EXPRIMENTAL INVESTIGATION IN PINE WOOD LAMINATED WITH REINFORCEMENT POLYMER TO ANALYZE STRENGTH AND FACTOR OF SAFETY

Ramesh Pal [1], Prof. Harsh Panthi[2], Prof. Kapil Soni[3]
ME.Scholar[1], Associate Prof.[2,3]
Department of Civil Engineering[1,2,3]
RNTU, Bhopal India.

Abstract

The effective uses of a pine wood are limited at its maximum strengthening limits. The study was conducted by using the experimental approach. The major study was done on pine wood by using polycarbonate reinforced polymer and epoxide reinforced polymer with different thickness i.e. 10mm, 15mm, 20mm, 25mm, A factor of safety was analyzed by performing experimental investigation.

In our analysis, pine wood sample was used and the reinforced polymer was laminated on the surface of pine wood of rectangular cross – section, In order to verify the sample, the critical buckling with their deformation by using different reinforced polymer with different thickness are compared with the available experimental results.

The results show that increasing thickness of reinforced polymer increases radius of gyration and factor of safety for each location of coated pine wood sample and decreases the slenderness ratio with increase in a thickness simultaneously. The factor of safety of the coated pine wood is compared by using four types of thickness i.e. 10mm, 15mm, 20mm, 25mm of optimized coated pine wood for various thickness of polymer.

Keywords— *Internal Combustion Engine Fins, Temperature Distribution, Surface Area of Fin, Fillet in Fin. Buckling, Factor of Safety, Allowable stresses*

I INTRODUCTION

A column or pillar in architecture and structural engineering is a structural element that transmits, through compression, The load of the structure above to other structural elements under. In other words, a column is a compression member. The time period column applies particularly to a big spherical aid (the shaft of the column) with a capital and a base or pedestal[1] that's manufactured from stone, or acting to be so. A small wooden or metallic assist is generally referred to as a put up, and helps with a rectangular or other non-round phase are usually referred to as piers. For the cause of wind or earthquake engineering, columns may be designed to resist lateral forces. Other compression contributors are regularly termed "columns" due to the similar stress situations. Columns are often used to aid beams or arches on which the top elements of walls or ceilings relaxation. In architecture, "column" refers to such a structural detail that still has sure proportional and decorative features. A column might also be a ornamental element not wished for structural functions; many columns are "engaged", that is to mention shape a part of a wall. A column is a vertical structural member meant to interchange a compressive load. For example, a column might in all likelihood switch loads from a ceiling, floor or roof slab or from a beam, to a ground or foundations. Columns are generally created from substances together with stone, brick, block, concrete, wooden, metallic, and so on, that have properly compressive energy.

If the load on a column is implemented thru the middle of gravity (centroid) of its move section, it is referred to as an axial load. A load at some other component within the move segment is called an eccentric load. A short column underneath the motion of an axial load will fail by means of direct compression earlier than it buckles, however an extended column loaded in the same manner will fail through way of springing unexpectedly outward laterally (buckling) in a bending mode. The buckling mode of deflection is taken into consideration a failure mode, and it commonly takes location earlier than the axial compression stresses (direct compression) can cause failure of the fabric by using the usage of yielding or fracture of that compression member. However, intermediate-period columns will fail by the use of a aggregate of direct compressive pressure and bending. I-fashioned metallic participants constitute the fundamental structural detail in majority of structural steel constructing. Practical troubles may require a number of those contributors to have internet openings to permit for the passage and set up of piping, duct works and electric powered conduits. Typical net openings which may be generally utilized in uncovered steel structures encompass hexagonal, octagonal and cell perforations. Hexagonal perforations are genuinely added during the producing of castellated steel participants, wherein the member is lessen in a zig zag pattern through its net. The resulting quantities are then reassembled together by means of the usage of welding as shown in Figs. Respectively. Although, the principle intent of the Castellation approach is to offer stiffer I-sections through growing the net top and imparting better important-axis moment ability Than simple-web mattress contributors of the equal weight, it moreover affords get right of entry to to offerings and optimizes the use of the high-priced structural metal cloth. These blessings, mixed with the large improvement in automated production system have added approximately the full-size unfold use of castellated steel members in numerous structural programs. [3] Castellated beams have been used as structural participants in structural metallic frames [1]. An example is proven in Fig. 1. A castellated beam or column is made of a popular metallic I-form through slicing the web on a 1/2 hexagonal line down the center of the beam. The two halves are moved throughout by one spacing and then rejoined by using welding. This procedure will increase the depth of the beam and consequently the principal axis bending power and stiffness without adding extra substances. This permits castellated beams for use in lengthy span packages with ligh or slight loading situations in flooring and roofs. The fabrication procedure creates openings at the net, which may be used to house offerings. Despite the growth inside the beam intensity the overall building peak can for this reason be reduced, in comparison with a solid internet answer, where services are supplied below the beam. This results in savings inside the cladding prices. Despite the increase in the fabrication costs caused by cutting and welding, the advantages outweigh the disadvantage.

II HOLLOW STRUCTURAL SECTION

A hollow structural section (HSS) is a type of metal profile with a hollow cross section. The term is used predominantly in the United States, or different countries which follow US construction or engineering terminology. HSS individuals may be circular, rectangular, or rectangular sections, even though different shapes such as elliptical also are to be had. HSS is best composed of structural steel in step with code. HSS is now and again mistakenly referenced as hole structural metal. Rectangular and square HSS are also generally referred to as tube metallic or container segment. Circular HSS are every so often mistakenly known as metallic pipe, even though proper steel pipe is genuinely dimensioned and classed in another way from HSS. (HSS dimensions are primarily based on outdoors dimensions of the profile; pipes also are synthetic to an outside tolerance, albeit to a distinctive widespread.) The corners of HSS are heavily rounded, having a radius which is about twice the wall thickness. The wall thickness is uniform around the section. In the United Kingdom, or other international locations which follow British production or engineering terminology, the term HSS isn't used. Rather, the three fundamental shapes are referenced as CHS, SHS, and RHS, being circular, rectangular, and square hollow sections. Typically, these designations may also relate to metric sizes, therefore the scale and tolerances fluctuate slightly from HSS.

III BASIC PRINCIPLES OF I. C. ENGINE

Most internal combustion engines are fluid cooled using either air (a gaseous fluid) or a liquid coolant run through a heat exchanger (radiator) cooled by air. Marine engines and some stationary engines have ready access to a large volume of water at a suitable temperature. The water may be used directly to cool the engine, but often has sediment, which can clog coolant passages, or chemicals, such as salt, that can chemically damage the engine. Thus, engine coolant may be run through a heat exchanger that is cooled by the body of water. Most liquid-cooled engines use a mixture of water and chemicals such as antifreeze and rust inhibitors. The industry term for the antifreeze mixture is engine coolant. Some antifreezes use no water at all, instead using a liquid with different properties, such as propylene glycol or a combination of propylene glycol and ethylene glycol. Most "air-cooled" engines use some liquid oil cooling, to maintain acceptable temperatures for both critical engine parts and the oil itself. Most "liquid-cooled" engines use some air cooling, with the intake stroke of air cooling the combustion chamber. An exception is Wankel engines, where some parts of the combustion chamber are never cooled by intake, requiring extra effort for successful operation. There are many demands on a cooling system. One key requirement is to adequately serve the entire engine, as the whole engine fails if just one part overheats. Therefore, it is vital that the cooling system keep all parts at suitably low temperatures. Liquid-cooled engines are able to vary the size of their passageways through the engine block so that coolant flow may be tailored to the needs of each area. Locations with either high peak temperatures (narrow islands around the combustion chamber) or high heat flow (around exhaust ports) may require generous cooling. This reduces the occurrence of hot spots, which are more difficult to avoid with air cooling. Air-cooled engines may also vary their cooling capacity by using more closely spaced cooling fins in that area, but this can make their manufacture difficult and expensive. Only the fixed parts of the engine, such as the block and head, are cooled directly by the main coolant system. Moving parts such as the pistons, and to a lesser extent the crank and rods, must rely on the lubrication oil as a coolant, or to a very limited amount of conduction into the block and thence the main coolant. High performance engines frequently have additional oil, beyond the amount needed for lubrication, sprayed upwards onto the bottom of the piston just for extra cooling. Air-cooled motorcycles often rely heavily on oil-cooling in addition to air-cooling of the cylinder barrels. Liquid-cooled engines usually have a circulation pump. The first engines relied on thermo-syphon cooling alone, where hot coolant left the top of the engine block and passed to the radiator, where it was cooled before returning to the bottom of the engine. Circulation was powered by convection alone.

IV LITERATURE REVIEW

Xiaorui Wang et al.[1] A square hole wooden column made of Spruce-Pine-Fir (SPF) lumbers became evolved, for the motive of improving the utilization efficiency of wooden. The gift paintings conducted experimental investigations of the columns beneath centrically and eccentrically compression. A wide range of slenderness ratios of columns and eccentricities of loads turned into considered to carefully observe the failure modes in columns. The results indicated that blended fabric screw ups and buckling screw ups were found for the intermediately slender columns below axial compression, at the same time as buckling failures were discovered for the lengthy columns. The final power of columns underneath axial compression notably decreased with the boom of slenderness ratios. The expected results via the tangent modulus concept closed to the ones of experiments. The bending failure, which underwent a reported nonlinear system, turned into the foremost characteristic of the intermediately slim column with an eccentric compressive load. Typically, the burden carrying capability of columns confirmed a lowering trend with an increasing in eccentric ratios. Both the secondary bending and material nonlinearity have been critical elements that impacted the nonlinear response of the column. An analytical version became proposed for evaluating the load wearing capability of the rectangular hollow columns below the interaction among compressions and bending. There became properly agreement between the consequences of the experiments and calculation.

Bojan Cas et al. [2] Slip between layers, fabric residences of layers and geometric non-linearities largely dictate each the bearing capability and the ductility of a composite beam. That is why the accuracy of their modelling within the numerical evaluation of the composite beams is of utmost significance. In the present paper we present a new strain-primarily based finite element version which considers these troubles in a quite powerful manner. Each layer of the beam is modelled with the aid of geometrically specific Reissner's beam model. The layers are assumed to live within the contact at some stage in deformation however the relative tangential displacement (slip) is possible. The non-linear load–slip regulation of the interface is considered. The formula is discovered to be accurate, dependable and computationally time-effective. The further objective of the paper is an evaluation of the buckling force of axially compressed layered timber columns, being sincerely supported, constant–pinned or non-stop. We evaluate the existing numerical effects with the analytical values of [Girhammar UA, Gopu VKA. Composite beam-columns with interlayer slip–exact analysis, J Struct Engng ASCE 1993;199(4):1265–82] and with the values, encouraged via the European code for timber structures [Eurocode 5, Design of timber structures, Part 1-1: General rules and rules for buildings, 1993; ENV 1995-1-1]. The comparisons indicate that the European code for wood systems offers very conservative estimates for the buckling load.

Xiaobin Song and FrankLam [3] provides results of a study on the stability capability and lateral bracing pressure of wood beam-columns subjected to biaxial eccentric compression loading. A numerical analysis version based at the column deflection curve approach changed into advanced. The version considers nonlinear parallel-to-wooden-grain pressure–pressure dating, length and stress distribution results of timber strength, shear deformation, and the P-Delta effect of compression load. Material belongings exams and biaxial eccentric compression checks of wooden beam-columns had been carried out to offer input parameters and verification for the version. Good agreement becomes done. The adequacy of the two% rule of thumb became also studied.

Giovanni Rinaldin et al. [4] investigates the accuracy of the N2 spectrum for timber structures by using calculating the 'rigorous' inelastic spectra for natural seismic data decided on to suit, with their average, a designated design elastic spectrum. A purposely advanced software has been used to gain the inelastic spectra for a Single Degree of Freedom (SDOF) system characterised by means of a slip-kind hysteretic courting with pinching common of timber structures. Two different sets of information have been taken into consideration: the former is steady, on common, with a given design spectrum from Eurocode eight, the latter is taken from a sturdy movement database by choosing the facts having soil class A and PGA inside a delegated variety. Non-linear dynamic analyses have been done via various the level of ductility and the herbal vibration duration of the SDOF systems. The consequences of hardening or softening of the device behaviour have additionally been analysed. Two evaluation methods were used with the aim to have a similarly confirmation of the accomplished effects. The comparisons among the rigorous and the approximated N2 spectrum demonstrate that, in wellknown, the N2 technique always give pretty exact outcomes in estimating the inelastic spectra even for wooden systems.

A. A Chiniforush et al. [5] observed it a sustained load to 12 STC push-out test specimens and monitoring the load-slip behaviour of the shear connection (such as the interplay between wooden, steel beam, and shear connector) over a sixteen-month duration in a Service Class 2 surroundings according with EC5. The mechanical shear connectors utilised to attach the recent-rolled metal sections to cross-laminated timber (CLT) panels have been educate-screws, canine-screws, put up-tensioned excessive power bolts, and excessive energy bolts positioned in cementitious grout wallet. In addition to the trying out programme, a 3-D moisture diffusion analysis considering the effects of temperature became performed to predict the moisture content of the timber panels. The results of the experiments and diffusion evaluation have been hired to calibrate an extended-time period rheological model for the shear connection which considers the effect of the stiffness change because of variations of the moisture content, creep, mechano-sorption and inelastic shrinkage. The rheological version become used to are expecting the slip and thereby to calculate the creep coefficient of the STC participants over a provider life of 50 years. An average creep coefficient of two.Five for the STC joints examined turned into obtained. The high energy bolts in grout pocket shear connectors had the bottom creep coefficient of 0.6, while the submit-tensioned high power bolts exhibited the best creep coefficient of three.9, because of the loss of put up-tensioning.

Xianjie Meng et al. [6] paper offers the quasi-static check effects of a complete-scale timber structure specimen that has the architectural features of traditional timber homes from the Chinese Song dynasty. The specimen became tested six instances beneath various vertical hundreds. The seismic performance became investigated with attention of the vertical uplifting of the shape throughout lateral loading. The deformation styles, hysteretic characteristics, and vertical motion functions of the timber structure were acquired and analyzed. Based on these consequences, the energy dating within the timber structure inside the quasi-static check become hooked up. The energy input to the wooden structure was converted into hysteretic electricity, gravitational potential energy (GPE), and elastic stress strength (ESE). When the cyclic amplitude become small, the hysteretic power and ESE accounted for the general public of the input energy conversion. At massive cyclic amplitudes, extra than 50% of input power became converted into GPE. The strength conversion to GPE mechanism allows this form of conventional wood shape to resist huge earthquakes. Thus, GPE should be taken into consideration in both the static and dynamic tests of conventional timber systems.

V METHODOLOGY

3.1 Testing Apparatus for column made of Pine Wood -

Figure 3.1 Pine wood columns for test specimen

Figure 3.3 Schematic of test specimen with compression testing apparatus.

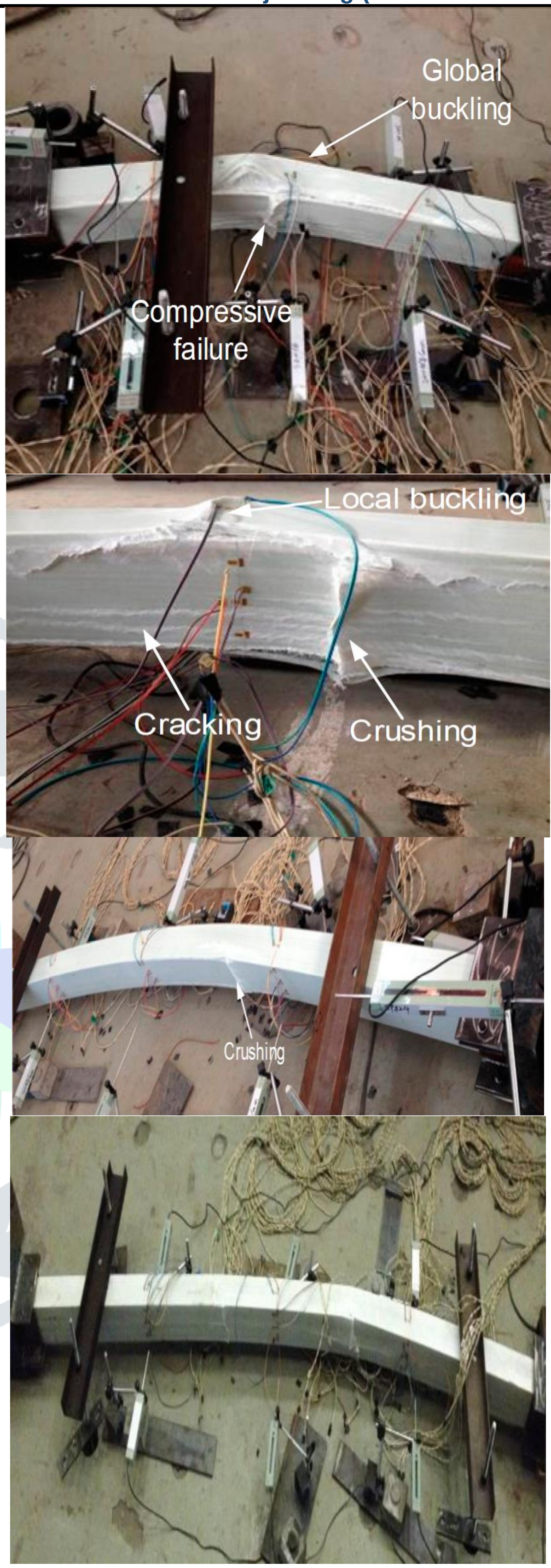

Figure 3.5 Representation of buckling of pine wood coated with epoxide reinforced polymer.

VI RESULT AND DISCUSSION

Experimental and Simulation Result for the pine wood coated with polycarbonate and epoxide polymer fiber plastic.

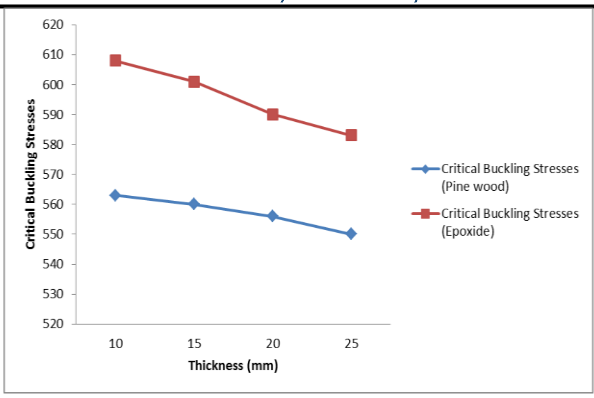

Figure 4.1- Experimental result for the pine wood with coated pine wood epoxide polymer fiber plastic.

4.3 The Calculation of Allowable Stress, Buckling Stress & Factor of Safety

graph shows a experimental result of pine wood coated with polycarbonate fiber of allowable stresses and factor of safety results and also buckling stress & allowable stress is calculated with different thickness of polycarbonate the value of buckling stress & allowable stress of respective location is shown in the table the value will further used to determine the factor of safety at various thickness polycarbonate reinforced polymer.

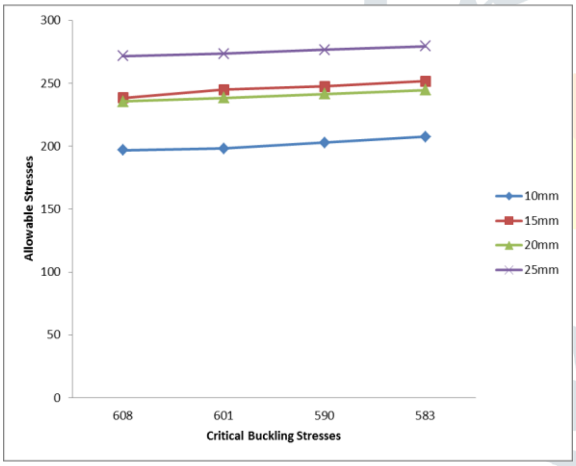

Figure 4.2- Allowable Stress of polycarbonate coated pine wood with different thickness.

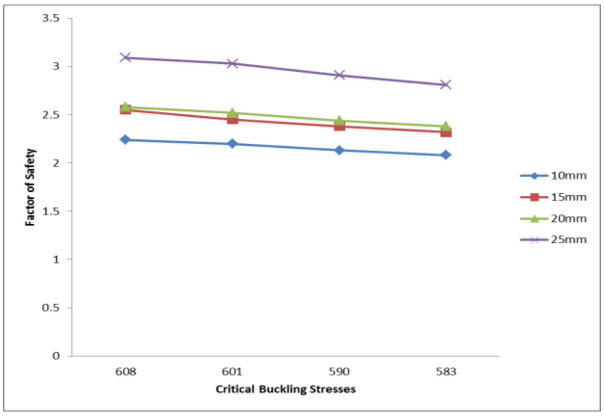

Figure4.3- Factor of safety for polycarbonate coated pine wood with different thickness.

The graph shows the comparative factor of safety of different thickness of polycarbonate fiber from the above graph it could be concluded that 25mm of thick layer of polycarbonate enhances higher factor of safety.

4.6 Epoxide Reinforced Plastic coated Pine wood Results -

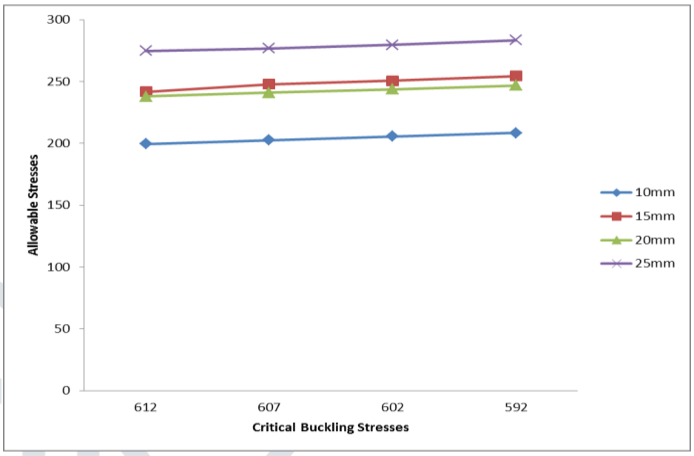

Figure 4.4- Allowable Stress of epoxide reinforced polymer coated pine wood with different thickness.

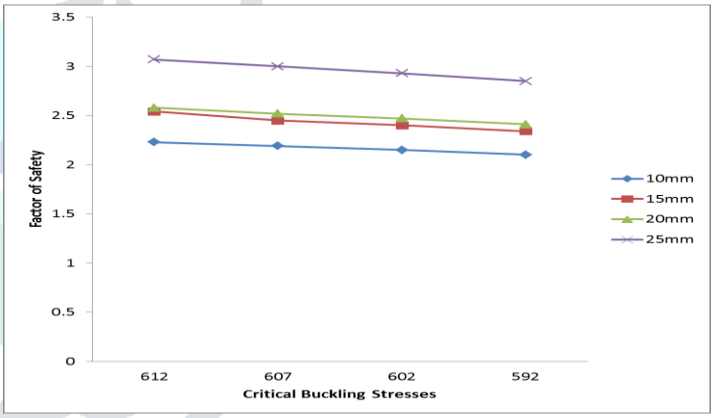

Figure4.5- Factor of safety for epoxide coated pine wood with different thickness.

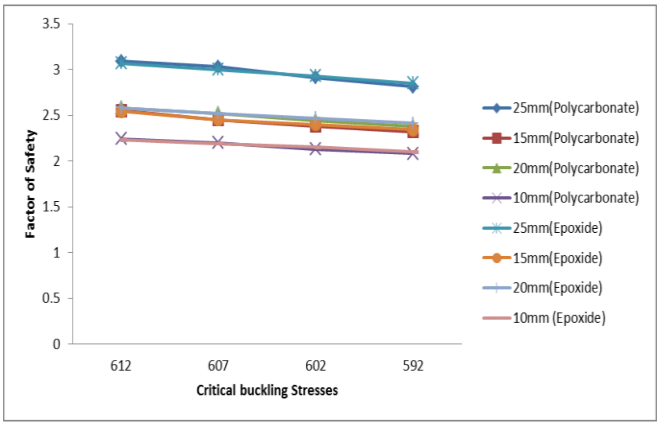

Figure 4.6 – This figure shows a comparative result of factor of safety for pine wood coated with polycarbonate and epoxide reinforced polymer with different thickness.

VII CONCLUSION

- The factor of safety along the pine wood of solid cross section profile is found to be maximum of the 25mm of coated thickness of polycarbonate reinforced polymer the critical buckling stress distribution along the length and middle portion of a pine wood is maximum.
- The magnitude of the critical buckling stress is minimum in the case of 25mm thickness in both reinforced polymer i.e. polycarbonate and epoxide material profile with pine wood.
- The nature of the allowable stress is maximum in 10mm of reinforced polymer thickness and changes with respect to its thickness for all the profiles of pinewood coated with different reinforced polymers.
- In a comparison with the different reinforced polymers coated in pine wood with respect to present model resulted in higher factor of safety, critical buckling stress characteristics close to the small end of the pine wood coated with different reinforced polymer. The allowable stresses are greater on present model in comparison with optimized model of pine wood coated with reinforced polymer.

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