praveen et.al.: This paper study examines car crash mechanisms using various compositematerials. A car hatchback body is designed with a rectangular concrete wall using Solid Works2016 software. Four materials are used: aluminium alloy, aluminium metal matrix (KS1275),Kevlar-49 and High strength carbon fiber. Crash analysis is performed at three different speedsand materials. Kevlar-49 shows the least stress value at 50km/hr., 100km/hr. and 150km/hr.,providing more safety and reducing fuel consumption. Kevlar-49 is the best material for carbodies,offeringmaximumsafetyandminimalweight.

VivekDayalet.al.: In this paper the work is mainly basedonAfrontalcarcrashsimulationof Suzuki swiftcar bodyusing structural steeland aluminium alloy wasconducted usingANSYSv19.Resultsshowedtotaldeformationincreaseswithspeed,continuousretardationand increased equivalent stress. Structural steel had higher stress values than aluminium alloy,while aluminiumalloy had only35% stress.

C. SaiKiranet.al.: This paper models a car structure using SOLIDWORKS and performsa crash analysis using ANSYS software. The total deformation of the car structure is analysedandtheresultsshowthatthemaximumdeformationsincarstructurescrashingacarandwallarewithinlimits.Thissuggeststhatthemodelledcarstructureissafeforpassengerstotravelin case of car accidents. Future research could involve modelling different car body structuresandmaterialsusingdifferentvelocitiesforcrashanalysis.

RELATED WORK

CATIA V5,themaindivisions, alsoknown as workbenchesor modules,covervariousaspectsofmechanical designandengineering.Herearesomeofthemaindivisions:

PartDesign:Thisworkbenchfocusesoncreatingandmodifying3Dsolidmodelsofindividual parts. It includes tools for sketching, extruding, revolving and filleting features tocreate complex partgeometries.

AssemblyDesign:AssemblyDesignworkbenchallowsuserstocreateandmanageassemblies of parts. It provides functionality for assembling components, defining relationshipsbetweenpartsandsimulatingmotionandinterferencechecks.

Generative Shape Design: This workbench offers advanced surface modelling tools forcreating freeform and organic shapes. It is commonly used in industrial design, styling andcreatingcomplex surfacegeometry.

Drafting:Draftingworkbenchisusedforcreating2Dengineeringdrawingsfrom3Dmodels. It includes tools for adding dimensions, annotations and other necessary details toproducedetailedmanufacturing drawings.

DMU Kinematics: Digital Mock-Up (DMU) Kinematics workbench is used for simulatingthe motion of mechanisms and assemblies. It allows users to define joints, constraints andmotionpathstoanalysethebehaviourofmovingparts.

DMU Space Analysis: This workbench provides tools for analysing the spatial relationshipsbetweencomponentsinanassembly.Itincludesfunctionalitiesforclearance analysis,interferencedetection andcollisionavoidance.

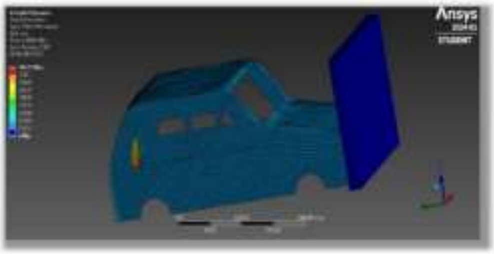
DMU Fitting Simulation: DMU Fitting Simulation workbench allows users to simulate theassembly and disassembly sequences of parts. It helps in evaluating the ease of assembly andidentifyingpotential interferenceissues.

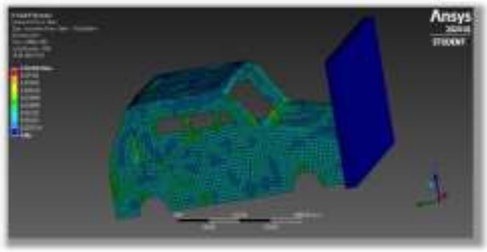
DMU Navigator: DMU Navigator workbench is used for navigating large assemblies andmanaging the visibility and organization of components. It provides tools for creating assemblystructures,arrangingcomponentsandcreatingexplodedviews.

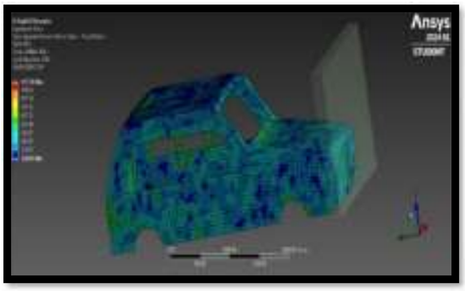
Sheet Metal Design: Sheet Metal Design workbench is used for designing sheet metalcomponents. It includes tools for creating bends, flanges and cutouts, as well as unfolding andflatteningsheetmetalparts.

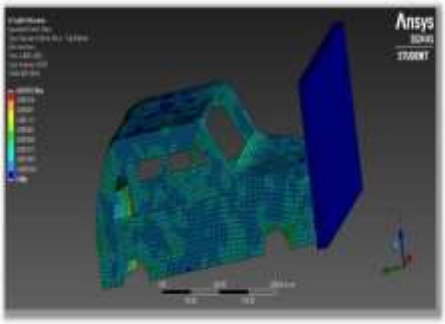
Wireframe and Surface Design: This workbench offers additional tools for creating andmodifyingwireframeandsurfacegeometry.Itincludesfunctionalitiesfor creatingcurves,surfacesandcomplexshapes.

SAMPLE RESULTS









CONCLUSION

Based on the results several conclusions are drawn regarding the performance of differentmaterialsatvariousspeeds:

Material Performance: The performance of the materials, namely Structural steel, Stainlesssteel and AMMC, varies significantly. AMMC consistently demonstrates superior performancecomparedtoStructuralsteeland Stainlesssteelacrossallspeedstested.

SpeedInfluence: Thereisanoticeableinfluenceofspeedontheperformanceofthematerials. Generally, higher speeds tend to result in lower S/N ratios, indicating decreasedperformance orincreasednoise relativetothesignal.

OptimalCombination: Amongthetestedcombinationsofmaterialsandspeeds,AMMCat a speedof60km/hr standsoutas the optimal combination,exhibiting the highest S/Nratio.Thissuggeststhat,forthespecifiedcriteriaorobjectives, AMMCperformsbestatthisparticularspeedcomparedtoothermaterialsandspeedstested.

REFERENCES

- Usama Idrees , Sajjad Ahmad, Imtiaz Alam Shah , Muhammad Talha , Rehman Shehzad,Muhammad Amjad, Seyed SaeidRahiaminKoloor, “FINITEELEMENT ANALYSISOFCARFRAMEFRONTALCRASHUSINGLIGHTWEIGHTMATERIALS”,JournalofEngineeringResearch,Elsevier,doi.org/10.1016/j.jer.2023.100007pp:1-9,2022.
- SoniyaPatil,RutujaWani,SudhakarUmale,“EXPLICITDYNAMICSCRASHANALYSIS OF CAR FOR DIFFERENT MATERIALS USING ANSYS”, InternationalResearch Journal of Engineering and Technology (IRJET), Volume: 09 Issue: 07, e-ISSN:2395-0056,p-ISSN:2395-0072,pp:2589-2596,2022.
- SaumyaaSinha,ShankarTewari,RohanDhawan,NarendiranathBabuT,D. RamaPrabha, “CRASH ANALYSIS OF THE FRONTAL STRUCTURE OF A CAR USINGEXPLICIT DYNAMICS”, Turkish JournalofComputerandMathematicsEducation,Vol.12No.14(2021),1627– 1634,pp:1627-1634,2021.
- Babalu Kumar, Suraj Sambhu Gupta, Rajeev Kumar, Ajay Kumar Verma, Om Prakash,“CRASHEVALUATION OFACOMPOSITECARBODYUSINGANSYSWORKBENCH15.2”,InternationalJournalofCreativeResearch Thoughts(IJCRT),Volume9,Issue 8,ISSN:2320-2882,pp:864-872,2021.
- AishaMuhammad,IbrahimHarunaShanono,“SIMULATIONOF ACARCRASHUSINGANSYS”,15thInternationalConferenceonElectronicsComputerandComputation(ICECCO2019),pp:1-5,2019.
- L Praveen, N Sandeep Kumar, “CRASH ANALYSIS OF A COMPOSITE CAR BODY”,IOPConferenceSeries:MaterialsScienceandEngineering,IOPPublishing,DOI:10.1088/1757-899X/455/1/012099,pp:1-6,2018.
- Vivek Dayal, Ashwani Sharma, M.A. Murtaza, “CRASH SIMULATION OF A CARBODY”,InternationalJournalofInnovativeResearchinScience,EngineeringandTechnology (IJIRSET),

Vol. 7, Issue 8, August 2018, ISSN(Online): 2319-8753 ISSN(Print):2347-6710,DOI:10.15680/IJIRSET.2018.0708005,pp:8521-8527,2018.