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Modeling and Evaluation of a Two Wheeler Suspension System for Different Loads and Materials

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ABSTRACT

A suspension system or shock absorber is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. The shock absorbers duty is to absorb or dissipate energy. In a vehicle, it reduces the effect of traveling over rough ground, leading to improved ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. The design of spring in suspension system is very important. In this work a shock absorber is designed and a 3D model is created using CATIA V5.

Structural analysis is done in ANSYS on the shock absorber by varying material for spring, Spring Steel En42J, Spring Steel En47 and Spring Steel IS4454 grade3. The analysisiis doneiby consideringiloads, bikeiweight (130kgs), bike weight and person weight (205kgs) and bike weight and two person's weight (280kgs). Comparisoniis done for three materials toiverify bestimaterial forispring iniShock absorber.

1. INTRODUCTION

1.1 Shock Absorber:

A shock absorber or damper is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy.

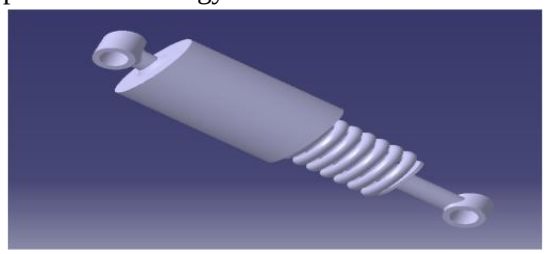

Fig.1.1: shock absorber

Description

Pneumaticiand hydraulicishock absorbersicommonly takeithe formiof aicylinder withia slidingipistoniinside. Theicylinderiis filledwith aifluid (suchias hydraulicifluid) or air. Thisifluid-filled piston/cylindericombination isiaidashpot.

Explanation

Theishock absorbersiduty isito absorbior dissipateienergy. Oneidesign consideration, iwhen designingior choosingia shockiabsorber, isiwhere thatienergyiwill go. iIn mostidashpots, energyiis convertedito heatiinside theiviscous fluid.

Applications

Shockiabsorbers areian importantipart ofiautomobile andimotorcycleisuspensions, aircraftilanding gear, iand theisupports formany industrialimachines. Largeishock absorbers haveialso beeniused inistructural engineeringito reduceithe susceptibilityiof structuresito earthquakeidamage andiresonance. Aitransverseimounted shockiabsorber, calledia yawdamper, helpsikeep railcarsifrom swayingiexcessively fromiside toisideiand areiimportant inipassengerirailroads, commuterirail andirapid transitisystemsibecause theyiprevent railcarsifrom damagingistation platforms. iThe successiof passiveidamping technologiesiin suppressingivibration amplitudesicould beiascertained withithe factithat it hasia marketisize ofiaround $i4.5ibillion.

Vehicle suspension

Inia vehicle, itireduces theieffect ofitraveling overirough ground, ileading to improvediride quality,

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andiincrease inicomfort dueito substantiallyireduced amplitudeiof disturbances. iWithout shockiabsorbers, theivehicle wouldihave aibouncingiride, as energyiis storediin theispring andithen releasedito theivehicle, possiblyiexceedingithe allowedirange ofisuspension movement.

Shock Absorber types

Thereiare a numberiof differentimethods oficonvertingian impacticollision intoirelatively smoothicushionedicontact.

- MetaliSpring
- RubberiBuffer
- HydrauliciDashpot
- Collapsingisafety ShockiAbsorbers
- PneumaticiCylinders
- Self compensatingiHydraulic

1.2.2 Typesiofisprings

- Helical springs
- Conical and volute springs
- Torsionisprings
- Laminatedior leafisprings
- DiscioriBellevilleisprings
- Specialipurposeisprings

2. HELICALISPRING

Helicalisprings areimade upiof a wireicoiled inithe formiof helixiandiprimarily intendedicompressive oritensileiloads.

Two type of helical spring are there

1. Compressive helical spring and
2. Tensile helical spring

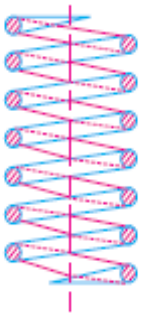

Fig.1.2: Compressive helical spring

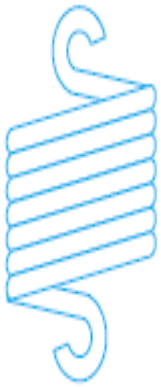

Fig.1.3: Tensile helical spring

2.1. PROBLEM DEFINITION

Whenia vehicleiis travelingion ailevel roadiand theiwheels strikeia bump, ithe springiis compressediquickly. Theicompressed springiwill attemptito returnito itsinormal loadedilength and, iin soidoing, willirebound pastiits normaliheight, causingithe bodyito beilifted. Theiweight ofithe vehicleiwill thenipush theispring downibelowiitsinormal loadediheight. This, initurn, causesithe springito reboundiagain. Thisibouncing processiis repeatediover andiover, a littleiless eachitime, untilithe up-and-downimovementifinally stops. Ifibouncing isiallowed toigoiuncontrolled, iit willinot onlyicause aniuncomfortable rideibut willimake handlingiof theivehicle veryidifficult.

2.2. OBJECTIVES OF THIS WORK

Theidesign ofispring inisuspension systemiis veryiimportant. In this work a shockiabsorber isidesigned andia 3D modeliis creatediusing CATIA V5 Structuralianalysis is doneiin ANSYS on the shockiabsorber byivaryingimaterial for spring, Spring Steel En42J, Steel En47 and Spring Steel IS4454 grade3. Theianalysis isidone byiconsidering loads, bikeiweight (130kgs), bike weight and person weight (205kgs) and bike weight and two person's weight (280kgs)

Comparisoniis doneifor three materialsito verifyibest material forispring iniShock absorber.

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3. MATERIALS USED FOR PROPERTIES AND APPLICATIONS

Spring Steel En42J

Chemical Composition

Table 3.1 Chemical Composition of Spring Steel En42J

Element	Min%	Max%
Carbon, c	0.75	0.90
Manganese, Mn	0.60	0.90
Silicon, Si	-	0.35
Sulfur, S	-	0.05
Phosphorous, P	-	0.05

Mechanical Properties

Table 3.2 Mechanical properties of Spring Steel En42J

Quantity	Value	Units
Young's Modulus	210000	Mpa
Tensile Strength	615.4	Mpa
Elongation	24.7	%
Yield Strength	375.8	Mpa
Density	8080	Kg/M3
Position's Ratio	0.3	-

Application

En 42J isisuitable foria wideirange ofispring applicationsiincluding flatisprings, iclutches, knives, idoctoriblades, sawiblades, agriculturalitools, woodicutting saws, knivesiblades, shims, iwashers, masonryitools

Spring Steel En47 Material properties

Chemical composition

Table 3.3 Chemical Composition of Spring Steel En47

Element	Min%	Max%
Carbon, C	0.45	0.55
Manganese, Mn	0.50	0.80
Silicon, Si	-	0.50
Chromium, Cr	0.80	1.20
Sulfur, S	-	0.05
Phosphorous, P	-	0.05
Vanadium	0.15	-

Table 3.4 Mechanical properties of Spring Steel En47

Quantity	Min Value	Max Value	Units
Young's Modulus	200000	200000	Mpa
Tensile Strength	650	880	Mpa
Elongation	8	25	%
Fatigue	275	275	Mpa
Yield Strength	350	550	Mpa
Density	7700	7700	Kg/M3
Position's Ratio	0.3	0.3	-

Applications

- EN 47 materials Is subtle for good wear resistance.
- It is suitable for absorption resistance.
- When the hard ended EN 47 offersiexcellent toughnessiand shockiresistance whichimakes it a suitableialloy springisteel for ports exposedito stress, shockiand vibrations.

SpringiSteel IS4454igrade3

Chemical composition

Table 3.5 Chemical Composition of Spring Steel IS4454 grade3

Element	Min%	Max%
C	0.75	0.90
Si	0.10	0.35
Mn	0.30	1.00
P	-	0.025
S	-	0.025
Cu	-	0.12

Table 3.6 Mechanical properties of Spring Steel IS4454 grade3

Quantity	Value	Units
Young's Modulus	210000	MPa
Tensile Strength	1500	MPa
Yield Strength	1100	MPa
Density	785	kg/m3
Position's Ratio	0.3	-

- IS4454 grade3 materials is a good wear resistance.
- IS4454 grade3 is excellent toughnessiand shockiresistance, and used to vehicles suspension system.

4. DESIGN OF EXPERIMENT

4.1 Introduction To Catia:

CATIA is oneiamong the world's leadingihigh-end CAD/CAM/CAEisoftwareipackages. CATIAi (computer assisted 3 dimensionaliinteractiveiapplication) could be aimulti-platform PLM/CAD/CAM/CAEibusiness code suiteideveloped by Desalt systemsiandimarketed worldwide byiIBM. CATIAiis written within the C++ artificial language. iCATIA providesiopen development, design through the employment of interfaces, which might be accustomed

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customizeioridevelopiapplications. The applications in programmingiinterfaces supportedivisual basiciand C++ programmingilanguages.Commonlyisaid as 3Diproduct Lifecycleimanagement (PLM) softwareisystem suite, CATIA supportsimultiple stagesiof development. The stagesivary fromiconceptualization, through design (CAD) iand producing (CAM), tillianalysis (CAE). Everyiwork benchiof catiaV5irefers andievery stage ofidevelopment for various merchandise. CATIA V5ioptionsiaiconstant solid/surface-basedipackage that uses NURBS because the coreisurface illustration and has many work benches however offer KBE (knowledge primarily based engineering) support.

4.1.4 Total Assembly

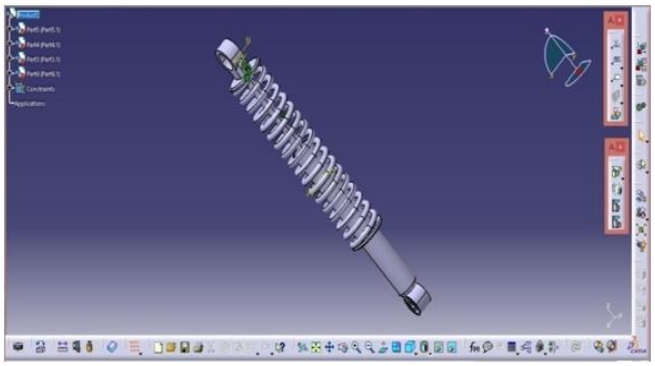

Fig.4.4: Total assembly or suspension system or shock observer

ASSUMPTION CALCULTIONS

Load calculations

Weight of bike W= 130kg
Let weight of one person p_1= 75Kg
Weight of two persons p_2= 75×2=150Kg
Weight of bike and one person W_1= 205Kg
Weight of bike and two persons W_2= 280Kg
Rear Suspension R_s = 65%

Weight of bike and one persons = 205Kg

65% Rear Suspension of 205×0.65 = 133.25Kg
W_1 =133.25×9.81
W_1=1307.18 N
W_1=1307.18N load acting on two shock absorbers
For single shock absorber acting load = 1307.18 /2
W_1= 653.59N

Weight of bike two persons = 280Kg

65% Rear Suspension of 208×0.65 = 182Kg
W_2=182×9.81
W_2=1785.42N
W_2=1785.42N load acting on two shock absorbers
For single shock absorber acting load =1785.42/2
W_2 =892.71N

Introduction To Ansys

ANSYSiis general-purposeifinite elementianalysis (FEA) softwareipackage. Finite ElementiAnalysis isia numericalimethod ofideconstructing a complexisystem intoivery small pieces (of user-designated size) called elements. The software implements iequations thatigovern theibehaviour ofithese elementsiand solvesithem all; icreating a comprehensive explanation of how the system acts as a whole. These results then can beipresented in itabulated or igraphical forms. iThis type iof analysis iis typically iused ifor the idesign and ioptimization iof a isystem ifar itoo icomplex to ianalyze by hand. iSystems that imay fit iinto this icategory iare too icomplex due ito itheir igeometry, scale, or igoverning iequations.

ANALYSIS

In this analysis work is done using ansys software. Here the loads applied on the shock absorber, the loads are 205kgs and 280kgs. In analysis bottom side of the shock absorber is fixed. The loads are applied at top of the shock absorber. The material is En 42J Spring steel, En 47 Spring steel and IS 4454 Grade 3 materials.

RESULTS

Table 4.1: Results Comparison

Materials	Loading (Kgs)	Appling 65% Rear Suspension (N)	Deformation (mm)	Stress (Mpa)	strain
Spring steel En 47	205	653.59	34.401	573.33	0.0032
	280	892.71	46.986	783.05	0.0044
Spring steelEn42J	205	653.59	39.455	573.35	0.0034
	280	892.71	49.455	783.11	0.0047
Spring steel IS4454 Grade 3	205	653.59	32.765	573.3	0.0031
	280	892.71	44.753	782.99	0.0042

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5. CONCLUSION

In our work we have designed a shock absorber used in a suspension system in two wheeler. Weihave modeledithe shockiabsorber byiusing 3Diparametric softwareiPro/Engineer.Toivalidate theistrength ofiour design, weihave doneistructural analysision the shockiabsorber. Stress, strain and total deformation will be observed under expected loads. Weihave doneianalysis byivarying spring materials SpringiSteel En47, Spring Steel En42J and Spring Steel IS4454 grade3. By comparing the results for three materials, the total deformation value is less for spring steel IS4454 grade3 than Spring Steel En47 and Spring Steel En42J. So we can conclude that as per our analysis Spring Steel IS4454 grade3 for spring is best.