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Performance Analysis of Composite Box Girder Using Ansys.Pro

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Abstract: *The Developments In Transportation Engineering Have Led To Several Researches On New Applications In Road And Bridge Constructions. This Paper Focuses On The Responses Of A Composite Box Girder. It Is A Comparative Study Of Performance Of Rectangular And Trapezoidal Composite Box Girder. Properties Of Concrete And Loading Of Analysis Are As Per Irc 18-2000 And Irc 21-2000. Load Of 70r Class Was Provided. Responses Like Deformation, Equivalent Stress, Normal Stress, Shear Stress And Moment Reaction Were Compared. Selection Of A Better Section Among Rectangular And Trapezoidal Was Done After Analysis The Results. Percentage Variation Of The Better One Is Also Provided In This Paper.*
Keywords – *Bridge, Girder Bridge, Box Girder Bridge, Composite Box Girder, Ansys. Pro*

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I. Introduction

A Bridge Is A Structure Built To Span Physical Obstacles Without Closing The Way Underneath Such As A Body Of Water, Valley, Or Road For The Purpose Of Providing Passage Over The Obstacle. There Are Many Different Designs That Each Serve A Particular Purpose And Apply To Different Situations. Designs Of Bridges Vary Depending On The Function Of The Bridge, The Nature Of The Terrain Where The Bridge Is Constructed And Anchored, The Materials Used To Make It And The Funds Available To Build It. Bridges Can Be Categorized In Several Different Ways. Common Categories Include The Type Of Structural Elements Used, And By What They Carry, Whether They Are Fixed Or Movable And By The Materials Used.

Bridges May Be Classified By How The Forces Of Tension, Compression, Bending, Torsion And Shear Are Distributed Through Their Structure. Most Bridges Will Employ All Of The Principal Forces To Some Degree, But Only A Few Will Predominate. Some Of Major Types Of Bridges Are Girder Bridge, Truss Bridge, Cantilever Bridge And Arch Bridge. A Girder Bridge Is Very Likely The Most Commonly Built And Utilized Bridge In The World. Its Basic Design, In The Simplest Form Can Be Compared To A Log Ranging From One Side To The Other Across A River. The Two Most Common Shapes Are Plate Girders And Box Girders. The Term “Girder” Is Often Used Interchangeably With “Beam”. A Beam May Be Made Of Concrete Or Steel. Many Shorter Bridges Especially In Rural Areas, Where They May Be Exposed To Water Overtopping And Corrosion, Utilize Concrete Box Girders. The Term “Girder” Is Typically Used To Refer To A Steel Beam. In A Beam Or Girder Bridge, The Beam Themselves Are The Primary Support For The Deck, And Are Responsible For Transferring The Load Down To The Foundation. Material, Type, Shape And Weight All Affect How Much Load A Beam Can Hold. Due To The Properties Of Inertia, The Height Of The Girder Is The Most Significant Factor To Affect Its Load Capacity. Longer Spans, More Traffic, Or Wider Spacing Of The Beam Will Directly Result In A Deeper Beam.

Major Three Types Of Girder Bridges Are Namely Rolled Steel Girder, Plate Girder And Box Girder Bridges. A Rolled Steel Girder Is A Girder That Has Been Fabricated By Rolling A Blank Cylinder Of Steel Through A Series Of Dies To Create The Desired Shape. These Create Standardized I-Beam And Wide Flange Beam Shapes Up To 100 Feet In Length. A Plate Girder Is A Girder That Has Been Fabricated By Welding Plates Together To Create The Desired Shape. The Fabricator Receives Large Plates Of Steel In The Desired Thickness, And Then Cuts The Flanges And Web From The Plate In The Desired Length And Shape. Plate Girder Can Have A Greater Height Than Rolled Steel Girders And Are Not Limited To Standardized Shapes. The Ability To Customize A Girder To The Exact Load Conditions Allows The Bridge Design To Be More Efficient. Plate Girder Can Be Used For Spans Between 10 Metres And More Than 100 Metres. Stiffeners Are Occasionally Welded Between The Compression Flange And The Web To Increase The Strength Of The Girder. A Box Girder Or Tub Girder Is A Box Shape. They Consists Of Two Vertical Webs, Short Top Flanges On Top Of Each Web, And A Wide Bottom Flange Connecting Webs Together. A Box Girder Is Particularly Resistant To Torsion And While Expensive, Are Utilized In Situations Where A Standard Girder Might Succumb To Torsion Or Toppling Effects.

A Box Girder Bridge Is A Bridge In Which The Main Beam Comprise Girder In The Shape Of A Hollow Box. The Box Girder Normally Comprises Either Pre-Stressed Concrete, Structural Steel Or A Composite Of Steel And Reinforced Concrete. The Box Is Typically Rectangular Or Trapezoidal In Cross-Section. Box Girder Bridges Are Commonly Used For Highway Flyovers And For Modern Elevated Structures Of Light Rail Transport. Although Normally The Box Girder Bridge Is A Form Of Beam Bridge, Box Girders May Also Be Used On Cable-Stayed Bridges And Other Forms. In Case Of Bridges As Span Increases, Dead Load Is An Important Increasing Factor. To Reduce The Dead Load, Unnecessary Material Which Is Not Utilized To Its Full Capacity Is Removed Out Of Section, This Results In The Shape Of Box Girder Or Cellular Structures. The Closed Cell Formed Has A Much Greater Torsional Stiffness And Strength Than An Open Section And It Is This Feature Which Is The Usual Reason For Choosing A Box Girder Configuration. When Tension Flanges Of Longitudinal Girders Are Connected Together, The Resulting Structure Is Called Box Girder.

II. RELATED WORKS

Gupta (2010) Conducted A Parametric Study On Behaviour Of Box Girder Bridges Under Different Depth Of The Cross Section.Three Dimensional 4-Noded Shell Elements Have Been Employed For Discretization Of Domain And To Analyse The Complex Behaviour Of Different Box-Girders. The Linear Analysis Has Been Carried Out For The Dead Load (Self Weight) And Live Load Of Indian Road Congress Class 70r Loading. The Paper Presents Study On Various Parameters For Deflection, Longitudinal And Transverse Bending Stresses And Shear Lag For The Cross-Sections Considered. The Finite Element Computational Model Are Validated By Comparing Few Obtained Results With The Published Paper. Analysis Of Box Girder Bridges With Four Noded Shell Elements And Its Effectiveness Is Mentioned. From The Journal It Was Concluded That Increase In Depth Of Box Girder Rsults In Reduced Deflection. Similarly With Increase In Depth The Bending Stress Distribution Also Decreases.

Shi-Jun Zhou (2010) This Paper Considered The Interaction Of The Bending And Shear-Lag Deformation Of A Box Girder And Established A Finite-Element Method. A Shear-Lag-Induced Stiffness Matrix Was Defined And The Stiffness Matrices Considering The Effect Of The Shear Lag Was Formulated. At Each Node Of The Beam Element, Two Shear-Lag Degrees Of Freedom Are Used As Boundary Conditions For The Box Girders. The Proposed Formulations Is Then Applied To Analyse The Effects Of The Shear Lag On The Deflection, The Internal Forces, And The Shear-Lag Coefficients In The Simply Supported, Cantilever And Continuous Box Girders Under Concentrated And Uniformly Distributed Loads. The Results Obtained Using The Proposed Procedure Was In Good Agreement With Using Different Methods Such As The Analytical Method, The Finite-Stringer Method, The Finite Shell Element Method Through Variational Principle, And The Model Tests. The Proposed Method Is Dependable And More Effective For The Analysis Of The Shear Lag In The Actual Box-Girder Structures.

Nikolaos Pnevmatikos And Vassilis Sentzas (2012) This Paper Focused On The Seismic Response Of The Curved And Post-Tensioned Concrete Box Girder Bridges. It Investigates Influence Of Curvature And Its Responseof A Bridge Subjected To Earthquake. Parametric Analysis Of Different Radius Of Curvature Is Analyzed And The Internal Forces, Torsion Moment, Axial And Shear Along The Bridge Are Found Out. Two Types Of Connections Are Carried Out For Investigation, The Monolithic Connection And Deck Connection With Bents And Abutments With Bearing. The Response Spectrum Seismic Analysis Was Performed. Diagrams Relating The Curvature With The Torsion Moment Have Been Obtained From The Results Of Analysis. These Diagrams Can Be Used By Engineers For Preliminary Design Of Such Kind Of Bridges.

C. Lande, S. K. Kamane, S. A. Mahadik.:-In The Study, Analysis Of A Rcc Box Culvert Is Presented Using Finite Element Method. 3d Configuration Of The Space Is Considered And Computer Code Is Developed To Find The Bending Moments, Support Reactions And Member Forces Due To Lateral Soil Pressures And Equivalent Traffic Load. With The Help Of Excel Programming, Member Forces Equivalent Moments And Support Reactions Are Calculated. It Concludes That Culvert Box Full With Water And Live Load Surcharge On Top Of Slab Then There Is Increase In Bending Moments At Centre And End Of The Top. On The Contrary, Empty Box Culvert, Live Load Surcharge On Top Slab, Vertical Wall Bending Moment At Centre And End Is Increased.

III. MODELS

Modeling Of A Structure Is The Most Important And Preliminary Step Towards The Efficient Utilization Of The Structure For The Purpose It Is Indented To. A Structure Can Be Considered Worthy Only If The Structure Withstands The Loads It Is Expected To Carry Within Its Service Life. As A Material Model Is Important For The Conduction Of An Experiment, Analytical Study Also Equally Needs A Proper Model For Its

Successful Execution. Analytical Models Can Be Created Through Numerous Designing And Drafting Software's Available, After Accomplishing A Proper Design.

In This Study, A Box Girder Is Considered. This Model Contains A Central Hollow Portion In Between The Flanges. There Are A Lot Of Softwares In The Line Allowing The Creation Of Models; Ansys Was Chosen Here For The Modeling Purpose As It Was Found To Be More Suitable To Go Along With The Requirements And Creation Of The Model. In The Present Study Finite Element Analysis Of The Models Created Were Carried Out Using The Finite Element Modeling And Analysis Software Ansys. As Ansys Offers More Accuracy And Multiple Ranges Of Platforms And Tools To Work With Easiness, It Was Chosen For The Study.

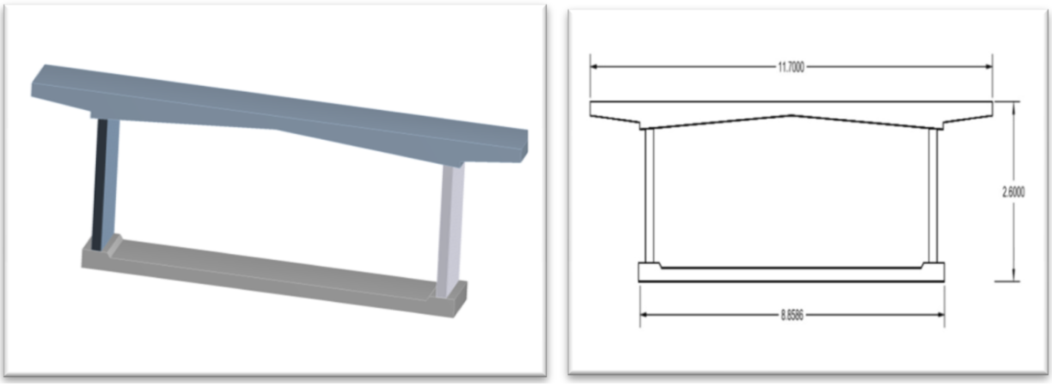


Fig.1 Ansys And Autocadd Model Of Rectangular Composite Box Girder

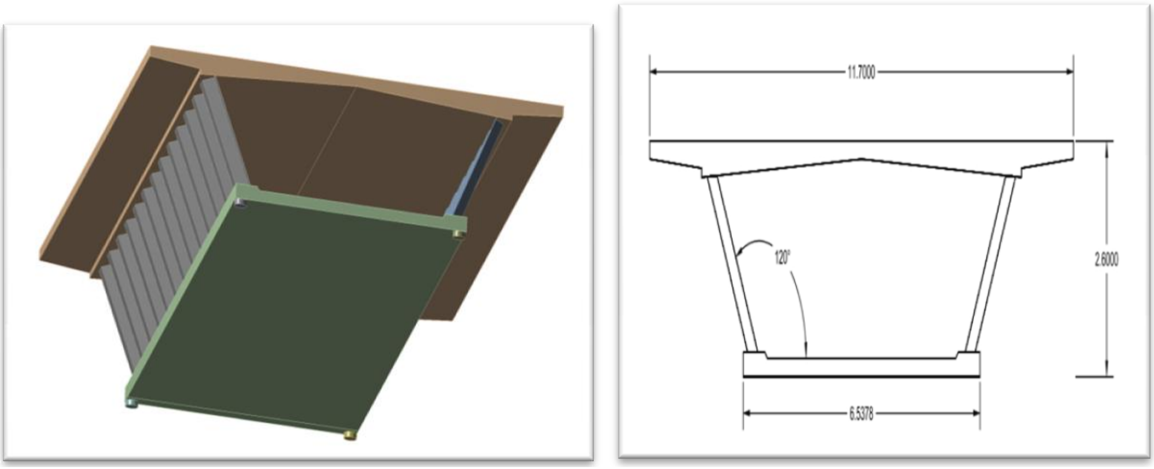
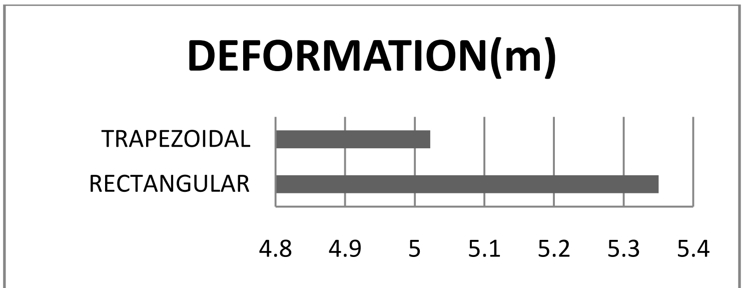


Fig.2 Ansys And Autocadd Model Of Trapezoidal Composite Box Girder

IV. Result And Discussion

After Performance Analysis Deformation, Equivalent Stress, Normal Stress, Shear Stress And Moment Reactions Were Compared. The Graph Showing The Results Are Given From Figure 3 To Figure 7.



	RECTANGULAR	TRAPEZOIDAL
DEFORMATION(m)	5.3502	5.0222

Fig.3 Graph Showing Deformation Of Two Models

Deformation Was Decreased For Trapezoidal Cross Section Compared To Rectangular. Reduction Deformation Makes Trapezoidal A Better Cross Section.

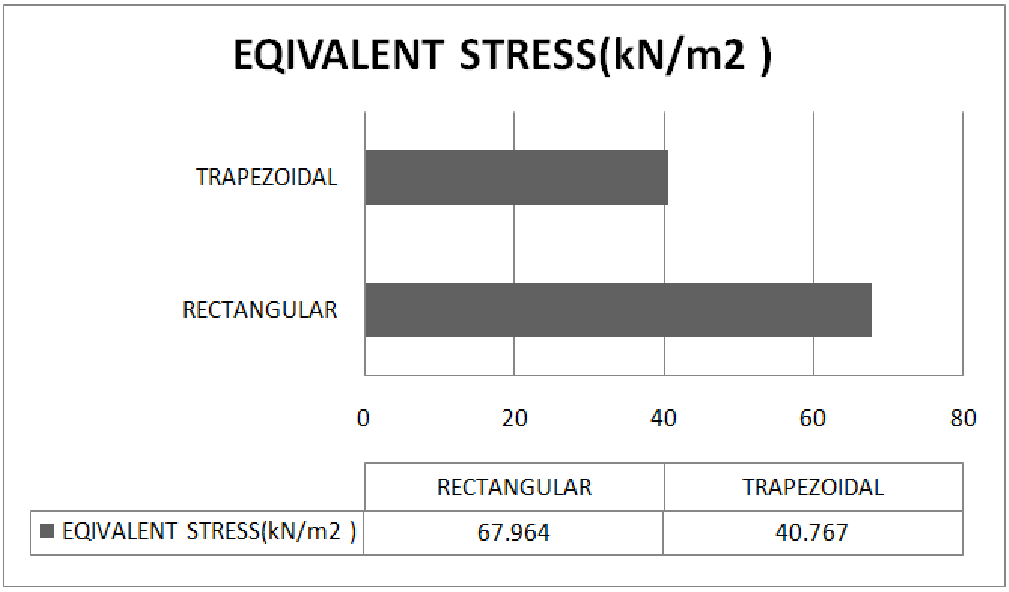


Fig.4 Graph Showing Equivalent Stress Of Two Models

After Comparing Equivalent Stress It Was Found That Stress Formed In Trapezoidal Was Less Compared To Rectangular. This Also Shows That Trapezoidal Sections Are A Better Cross Section.

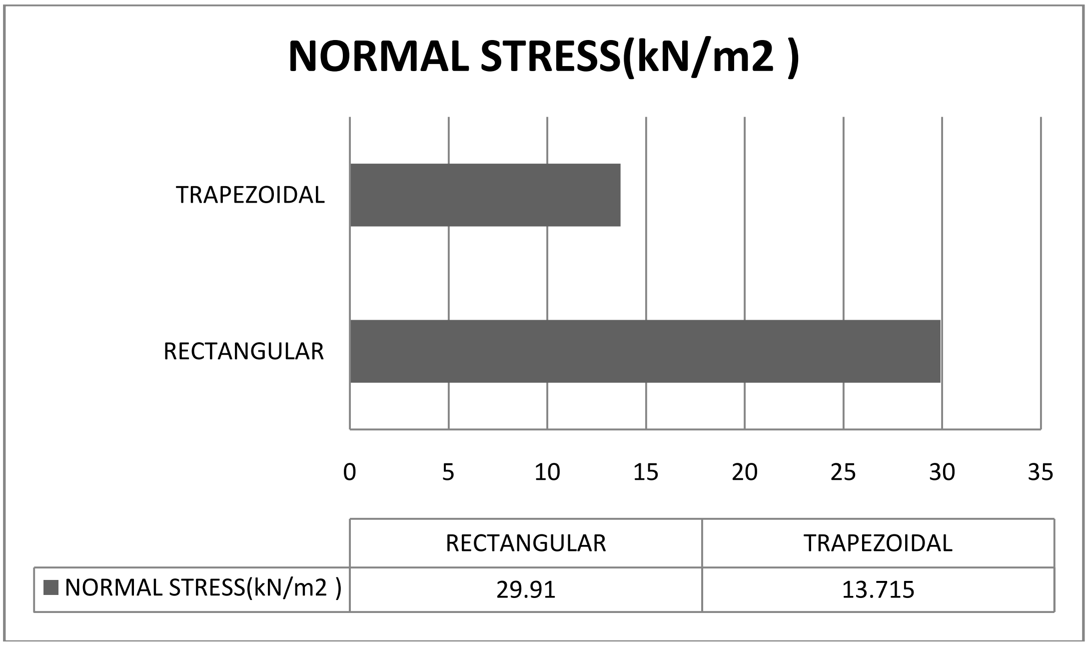
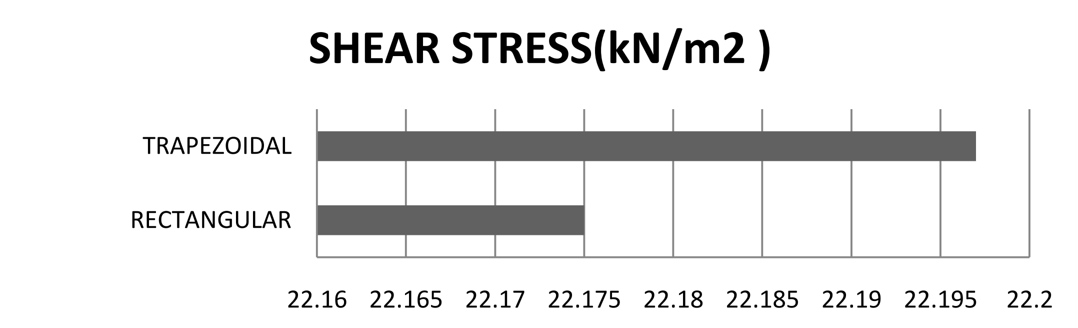


Fig.5 Graph Showing Normal Stress Of Two Models

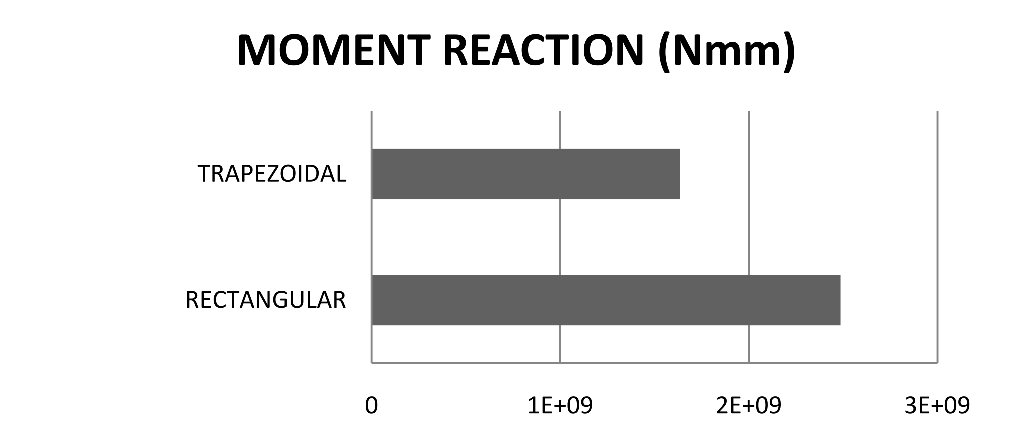
On Comparing The Normal Stresses Formed In Both Sections, Trapezoidal Shows Lesser Value Than Rectangular Section.



	RECTANGULAR	TRAPEZOIDAL
SHEAR STRESS(kN/m2)	22.175	22.197

Fig.6 Graph Showing Shear Stress Of Two Models

Among The Stresses So Far Analysed, Shear Stress Was The Only Stress That Shows Greater In Trapezoidal Than In Rectangular. In Composite Box Girders Top And Bottom Flanges Were Made Concrete And Two Webs Connecting The Flanges Were Made Of Steel. In Rectangular Cross Section These Steel Webs Are Placed Straight And Right Angled To The Flange. And In Trapezoidal Cross Section Steel Webs Were Placed With An Inclination, This May Be The Reason Why Shear Stress Showed A Greater Value In Trapezoidal Than In Rectangular.



	RECTANGULAR	TRAPEZOIDAL
MOMENT REACTION (Nmm)	2485800000	1633800000

Fig.7 Graph Showing Moment Reaction Of Two Models

After Analysis, Moment Reaction Showed A Greater Value For Rectangular Than Trapezoidal. Less Moment Reaction Also Made Trapezoidal A Better Section.

V. Conclusion

After Performance Analysis Of Composite Box Girder We Can Conclude That Deformation Is 7% Less In Trapezoidal Compared To Rectangular, Moment Reaction Is 35% Less In Trapezoidal Compared To Rectangular, Normal Stress Is 55% Less In Trapezoidal Compared To Rectangular. Equivalent Stress Is 40% Less In Trapezoidal Compared To Rectangular. Shear Stress Is 1% More In Trapezoidal Compared To Rectangular.

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