RESEARCH ARTICLE OPEN ACCESS

Experimental Investigation of Torque Convertor Using Different Masses for Medium Duty Vehicles

Prasant Kumar Swain, Payal Behera,
Gandhi Institute of Excellent Technocrats, Bhubaneswar, India
Capital Engineering College, Bhubaneswar, Odisha, India

ABSTRACT: Mechanism transferring torque from one rotating shaft to another and in particular to a transmission mechanism that willenable an engine or motor to deliver power to a load at optimum torque and speed levels. The relationship between the stress andtransmissionwhich is based on the results of two different mass strategies with dynamometer and motor is constructed to test thetransmission to speed the results of those tests which shows the efficient at low input torque levels. To understand the descriptions of a newmechanism for design and construct a virtual prototype in the computer environment and finally to propose modifications to improve theoriginaldesign.
Keywords: InfinitelyVariableTransmission, NovelCam,VelocityTheorem,PositiveDrive

I. INTRODUCTION

The linear IVT is solving the problem in modern automobileindustry to develop new generation in vehicle to sustain. Theinput and output ratio in traction the linear IVT parameters tosustain the limited Two masses profile and masses the IVTinfinity check the depending upon various load condition ingear,clutch,TwomassesandTwomassesfollower.Thesuperior in automobile cycle, the linear IVT dissolve inputspeedtotheshafttractiontotheoutputshafttothetransmissionsolvertransmissionratio.Thedifferentinvestigators presents the background and theory related to theIVT,considersalternativedesigns,andpresentsthefinaldesign.It also outlines improvements for the IVT which willbeinstalledinautomobiles.

A two masses-based infinitely variable transmission systemallowsausertovarythespeedbetweeninput&outputprogressivelyfromonepositivevaluetoanother.Unlike,conventionaltransmissionstheselectionofgears isnotrestricted to a finite number of ratios. The two masses-basedinfinitelyvariabletransmissionsystemscanbeusedinautomobiledriveapplicationstoimproveperformance,economy&functionality.

Objectives

a) To Design & Development of Infinitely variabletransmissionbased onTorque convertor mechanism.
b) Experimentaltestingandtrialtoderivethefollowingperformancecharacteristics :
a)TorqueVsSpeed
c) Manufacturing experimental setup of torque convertor usingIVTsystem.

ResearchMethodology

a) Reviewofliteratureregardingtheworkdone.
b) AnalyticaldesignofIVT.
c) ManufacturingandassemblyoftheActualtestingset-up.
d) PerformexperimentaltestingonIVTwithdifferenttwomasses.
e) ResultandDiscussion.

II. ANALYTICAL ANALYSIS

1.1 DesignofMass-01:

The mass-01 is a link that is subjected to direct tensile load intheformofpull =48N material selection

Table1: Massno.1material

Material Designation	TensileStrength(N/ mm^2)	YieldStrength(N/ mm2)
EN9	600	380

Check for failure of mass under direct tensile load at the eyeend. This is the portion where the lever pin fits, the crosssectionalarea atthispointis288 mm^2 now,

I. FT =LOAD/AREA

Ftact= 48/288

=0.166/mm^2

II. ASFTACT<FTALL

Thelinkissafeundertensileload.

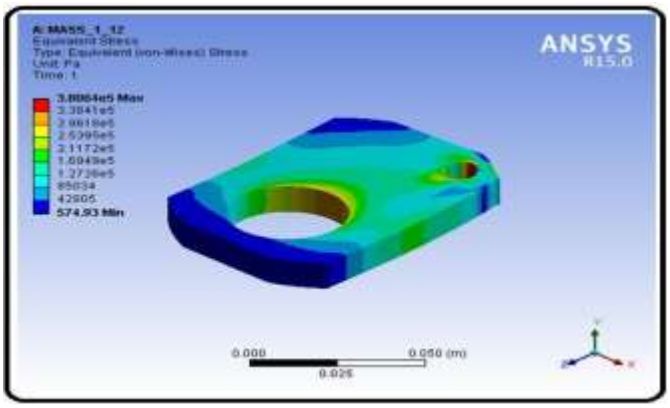


Figure1:FEAAnalysisofMassNo.1

Table2: Massno.1material

Sr.No	Thickness(mm)	Deformation (m)	Stress(Max)N/m^2
1	4	3.1398X10^{-7}	1.1923
2	6	2.0927X10^{-7}	8.246
3	8	1.5693X10^{-7}	5.896
4	10	1.2553X10^{-7}	4.811
5	12	1.0456X10^{-7}	3.8064

1.2 DesignofMass-02:

The mass -02 is a link that is subjected to direct tensile load intheformofpull = 48 N Material Selection:

Table3: Massno.2material

Material Designation	TensileStrength(N/ mm^2)	YieldStrength(N/ mm2)
EN9	600	380

Check for failure of mass under direct tensile load at the eyeend. This is the portion where the lever pin fits, the crosssectional area at thispointis576 mm^2,now

FT=LOAD/AREA FTACT=48/576

=0.0833N/mm2 ASFTACT<FT ALL

TheMassNo.2 issafeundertensileload.

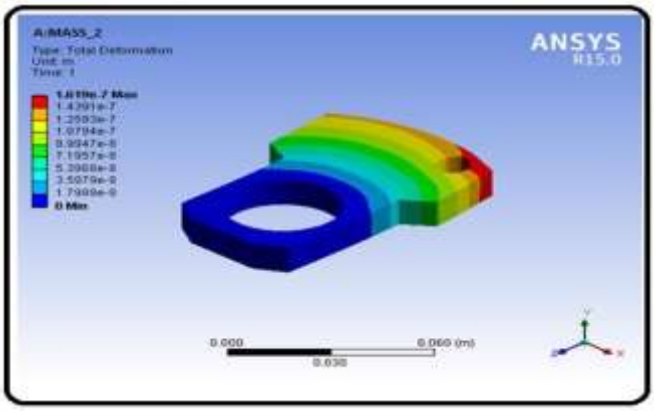


Figure2:FEAAnalysisofMassNo.2

Table4: Massno.2material

Consider,

N_2 = 520r.p.m.

$w = \frac{2\Pi N}{60}$

$w = \frac{(2)\times(\Pi)\times(520)}{60}$

= 54.45

But,

w^2 = 2965.09rad/sec

Also,

Rcc = 0.056

$D_{(lobe)}$ = 0.032

$T = m\times w^2\times Rcc\times D_{(lobe)}$

= 0.033639X2965.09X0.056X 0.032

= 0.18 N-m

Consider,

N_4 = 650r.p.m.

$w = \frac{2\Pi N}{60}$

$w = \frac{(2)\times(\Pi)\times(650)}{60}$

= 68.07

But,

w^2 = 4632.96rad/sec

Also,

Rcc = 0.056

$D_{(lobe)}$ = 0.032

III. ANALYTICAL CALCULATIONS

Observationdata:

FortheAnalyticalanalysisobservationdataaregivenbelow:

1]	Load(kg)	=	0.33
2]	Acceleration(m/s^2)	=	9.81
3]	Mass(kg)	=	0.033
4]	Radiusofmass(R_{cc})inmeter	=	0.056
5]	Radiusoflobe(R_l)inmeter	=	0.032

The maximum torque is given by the formula:$T = m*\omega^2*RCG*D(lobeoffset)$ (1)

Where,

T	:	Maximumtorque(N-m)
m	:	Masse(kg)
ω^2	:	Angularacceleration(m/s^2)
RCG	:	Radiusofoffsetmass
D(lobeoffset)	:	Radiusoflobe

SampleCalculationsformaximumtorquearegivenbelow:

Sr.No	Thickness(mm)	Deformation(m)	Stress (Max)N/m^2
1	4	4.8732X10-7	1.4766
2	6	3.248X10-7	0.5983
3	8	2.429X10-7	0.72404
4	10	1.944X10-7	0.57489
5	12	1.619X10-7	0.48529

T = $m \times w^2 \times Rcc \times D_{(lobe)}$ **2.ExperimentalResult:**

= 0.033639X4632.96X0.056X 0.032 Thefollowingtestresultswillbederivedfromthetestandtrial

= 0.28N-monIVTDrive.

IV. ANALYTICAL RESULTS

Thefollowinganalyticalresultswillbederivedfromcalculationsfor maximumtorqueisgivenbelow:

Table5: AnalyticalResults

Sr. No	Speed(rpm)	AngularSpeed		Torque(N-m)
		(w)	(w^2)	
1	380	39.79	1583.4	0.10
2	520	54.45	2965	0.18
3	535	56.02	3138.6	0.19
4	650	68.07	4632.9	0.28
5	850	89.01	7922.6	0.48
6	1050	109.9	12089.5	0.73

V. EXPERIMENTAL SETUP

ExperimentSetupoftorqueconverterinofIVTsystem:

TheIVTtestrigconsistsofthefollowingassemblygivebelow:

1. Motor
2. SpeedRegulator
3. ReductionPulley
4. BearingHousing-1
5. BearingHousing-2
6. Mass-InertiaIVT
7. Brake Dynamometer pulley
8. Baseframe

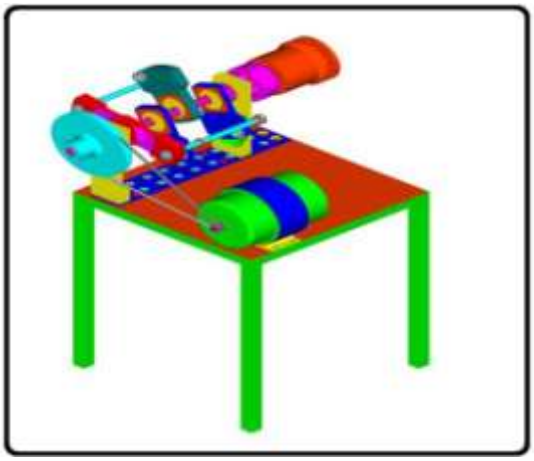


Figure3: ExperimentalSetupofmechanicaltorqueconvertorbyusingIVT

1.ExperimentalTestingProcedure:

a) Startmotorbyturningelectronicspeedvariatorkn ob.
b) Let mechanism run & stabilize at certain speed (say 2100rpm)
c) Place the pulley cord on dynobrake pulley and add 100 gmweight into, the pan, note down the output speed for this loadbymeans oftachometer.
d) Addanother100gmcut&takereading.
e) Tabulatethereadingsintheobservationtable
f) PlotTorque Vsspeed characteristic

Table6: ExperimentalResults

Sr.No	**Weight**	**Radius ofPulley**	**Speed**	**Angularspeed**	**Torque**
	(kg)	(m)	(rpm)	(w)	(N-m)
1	0.1	0.0375	2100	219.905	0.037
2	0.15	0.0375	1960	205.245	0.055
3	0.2	0.0375	1750	183.254	0.074
4	0.25	0.0375	1600	167.547	0.092
5	0.3	0.0375	1250	130.896	0.110
6	0.35	0.0375	1050	109.953	0.129

7	0.5	0.0375	810	84.8205	0.184
8	0.6	0.0375	650	68.0658	0.221
9	0.7	0.0375	535	56.0234	0.258
10	0.8	0.0375	520	54.4527	0.294
11	1	0.0375	380	39.7923	0.368

VI. RESULT AND DISCUSSION

Theresultsobtainedexperimentallyarecomparedtheoretically. The results are given in the form of tables. Alsothe results are comparedin the form of graphs. Hence theverification of proposed method is done by theoretically andexperimentally.

VII. SUMMARY OF RESULTS

Theresultcorrelationsummarized asshowintable7

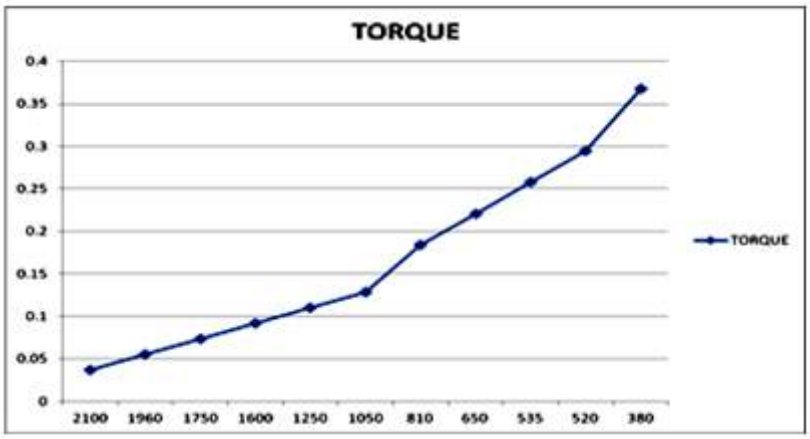
Table7:SummaryofResultscorrelationbetweentheoreticaland experimental

Sr.No	**Speed**	**Analytical Results Torque(N-m)**	**Experimental resultsTorque (N-m)**	**% error**
1	650	0.2793	0.2207	5
2	535	0.1892	0.2575	6
3	520	0.1787	0.2800	10

The error in prediction of IVT by theoretical analysis is therange of 3 to 4% and experimental analysis 5 to 20%. Thepropose method isconfirmed bythecomparingitwithresultofAnalytical and Experimental result. This is in well agreementtheacceptablelimit ±10%.

TorqueVsSpeedCharacteristics

Thefollowingtestresultswillbederivedfromthetestandtrialon IVTDrive:



GraphNo.1:SummaryofResultscorrelationbetweentheoreticaland experimental

VIII. CONCLUSION

The IVT is infinity variable transmission of input speed to theoutput speed in torque convert ratio will be change. In twomasses like Rectangular shape, irregular shape, the input shaftgiven the specific speed motor to the output result is varyingdifferentmassestodeterminetorqueconverter bytheInfinitelyVariable Transmission (IVT). The speed difference ratios aredesign criteria of IVT and development in torque in the massmomentandconvertdifferentmassesinlinearspeed.

Theerrorinpredictionoftorqueconverterbytheoreticalanalysisisintherangeof3%to15%andexperimentalanalysisitistherangeof5%to20%.Theproposedmethodis confirmed by comparing it with results of FEA results andexperimentalresults.Theproposedmethodisfound tobesimple and accurate. The IVT is newly concept in Light andMediumvehicleonautomobileindustriesisdevelopmentresearchtheyaretorqueconvertorinvariousmasseswithdifferent input speed to very output speed to give the moreefficientinoutput power.

FutureScope

In this transmission system to develop the maximum torqueandminimumoutputspeed.TheIVTdissolvethe

speedvariation in medium duty vehicleare used. But IVTis themore powerful as compared to CVT. The two masses profilefurther development of masses with mechanism, experimentalanalysis, FEA analysis. The linear repeated of the transmissionratio.Inanytechnologywithinherentben efitseventuallyreachtheIVThas onlyjust beguntoblossom.

REFERENCES

[1] Dr.N.Arunkumar,InfinitelyVariableTransmis sionUsingFourBarMechanism,InternationalJ ournalofEngineeringScienceandTechnology(IJEST)2014;6(4):170-176.

[2] DerekF.Lahr,DennisW.Hong,TheOperation AndKinematicAnalysisOfANovelCam-BasedInfinitelyVariable Transmission, ASME 2006 International DesignEngineeringTechnicalConferences& ComputersandInformation in Engineering Conference September 10-13,2006, Philadelphia, Pennsylvania, USA.

[3] GregoryF.Hickman,KinematicModelingand AnalysisofaCamBasedCVTForaCapstoneDe signProjectExperience,Proceedingsofthe201 3ASEENorth-CentralSectionConference,AmericanSociety forEngineeringEducation.

[4] Amjad M. Abood, A Novel Cam-Based Infinitly VariableTransmission, Journal Of K Erbala University, 2010; 8(4):61-74.

[5] GiuseppeCarbone,Modelling,Optimizationan dverificationofpowersplitinfinitelyvariabletr ansmissions,Ph.D.Dissertation,Northwestern University, 2009.

[6] RanbirSingh,abriefreviewoftransmissioninau tomobiles, International Journal of Latest Research inScience andTechnology, 2012; 1(2):222-226.

[7] Konstantin Ivanovo, A CAD Design of a New PlanetaryGearTransmission, International Journal Of InnovativeTechnologyandResearch, 2014; 4(2):1063-1067.

[8] F.G. Benitez, J.M. Madrigal, J.M. del Castillo, Infinitelyvariable transmission of Ratcheting drive type based onone-wayclutches,JournalofMechanicalDesign,Jul y2004; 126:673-682.

[9] F.A.Fitz,P.B.Pires,Agearedinfinitelyvariable transmission for automotive applications, SAE paper no.910407,1991:1-7.

[10] S.Matsumoto,N.Inoue,Y.Tsukada,Continuou slyvariable transmission forBicycles UnitedStates PatentApplication20030221892,2003.

[11] DouglasMagyari,InfinitelyVariableTransmis sioninPatentApplicationPublication,on01No vember, 1999.

[12] PeterEichenberger,DualRangeInfinitelyVari ableTransmission, Patent Application Publication, on 07 July,1988.

[13] WaynePaulBishop,PositiveDriveInfinitely VariableTransmission,PatentApplicationPub lication,04Auguest,2011.

[14] Lohr,Charles,Stevenson,Gregory,InfinitelyV ariableTransmissions, Methods, Assemblies, Subassemblies andComponents,PatentApplicationPublicatio n,10December, 2009.

[15] DieterHahne,InfinitelyVariableTransmission forAutomotiveVehicleDriveline,PatentAppli cationPublication, on21February,1984.

[16] PaulK.Coronel,DualConcentricPositivelyInfi nitelyVariable Rotary Motion Transmission, Patent ApplicationPublication, on16November,1992.

[17] Brian S. Andersen presented paper on An Investigation ofaPositiveEngagementContinuouslyVariabl eTransmission,BrighamYoungUniversity,Ha rryValentine, August 2005.

[18] E. Faulring, The cobotic hand controller: Design, controland analysis of a novel haptic display, Ph.D. Dissertation,NorthwesternUniversity,2005