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Root Canal Filling Process Enhancement in Simulated Dental Block Using Static Analysis

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Abstract: *Root canal is a treatment sequence for the infected pulp of a tooth which result in the elimination of infection and protection of the decontaminated tooth from future microbial invasion. There are two process one is cleaning and another one is obturation. During the second visit the temporary filling material like guttaparcha is placed. A temporary filling material is placed again. This process is called obturation. It is assumed that obturation method closely resembles with mechanical injection moulding. Thus to carry out study on compantion load in dental obturation.Acralyc blocks are required.Root canal is the naturally occurring anatomic space within the root of a tooth. It consist of the pulp chamber (within the coronal part of tooth), the main canal and more intricate anatomical branches that may connect the root canals each other or to the surface of the oot. For measurement of compention load generally photoelastic techniques are used. Thus the material should be photoelastic. Acralyc is 2D photoelastic material and which is easily available and cheaper in cost.In Dental obturationphotoelastic blocks are necessary to study mechanical aspects. For doing dental operation we generally used traditional method to fill the dental cavity. There is a no standard for applied load we don't have any analytical result for safe operation in endodontic treatment. After completion of this project we get proper values of compantion load and we fill material and make surgery safely.But manufacturing of this acralyc block is very complicated due to its shape so static analysis is one of the best techniques to analyze the stress concentration and deformation in the filler material. By using it we easily make the safe dental treatment and we avoid the creation of voids in the cavity.*
Keywords: *Root Canal, GuttaParcha, Photoelastic, Static Analysis, Obturation.*

I. Introduction

Root canal treatment (RCT) is a treatment (Fig.No:-1.1) used to repair and save the tooth hich is badlydecayed or becomes infected. It is the process by which a dentist treats the inner aspects of a tooth calledroot canals which most commonly is referred as the nerve. It is a part ofEndodontic (means inside tooth)treatment study. [7]

Root canal treatment removes infected tissue from the root canal, or the pulp-filled cavity of a tooth. Referred to as Endodontic, this area of dentistry has a long history, with the most exciting innovations being introduced within the past decade. Meaning "inside the tooth," Endodontics is the area of dentistry specializing in the treatment of the dental pulpthe tissue within the root canal of the tooth. Standard endodontic treatment has largely remained the same over time, with minimal changes in the instrumentation used and the overall process of treatment. The first root canal instrument was constructed from a watch spring in 1838, used to access the pulp within the root of the tooth. Now referred to as files, these instruments are manually operated by the Endodontist throughout standard root canal treatment first used to open the path to the canal, and then assisting in the cleaning and shaping of the root canal. After they are cleaned and disinfected, the roots are filled to prevent reinfection. The filling material, Guttapercha, was first introduced in 1847 and is still used today in root canal therapy. These two tools the file and Guttapercha fillingremain part of standard endodontic treatment. The most recent innovation in root canal therapy, the GentleWave Procedure, occurred in the past decade. The GentleWave Procedure uses fewer files than standard root canal treatment, as they are only used at the beginning of the procedure to open a path to the root canal. Once the path is opened and the Endodontist has access to the root canal system, fluid dynamics take the lead. A vortex of procedure fluids then travel through the complex and turns of the canal to clean and disinfect the root canal system. The Gentle Wave Procedure reaches even the deepest portions where bacteria can hide, making it today's alternative to standard root canal treatment.[8]

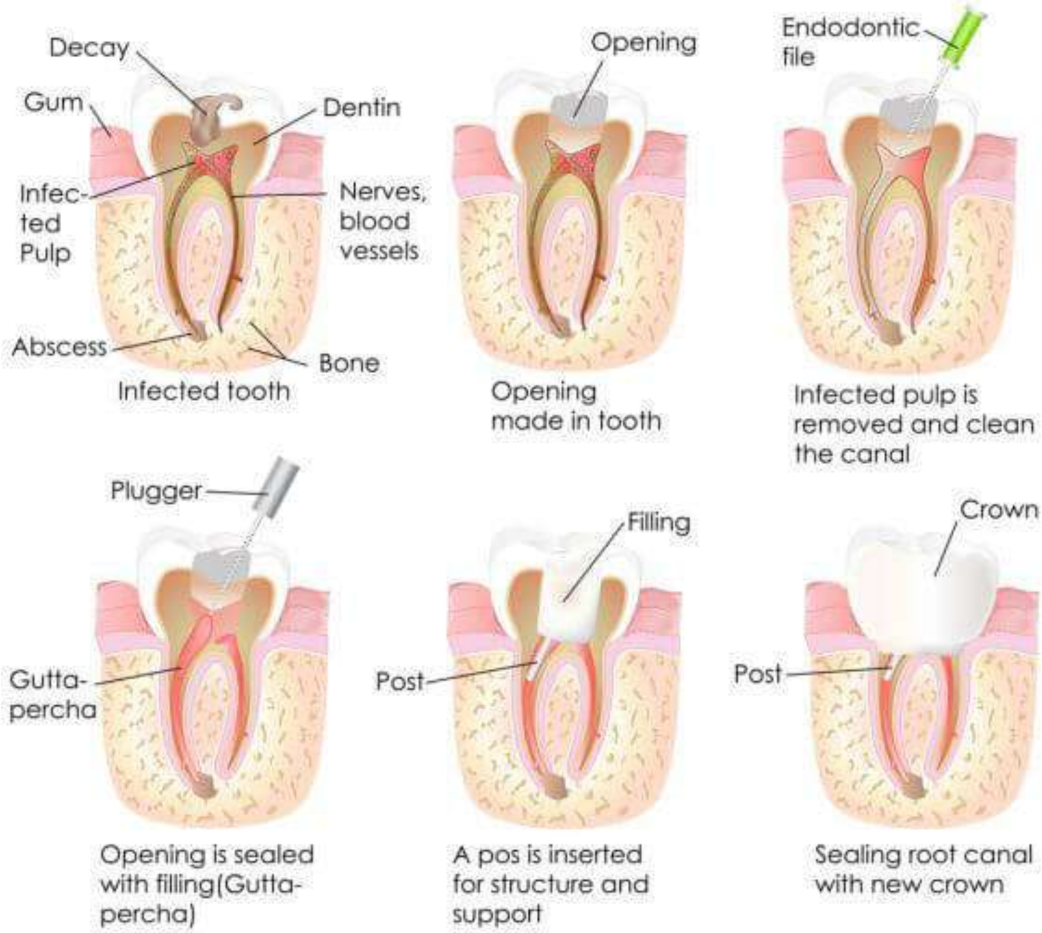

Fig No. 1.1:-Root Canal Treatment

Root canal obturation is a procedure in which the root canal space is filled with canal fillingmaterials at the final stage of root canal treatment, after cleaning and shaping.The objective of root canal obturation is to prevent or treat periapical disease by preventing recontamination by bacteria that may have remained in the dentinal tubules or that exist in the oral cavity.Previous studies have demonstrated that the quality of root canal obturation affects periapical healing and treatment success. Root canals often have a complex anatomy, including lateral canals and an isthmus. Isthmus communication in the mandibular first molar exists in 54.8% of cases. Although a few studies have used humanmolar teeth to evaluate the amount of voids in root canal fillings, the variation was large because of complex canal shapes. For these reasons, artificial resin teeth can result inmore reliable findings when measuring the void percentage.

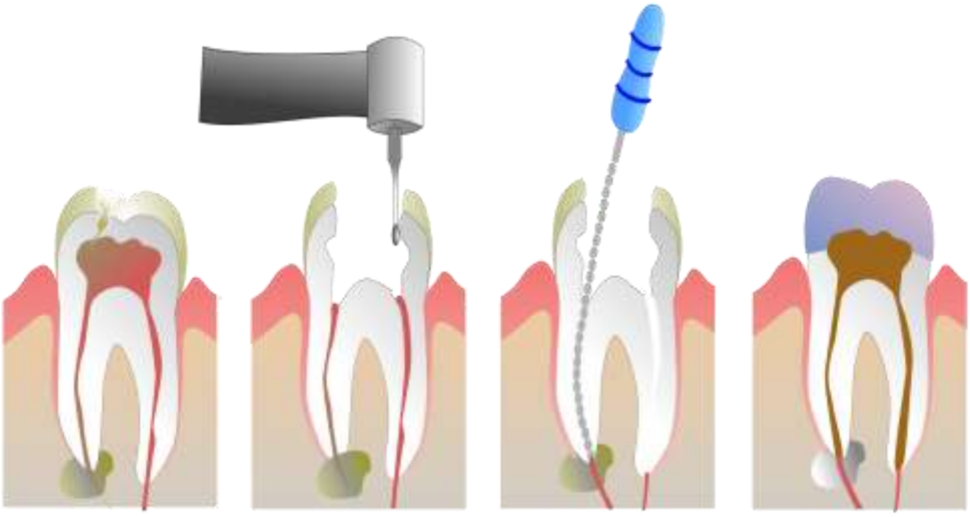

Fig. No. 1.2:- Obturation

Obturation (Fig.No:- 1.2) of the cleaned and shaped root canal system is a critical step in root anal therapy to inhibit the penetration of bacteria and their byproducts into the cleaned and disinfected root canal system, as well as preventing the recolonization of bacteria remaining after root canal therapy. Providing a filling in the root canal capable of sealing the coronal, apical, and lateral openings is one of the main treatment objectives Sealing the root canal system relies on the adequate adaptation of a filling material to obliterate the canal space and its intricacies: fins, deltas, isthmuses and lateral canals.Obturation of the root canal system hermetically, both apically and coronally, prevents leakage and contamination of the root canal space.Lateral compaction of gutta-percha cones remains widely accepted as a benchmark compared to other root filling techniques, as it is a simple and reliable technique that can be applied to most cases.6 However, it may leave gaps between gutta-percha cones, sealer and canal walls and there is a risk of vertical root fractures during compaction.Filling of root canals optimally in three dimensions after cleaning and shaping is paramount in preventing re-infection of the root canalspace. Single-cone techniques performed with conventional sealers have been perceived to be less effective in sealing root canals than the gutta-percha warm vertical compaction technique.However, non-compaction, singlecone filling of root canals has recently been revived with the introduction of master cones with greater taper that match the geometry of nickel–titanium instrumentation systems.The advent of contemporary root canal sealing systems, claimed to create bonds along the sealer–gutta-percha interface by modifications of the sealer or the root-filling material, may also support the use of a single-cone obturation technique.Limited information, however, is available on the sealing quality of these new singlecone root fillings as compared with that of warm vertical compaction of gutta-percha. Recently however, gutta-percha cones with increased taper have been developed because use of gutta-percha cones with the same taper as that of nickeltitanium instruments may reduce microleakage. [9]

In that perspective, a syntetic thermoplastic polymerbased root canal filling material (Resilon™, Resilon Research LLC, Madison, CT), has been developed. This root canal filling material behaves like gutta-percha, has similar handling properties, and may be softened with heat or dissolved in solvents such as chloroform. Based on polycaprolactone, a biodegradable aliphatic polyester, Resilon contains bioactive glass, dimethacrylates, bismuth oxychloride and barium sulfate. As it contains dimethacrylates, it is bondable to a variety of methacrylate-resin-based sealers such as Epiphany (Pentron Clinical Technologies, Wallingford,CT), Real Seal (SybronEndo, Orange, CA), and Next (Heraeus-Kulzer,Armonk, NY). These dual-curable dental resin composite sealers are bonded to dentinal walls using a corresponding self-etching primer. By bonding to both the obturating core material and the dentinal walls, Epiphany sealer claims to be more resistant to bacterial leakage *invitro* and *in vivo* and may help to reinforce the teeth lessening the chance of vertical root fracture. These favourable results require experimental confirmation.[10]

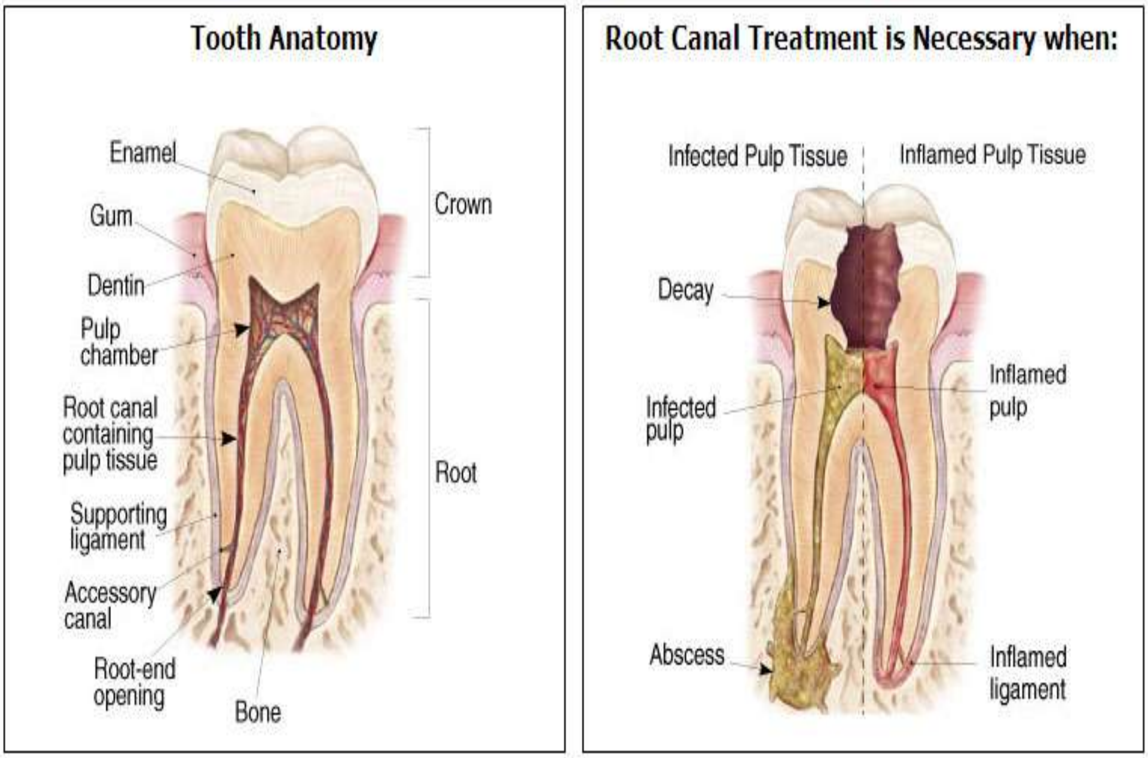

Fig.No. 1.3:- Nomenclature of Dental Cavity

II. Methodology

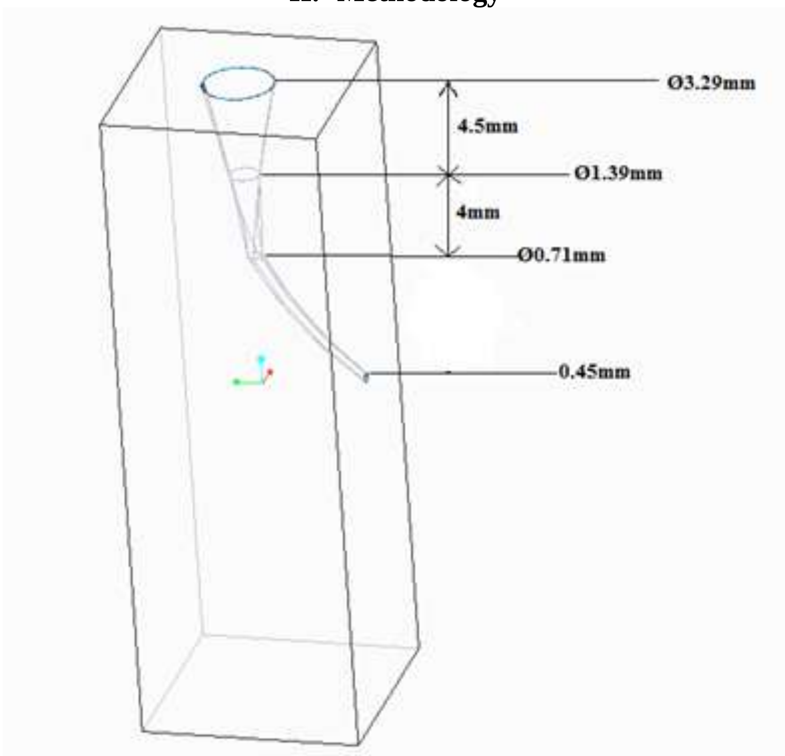

Fig. No.2.1:- Root Canal Block

2.1 STATIC ANALYSIS

Static analysis, also called static code analysis, is a method of computer program debugging that is done by examining the code without executing the program. The process provides an understanding of the code structure, and can help to ensure that the code adheres to industry standards.We are use of static analysis for the analysis of software code without using the software's in-built programs. Static Analysis is generally more beneficial than a dynamic analysis because it: Provides better understanding of the application and its code. Detects more vulnerabilities.

2.2 METHODOLOGY

As above discuss we are done statics analysis of root canal in ansys software, with following properties:-

Selection of statics structural analysis in home screen.Selection of engineering data. In that we have chosen GuttaPercha material and its material parameter like Density (380 kg/m^3),Poisson Ratio (0.45),Elastic module (0.69MPa) . Import Geometry of CAD model. Use Meshing on the model so that we gets accurate result with proper meshing. After we make support to the model and put force on it.Gets result like von misses stress and deformation.

2.3 Methods

This study has been carried out by numerical method of structural analysis of finite elements (FEM, Finite Element Method). Different tridimensional models were obtained by CAT images of an extracted tooth, endodontically treated, filled with guttapercha and triple conical glass post. Images have been elaborated by a software for images (Mimics and Ansys) and CAD (Rhinoceros 3 D). In the models a II Class restoration has been virtually created. In the numerical simulation dental tissues (enamel, dentine and root cement), guttapercha, root canal cement, different posts, different techniques of cementation and crown restoration (composites and adhesive systems) have been considered.

Properties Of GuttaPercha Material For Static Analysis :-

Density (Kg/m^3)	Elastic Modulaus (MPa)	Poissons Ratio	Force Minimum (N)	Force Maxmimum (N)
380	0.69	0.45	3	5

Table No.01:-Properties of GuttaPercha Material

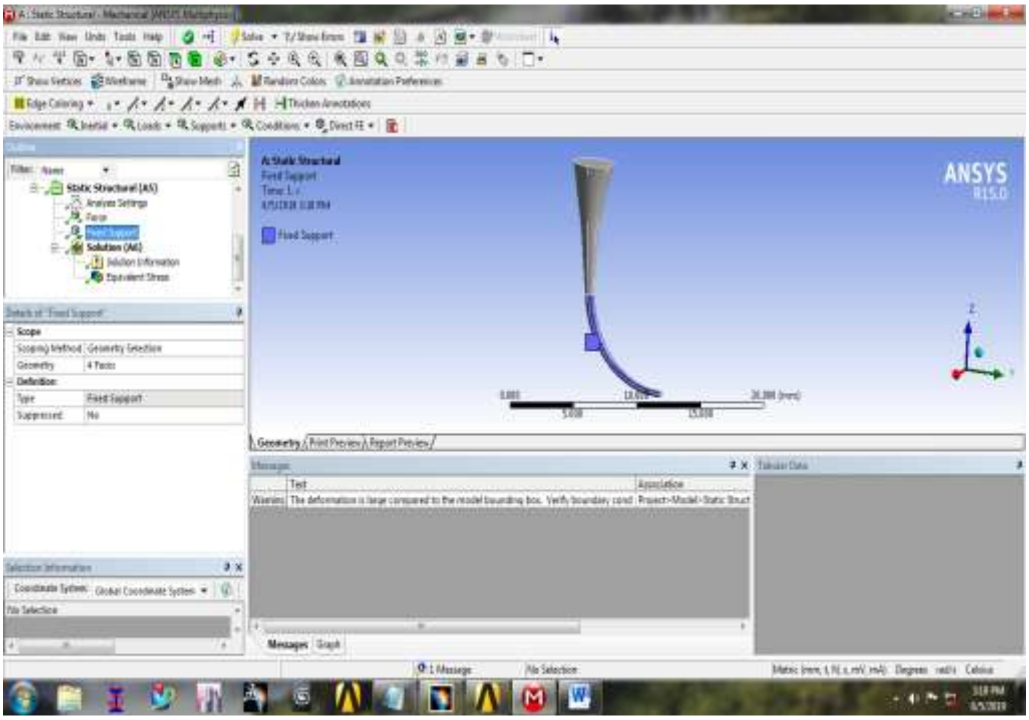

Fig No.3.2:- Fixed Support

After, import geometry into the ansys software apply support to the bottom of the root canal. The blue portion in the fig shows the apply fixed support to canal before apply load onto it.

After applying 3N force on the canal

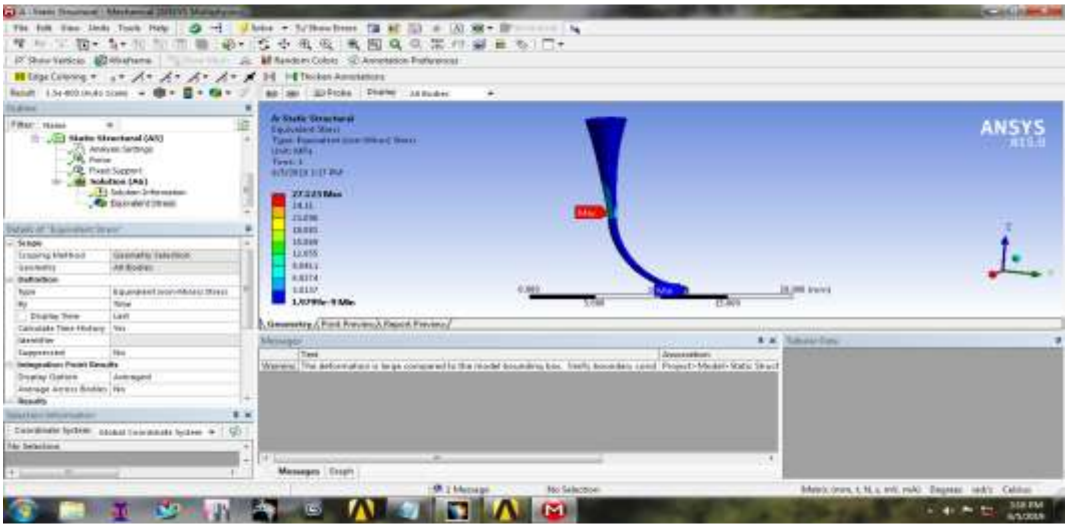

Fig.No.3.3:- Stress Analysis When Applied Force Is 3N

Result is generated, and it shows minimum and maximum force is 1.999 and 27.123MPa. which shows that force acting on the specimen is less than the material yield strength. So that behaviour of specimen at 3N load is safe for application.

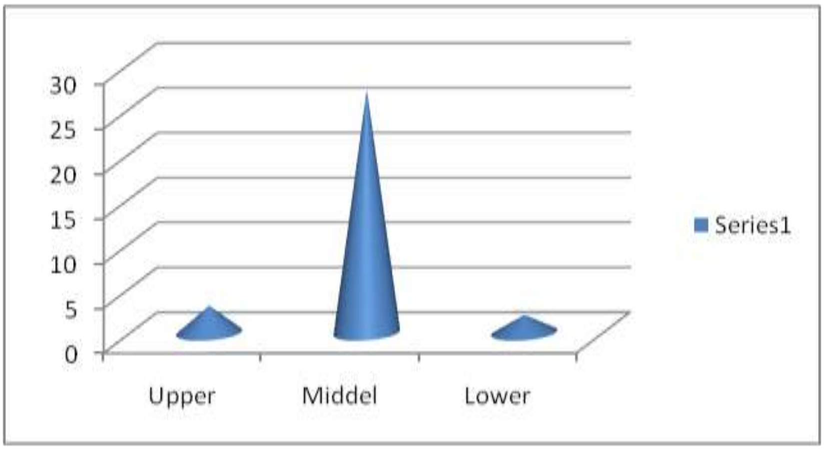

Fig No.:-3.4 Graph Of Stress Consentration When applied Fore is 3N

Terms expliened in Graph are as follows
On X axis
Upper:- Upper Part Of Root Canal
Middel:-Middel Part Of Root Canal
Lower:-Lower Part Of Root Canal

On Y axis
Equivalent (Von-Mises)Stress
Unit:- MPa

Maximum Stress :- 27.123MPa (At Middel Part Of Root Canal)
Minimum Stress :- 1.999MPa (At Lower Part Of Root Canal)

After applying 5N Force on the canal

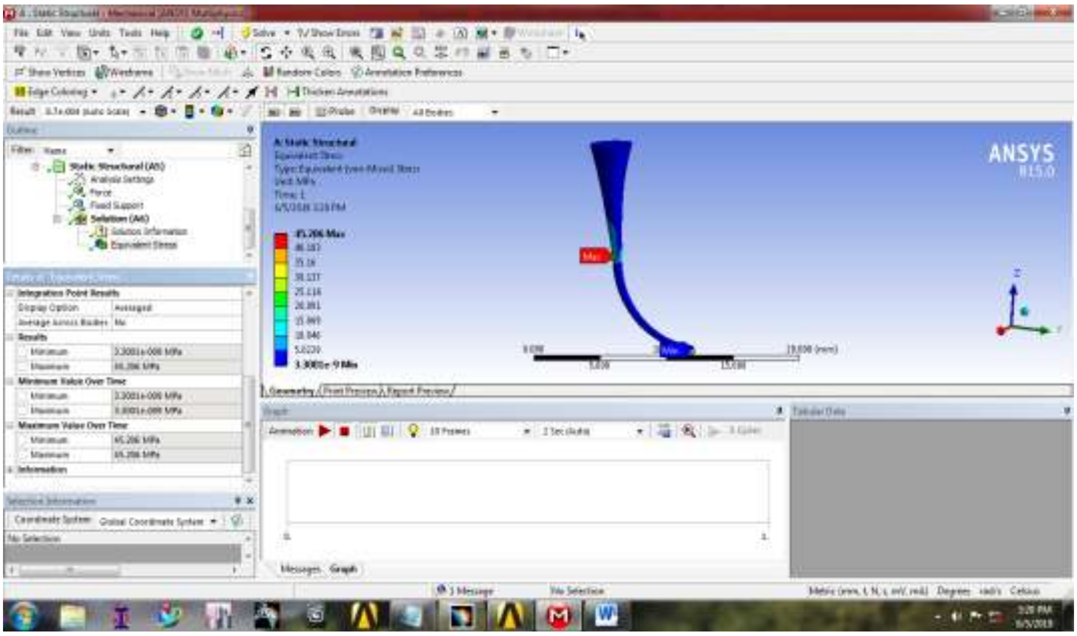

Fig.No.3.5:- Stress Analysis When Applied Force Is 5N

Result is generated, and it shows minimum and maximum force is 3.3001 and 45.206MPa. which shows that force acting on the specimen is less than the material yield strength. So that behaviour of specimen at 5N load is safe for application.

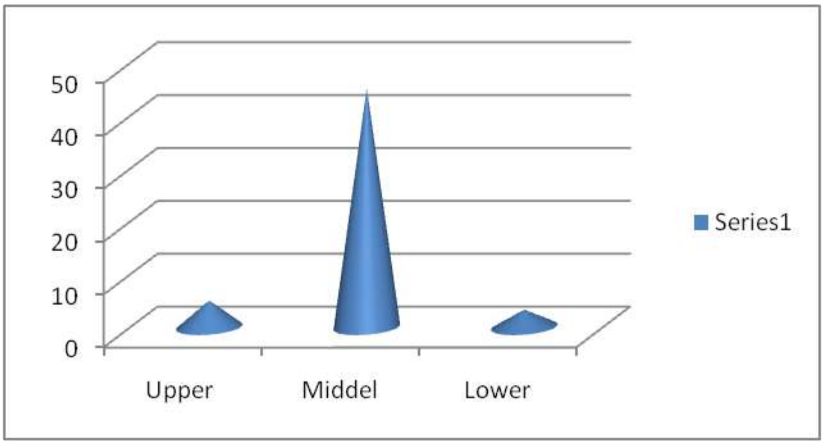

Fig.No.3.6:- Graph Of Stress Consentration When Applied Force Is 5N

Terms expliened in Graph are as follows
On X axis
Upper:- Upper Part Of Root Canal
Middel:-Middel Part Of Root Canal
Lower:-Lower Part Of Root Canal

On Y axis
Equivalent (Von-Mises)Stress
Unit:- MPa

Maximum Stress :- 45.206MPa (At Middel Part Of Root Canal)
Minimum Stress :- 3.3001MPa (At Lower Part Of Root Canal)

III. Result

Strain distributions in dental tissues, in root canal guttapercha and in posts have been compared. The equivalent tensions and the single components (traction, compression and cut) have been analysed. In all examined posts, the most strained part is resulted the coronal one, even if the total tension, in the different tooth-post analyzed systems, resulted uniformly distributed. A similar behaviour was shown by the root canal cement.In an industrial scenario a model of a structure can be formed out of photoelastic plastic, and load can be applied to it. Polarized light can be applied to the model and areas of high levels of stress will reveal more colorful light fringes than the other areas. Thus, all the breakage vulnerable areas can be easily detected and necessary precautions can be implemented.

IV. Conclusion

According to the analyzed conditions of bond and load, varying according to the geometry of the considered posts, our results confirm that there is no substantial difference of deformation in posts, root canal cement and treated tooth.

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