The use of better materials in the place of existing materials is much more need to improve the working conditions and obtaining the better result in the various engineering applications especially in the fabrication of automotive and air craft structures. The composite materials are one of the latest using materials in the fabrication of aircraft structures. With the consolidation of composite materials for the construction of aerospace structures, enormous effort is currently being focused on the development of smart or intelligent structures.

2.1 Introduction to Composites:

The composite material is defined as the combination of two or more chemically distinct phases of materials and the resulting properties of the composites are more superior to the individuals. The two constituent phases are called as ‘reinforcement phase’ and ‘matrix phase.’ Sometimes due to chemical interactions or other processing effects an distinct phase is formed in between the reinforcement and matrix phase and is called as an inter phase.

The small and discontinuous phase is called Reinforcement phase and it is strong, stiffer and main load bearing phase. The large and continuous phase is called Matrix phase and it is the weaker one whose sole purpose is to transfer the load to the reinforcements also it protects the reinforcement from external damage.

The composite materials are broadly classified in to three classes such as:

- Particle Reinforced Composite Materials.
- Fiber Reinforced Composite Materials.
- Structural Composites.

The Particle reinforced composite are further classified in to two types based on the size of the particle such as Small or Dispersed Strengthen particle composites and large particle composites. If the size of the particle is 10 to 100 nanometers the particle composites are called as Small or Dispersed Strengthen particle composites, if the size of the particle is greater than the 100 nanometers then it called as large particle composites.
The Fiber Reinforced Composites are mainly two types, they are short fiber reinforced composite and Aligned or Continuous Fiber reinforced composites. Further the short fiber reinforced composites are observed in two styles such as aligned and randomly oriented particle composites. From the literature study of different authors it is noticed that if the length of fiber range is 1-5mm then it is treated as short fiber composites otherwise it considered as long fiber composite.

The Structural composites are available in two types those are laminate composites and sandwich composites. Further the composite materials are classified based on their existence as Natural composites and Man Made composites or artificial composites. Natural composites exist in both animals and plants. Wood is a composite – it is made from long cellulose fibers (a polymer) held together by a much weaker substance called lignin. Cellulose is also found in cotton, but without the lignin to bind it together it is much weaker. The two weak substances – lignin and cellulose – together form a much stronger one. The bone in your body is also a composite. It is made from a hard but brittle material called hydroxyapatite (which is mainly calcium phosphate) and a soft and flexible material called collagen (which is a protein). Collagen is also found in hair and finger nails. On its own it would not be much use in the skeleton but it can combine with hydroxyapatite to give bone the properties that are needed to support the body.

Early composites, people have been making composites for many thousands of years. One early example is mud bricks. Mud can be dried out into a brick shape to give a building material. It is strong if you try to squash it (it has good compressive strength) but it breaks quite easily if you try to bend it (it has poor tensile strength). Straw seems very strong if you try to stretch it, but you can crumple it up easily. By mixing mud and straw together it is possible to make bricks that are resistant to both squeezing and tearing and make excellent building blocks. Another ancient composite is concrete. Concrete is a mix of aggregate (small stones or gravel), cement and sand. It has good compressive strength (it resists squashing). In more recent times it has been found that adding metal rods or wires to the concrete can increase its tensile (bending) strength. Concrete containing such rods or wires is called reinforced concrete. Making composites most composites are made of just two materials. One is the matrix or binder. It
surrounds and binds together fibers or fragments of the other material, which is called the reinforcement.

Modern examples, the first modern composite material were fiber glass. It is still widely used today for boat hulls, sports equipment, building panels and many car bodies. The matrix is a plastic and the reinforcement is glass that has been made into fine threads and often woven into a sort of cloth. The glass the glass is very strong on its own but brittle and it will break if bent sharply. The plastic matrix holds the glass fibers together and also protects them from damage by sharing out the forces acting on them.

Some advanced composites are now made using carbon fibers instead of glass. These materials are lighter and stronger than fiberglass but more expensive to produce. They are used in aircraft structures and expensive sports equipment such as golf clubs. Carbon nanotubes have also been used successfully to make new composites. These are even lighter and stronger than composites made with ordinary carbon fibers but they are still extremely Composite materials. They do, however, offer possibilities for making lighter cars and aircraft (which will use less fuel than the heavier vehicles we have now). The new Airbus A380, the world’s largest passenger airliner, makes use of modern composites in its design. More than 20 % of the A380 is made of composite materials, mainly plastic reinforced with carbon fibers. The design is the first large-scale use of glass-fiber-reinforced aluminum, a new composite that is 25 % stronger than conventional airframe aluminum but 20 % lighter.

Again the composite materials are classified based on the type of matrix used, so the composites on these criteria are:

- Polymer Matrix Composites (PMC).
- Metal Matrix Composites (MMC).
- Ceramic Matrix Composites (CMC).
- Carbon Graphite Matrix Composites (CGMC).

The Laminated composites are formed by bonding the layers of fiber reinforced composites to get the desired engineering properties such as in plane stiffness, bending stiffness, buckling strength, natural frequencies, and hygro-thermal expansion. The hybrid composite are also formed by bonding the different layers of materials. The individual layers generally
are orthotropic (that is, with principal properties in orthogonal directions) or transversely isotropic (with isotropic properties in the transverse plane) with the laminate then exhibiting anisotropic (with variable direction of principal properties), orthotropic, or quasi-isotropic properties. Depending upon the stacking sequence of the individual layers, the laminate may exhibit coupling between in plane and out-of-plane response. An example of bending-stretching coupling is the presence of curvature developing as a result of in-plane loading.

At present our focus is completely on the laminated composites and its behavior in the engineering applications. The laminated composites consists of thin layers of different metals bonded together such as bimetals , clad metals, plywood, Formica and so on.. A lamina or ply is a plane layer of unidirectional fibers or woven fabric in a matrix. A laminate is made up of two or more number of unidirectional lamina or plies bonded or staked together at different orientations. The orientation of principal material axes are varies from ply to ply hence it is better in the analysis of laminated composites a common fixed coordinate system can be followed. Normally the orientation of ply is defined as the angle between the reference axes and the material principal axes of the individual ply which is to be measured in anti-clockwise direction on the respective plane.

A composite laminate containing the two or more different materials of the ply, then it is called as a hybrid laminated composite. These are normally two types such as interplay hybrid composites and intra ply hybrid composites. The laminated composites are normally designated in the manner indicating the number of plies, stacking sequence, type and orientation. The exact location or sequence of different plies is called as stacking sequence. The laminate composites are fabricated based on its designation and few examples of such are cross ply, angle ply, symmetric, anti-symmetric, unidirectional, multidirectional, balanced, unbalanced etc. The design of laminated composites are mainly involved the study the effect of various induced stresses which cause the failure of the laminate. Normally the main failure of laminated composites is ‘delamination’ this failure is due to the interlaminar stresses.

The functional analysis of laminated composite plates is very important in the present engineering applications especially in aircraft applications. The continuous investigation has been focused on the new intelligent materials in the recent researches. Using piezoelectric materials along with conventional composite materials can give the better control over the
deformation of the structures when they are subjected to external loading. In the design of dynamic structures, the knowledge of static bending, vibration and transient analysis are very much useful.

Many investigators are proposed different analytical solutions and theories for laminated composite plates subjected to electromechanical loading. The following section is dealt with the literature review of analysis of different plate theories on composite materials.

2.2. Static Bending analysis:

Nilanjan Mallik and M.C.Ray [1], have presented an exact solutions for static analysis for simply supported symmetric and anti-symmetric cross-ply smart composite laminated plates. They investigated the suitability of piezoelectric fiber reinforced composite materials as the distributed actuators for the smart composite plates. The expressions for the displacements, stresses, strains and electrical potential are to be derived for each layer of plate by satisfying the all boundary and interface continuity conditions. The PFRC layer becomes more effective in defending the deformations of thick plates than the thin plates. The exited PFRC layer causes better coupling and stretching in case of symmetric cross-ply plate. The transverse normal, transverse shear stresses and in plane shear stresses are studied for different aspect ratios, orientations with and without applied voltages.

S.M.Shiyekar and Tarun Kant [2] have proposed a higher order shear and normal deformation theory with 12 parameters in the displacement field. Taylor’s series has used to analyze the thickness coordinates in the developed model. The governing equations of equilibrium are obtained by the approach of minimum potential energy principle. The solutions are achieved by using Navier’s method. The variation of normalized in plane displacements, transverse displacements, normal stresses,transversre stresses with respect to different aspect ratios, thickness ratios, different voltages are studied. The obtained results it observed that actuating effects are more in the case of thick laminates rather than thin laminates. The effect of actuation is observed at the interfaces of the laminates and they are compared along the both –x- and –y- axis for the normal and transverse shear stresses.

A.M.A.Neves et al [3] are proposed Murakami’s zigzag theory for functionally graded materials. The thickness stretching effects are studied for functionally graded sandwich plates. In this work a new hyperbolic sine zigzag function is used in the displacement field for the analysis. The Carrera’s formulation is interpolated by collocation using RB functions to formulate the
respective governing equations and boundary conditions. It is concluded that the deflections in sandwich plate is increases with the increase of the index of power law of the material. It is observed that the transverse displacements are decreases with the increase with ratio of core to plate thickness.

Jafar Rouzegar and Farhad Abad [4] have proposed a four variable refined theory to analyze the parabolic variation of transverse shear stresses in the absence of shear correction factor. A doubly sinusoidal mechanical load is applied on smart plate without and with applied voltage of positive and negative polarity. The governing equations of motion are obtained by using the minimum potential energy principle and corresponding solutions are gained with the help of Navier’s technique. The investigation is focused on the effects of the thickness ratio, stacking sequence, number of layers aspect ratios, various voltages to analyze the variations in the displacements and stresses in the smart laminated plates subjected to electro-mechanical loading. In this formulation only four unknown variables are used to be compared with other investigations and it is simple and accurate one. The induced normal stresses and displacements are reduced by increasing the number of layers in square laminates.

Diego Amadeu F.Torres and Paulo de Tarso R.Mendoca [5] have developed the higher order shear deformation theory for layer wise analytical solution for smart plates. The Maxwell relations and thermodynamic principles can give the good coupling between the mechanical, electrical and thermal fields. The kinematic hypothesis is obtained by Equivalent Single Layer methodology. The governing equations in terms of inertia forces are obtained from principle of virtual work. The possible observation from the study is that the applied voltage changes effectively the response of thin plates. The variation in stiffness among the materials causes the low applied voltage increases the normal stress in the layer contacted with the activated layer. It is concluded from this theory a piezo layer can be placed any position in the laminate thickness.

Tarun Kant,S.M.Shiyekar[6],are expanded the primary displacement terms in thick coordinates of composite laminated flexural plate in the proposed higher order shear and normal deformation theory. An analytical solution is developed for piezoelectric plates with eight degrees of freedom. Exact variation of electric field is obtained in piezo layers by solving the second order differential equation satisfying the boundary conditions. The governing equations of motion are obtained with principle of minimum potential energy and solutions are by Navier’s technique. The effect of electrical potential on the piezoelectric plates under single sinusoidal
electro-mechanical loading is investigated. The results are obtained for normal and transverse stresses, displacements, with respect to different aspect ratios, thickness ratios for various voltages.

P.Ravikant Raju et al [7] have studied the responds in molecular structure and ways of its control for smart composite materials subjected to electro mechanical loading. The proposed higher order shear deformation theory is applicable all type of smart materials such as piezoelectric, magneto-rheostat, electro-rheostat and shape memory alloys. The formulation of higher order theory and constitutive equations are by using the principle of potential energy and Hamilton’s principle. The variation of non dimensional transverse displacement and transverse shear stresses with aspect ratios and thickness ratios are studied under various with and without applied voltages. The shear deformation effects are crucial one to consider in the design of smart laminated composites.

Sang Jin Lee and Ha Ryong Kim [8], are developed FE analysis for smart laminated composite plates. A Four node element is newly invented by using higher order shear deformation theory. In formulating the displacement field; it is assumed that the strains are neutral. Seven degrees of freedom per node is formulated using iso parametric formulation. The kinematical hypothesis is obtained by using the minimum potential energy principle. The non dimensionalized centre deflection and stresses for assumed boundary conditions under sinusoidal loading is studied. The in plane stresses, transverse shear stresses also investigated under sinusoidal loading with different aspect ratios, thickness ratios, and number of layers. From the numerical results it is found that the present FE analysis will not produce any locking phenomena for the cases having very small aspect ratios and it can be positively applied for laminated composite structures.

A.M.Naserian Nik, M.Tahani [9], is introducing the arbitrary boundary conditions for bending analysis of laminated composite plates. Most of theories used the Levy’s solutions to solve the governing equations of motion. The proposed arbitrary method is based on the separation of special variables from the displacement field. The results obtained by this method are closely agreement with the Levy’s method.

Bouazza Mokhtar et al [10] is strongly emphasized the considering the normal shear stresses in the case of thick laminated composite plates. So there is a significant focus on the transverse shear strains. The FEM is used for the bending analysis of the laminated plates in this
study. The results are obtained with ANSYS software and compared with available results from literature and concluded that there is a close agreement between them. They found that the longitudinal stress is higher than the transverse stress.

Md Iftekhar Alam and Tasmeem Ahmad Khan [11] have studied various analyses related to laminate composite plates using higher order theories. It is concluded that the transverse stains and shear stresses are varies in the direction of thickness of plate. In this they studied the classical plate theory and its extension such as classical laminated plate theories like first order shear deformation theory. This study mainly focus on the deflection in the rectangular plates with SS conditions, which are varied with respected to aspect ratio, thickness ratio, and different ply angles under different loadings. From this it is observed that the deflections are decreased with the increase in side to thickness ratio.

P.Nanderpour et al [12] have investigated the non linear bending analysis of functionally graded plates under mechanical loading. In this work a third order shear deformation theory is developed and the governing equations of motion are obtained by using principle of virtual work. The main advantage of this method is the whole plate is assumed as one element. The transverse shear strains and Von Karman non linear strain displacements are reckoned in this work. The results of non dimensional central deflections with various aspect ratios, side to thickness ratios, numbers of interpolation functions are obtained and all are compared with available literature results and concluded satisfactory.

B.N.Pandya and T. Kant [13] are developed a higher order displacement model to study the finite element analysis of laminated composite plates. The theory involves a $C^0$ finite element formulation for thick composite laminated plates under transverse loading. The proposed element is nine node quadrilaterals with nine degree of freedom per node. The shear correction coefficients are completely eliminated in this theory. The effect of inter laminar stresses are studied. The in plane lamina stresses are evaluated as usual manner by using available literature.

Klaus Rohwer et al [14] have emphasized the need to use in plane derivatives at least cubic shape functions. The in plane stresses are fully enough to estimated the structural strength of plates. The proposed theory is quite good for both mechanical and thermal loads. The cubic and fifth order polynomials of displacement distribution in the thickness direction will gives the better results.
Ngo Nhu Khoa et al [15] have developed a higher order shear deformation theory based of a rectangular non conforming element. The displacement model is formulated based on Reddy’s model. This model is containing four nodes and each node is having seven degrees of freedom. The field variables are expressed in terms of number of nodes, Lagrange interpolation functions and Hermits interpolation functions. The static behaviour of the plate is analyzed by finite element analysis. The element is tested for various boundary conditions, staking sequences, material properties, loads etc.

T.K Meghare et al [16], are submitted a paper on simple higher order theory for bending analysis of thick isotropic steel beams. The elementary theory of beams is the basis for developing the higher order theory. The shear correction factors are not required for this work. The displacement field and equations of motion are obtained by using the principle of virtual work, and the solutions are by using Navier’s technique. The results are computed for variations of in plane displacements, transverse displacements, normal and transverse stresses with respect to different aspect ratios, subjected to sinusoidal loading.

Bharati M.Shinde et al [17], are investigated a refined higher order shear deformation theory for isotropic and orthotropic plates in order to analyze its bending characteristics subjected to different loadings. The shear stress at top and bottom of a plate is assumed zero and shear correction factors are neglected in this proposed theory. The displacement field contains new variables with trigonometric functions. The equations of motion are formulated by using virtual work concept and the solutions are obtained by using Navier’s double trigonometric technique. The results are obtained for sinusoidal, uniformly distributed and linearly varying loads.

N.D.Phan and J.N.Reddy [18] are developed a displacement finite element model theory using higher order shear deformation theory. The theory mainly accounts for parabolic distribution of transverse stresses by neglecting the shear correction factors. The investigations in the present work are the bending, vibration and transient characteristic of laminated composites.

Neser U.Ahmed et al [19 ], has developed higher order theory based model for composite plates .In this paper three displacement fields are used for general composite laminates and it is sufficient only two displacement fields for special laminates such as cylindrical shells. The displacement field is a product of two variables in this work one variable is for in plane displacements and other is for out of plane coordinates.
J.G. Ren, E. Hinton [20], have developed a new two finite elements for investigating the bending characteristics of laminated composite plates using the different higher order theories available in Reddy’s and other proposed literature. This theory allows the parabolic distribution of transverse shear strains in thickness direction of plates. The solutions obtained here are closely matches with exact solutions in the literature.

J.L. Mantari et al [21] have given a new higher order shear deformation theory for sandwich and composite laminated plates. The displacement field in this one is ‘m’ parameter dependent. The governing equation of motion and the boundary conditions are obtained by principle of virtual work and the solutions are by using Navier’s method. In this the distribution of transverse shear strains through the plate thickness and the tangential stress free conditions on the plate is studied. The bending response of plates is analyzed under sinusoidal and uniformly distributed loads.

R.C. Batra and S. Vidoli [22] are proposed a higher order piezoelectric plate theory. The development of theory is based on the 3 dimensional mixed variation principles. The displacements and stress tensors are expressed in the thickness coordinate. The results are analyzed for bending of cantilever type thick plate subjected to top and bottom by uniformly traction normal, tangential loading.

Y.X. Zhang et al [23] have presented a paper on laminated plate elements based on the higher order shear deformation theories. The exact structural behavior can be predicted with the help of developing an accurate and efficient finite element models. The object of this investigation is a finite element analysis is carried by using the various laminated plate theories.

A.J. Ferreira et al [24] are recommended two higher order zigzag theories for composite laminated plates. The developed theory is obtained by the combination Carrera’s Unified Formulation and Radial Basis function collocation approach to investigate the bending, vibration and buckling characteristics of thick and thin plates. The Murakami’s zigzag function is the crucial in the development of the two theories. The caliber of the collocation technique for the said investigated characteristics is measured by this study.

Nawale V.D et al [25], are used the FEM analysis to investigate the bending behavior of laminated composites by using the classical laminate plate theory. The mathematical formulation is by CLPT and the solutions are obtained with the Navier’s technique. The present bending
analysis is carried for the conoidal laminated composite shell under uniformly distributed loads for its stacking sequences varied to different aspect ratios and degrees of truncation.

T.Kant and K.Swaminathan [26] are found the analytical solutions to study the static behavior of the laminated composite and sandwich plates. The higher order theory is developed and the equations of equilibrium are obtained by using the principle of minimum potential energy. The solutions are attained by using the Navier’s approach. The results are computed for in plane normal and shear stresses, displacements for various aspect ratios, side to thickness ratios under sinusoidal loading.

A.R.Setoodeh and A.Azizi [27] are presented a refined shear deformation theory. The bending and vibration response of laminated composites on elastic foundations has been investigated. A first order shear deformation theory is developed and the Winkler-pastern model is considered to study the coupling relation between the plates and foundation. The governing equations of motion are obtained by Hamilton’s principle. The deflections and natural frequencies are investigated for elastic foundation parameters, degrees of orthotropy, aspect ratios, side to thickness ratios.

M.A. Torabizadeh et al [28], are carried a Navier type bending analysis on laminated composite plates subjected to thermo mechanical loading. The governing equations of motion are derived by using the classical laminate plate theory. The strain - displacement relations are obtained by using the Von Karman strains and the equations of equilibrium can be derived by using the variation principle. The two boundary conditions SS1 & SS 2 types are used and the solutions are obtained by the Navier’s methodology. It is observed that the bending – stretching coupling coefficient are influencing the thickness of laminate composites under sinusoidal loading.

Ali Mohammad Naserian Nik et al [29] are presented a Kantorovich method for analytical solution for rectangular laminate plates to investigate its bending characteristics. The method is mainly based on the separation of spatial variables in the displacement field. The formulation the displacement field is by using CLPT and FSDT. The equilibrium conditions are obtained by using the potential energy principle and the solutions are Levy’s method.

Belkacem Adim et al [30] have presented a refined shear deformation theory for the bending analysis of composite plates under different boundary conditions. The displacement field is developed such that the in plane displacements varies none linearly through the thickness
direction of the plates. The equations of motions are obtained by using Hamilton’s principle. The proposed theory is simple compare with other theories due to dividing the transverse displacements into bending and shear parts and making further assumptions and hence reduction in the number of unknowns in the equations of motion.

Upendra.N and Reddy.B Sidda et al [31] have presented a mathematical formulation and solutions based on the HOSDT to study the bending response of laminated composite plates. The kinematic hypothesis is obtained by Hamilton’s principle. The conditions of equilibrium and solutions are by using the Navier’s method. The results are computed for deflections and stresses for the various aspect ratios, side to thickness ratios, degree of orthotropic, stacking sequence and number of layers.

A.Y.T.Leung et al [32], are invented a new unconstrained third order plate theory to account the bending and stress analysis of multilayered symmetric composite laminated plates by using Navier’s solutions. This theory is useful for the plates under contact frictions and fluid frictions where normally boundary layer is existed. In this theory the shear correction factors are considered but the higher order rotations are neglected.

Padmanav das and B.N.Singh [33], are carried the work on geometrically non linear analysis of laminated composite plates. The governing equations of motion are formulated by using higher order shear deformation theory. A $C^0$ isoparametric finite element with 10 field variables is used in the present analysis. The transverse strains are neglected on the top and bottom of the plates. The transverse bending of the plate is accounted by Green Lagrange sense.

Tran Ich Thinh et al [34] have presented the bending and vibration analysis of multi folding laminated composite plates based on the first order shear deformation theory. An eight nodded rectangular isoparametric element with five degree of freedom is employed in the study. The effect of folding angle on deflections, natural frequencies and transient displacements on the plates are investigated. The Reissner-Mindln plate theory is the basis of the development of the theoretical formulation. MAT lab coding is used for obtaining the numerical results.

Jeeoot Singh and Sandeep Singh [35], are performed the bending, buckling and vibration analysis of laminated composite plates using a mesh less collocations. A radial basis function is involved in the formulation by using higher order shear deformation theory. In the present work a 3 & 4 layered composite plate with SS boundary conditions subjected to transverse loading is
considered. The effects of aspect ratio, modular ratio, and span to thickness ratio, number of layers on the bending, vibration and buckling of laminated composite plates are investigated.

2.3. Vibration analysis:

T.Kant and K.Swaminathan [36] have developed analytical formulations and solutions to find the natural frequencies of sandwiched laminated composite plates using higher order refined theory. This theory gives the effect of transverse shear deformation, transverse normal stresses and strains, variation of in plane displacements with respect to thickness coordinates. In this theory Hamilton’s principle is used for developing the equations of motion. The solutions are achieved in close form by using Navier’s principle and by solving with Eigen value equation.

Rajan L.Wankhade and Kamal M.Bajoria [37] have analysed free vibration and shape control of annular circular plates and rectangular plates embedded with piezoelectric materials. They used first order shear deformed theory in the analysis. In the formulation a four nodded rectangular isoparametric element is used. The vibration analysis is done by using rectangular plate shear actuator. The numerical results are obtained for different voltages and different plate thicknesses.

M.Rastgaar Aagaah et al [38], have developed Third order shear deformation theory, which is categorized in equivalent single layer theories. FEM is used for solving the equations and the fundamental natural frequencies are computed for angle ply and cross ply laminates. They developed seven – parameter displacement field by using the shear deformation theory. They assumed that the plate is simply supported at two edges with the two other edges with the different combinations of boundary conditions. The results are obtained for non dimensional natural frequencies with respect to different modular ratios, aspect ratios; different orientations with the different support conditions for both square angle ply and cross ply laminated plates.

Shiuh-Chaun Her and Chi-Sheng Lin [39], are used piezoelectric patches as a surface bonded to laminated composite plates to analyze the vibration characteristics. The piezoelectric patches are subjected to time harmonic voltages as a load to analyze the vibration response. They developed FEM by using ANSYS software and obtained the various mode shapes of exited plate model. The model has been applied to simply supported cross-ply and angle-ply plates bonded with piezoelectric actuators on both sides and exited by time harmonic electrical loading. The results expressed for the amplitude of vibration with different side of the plates with three different exiting frequencies.
J.Suresh Kumar et al [40] have developed a higher order shear displacement model with zigzag function to analyze the vibration characteristic of the laminated composite plates subjected to electromechanical loading. The investigations for failure mechanisms are vital in design of composite structures, by using zigzag functions; the slope discontinuities at the interfaces of laminated composite plates are improved. In this analysis the displacement models are obtained by the governing motions of equation and solutions are obtained by using Navier’s method. The assumed boundary conditions SS1 & SS2, the numerical results are computed for both anti-symmetric cross-ply and angle-ply composite laminated plates. It is noticed that the higher order theories are improved by using zigzag functions and it is further reduces the natural frequencies.

B.Sidda Reddy et al [41] have developed the higher order shear deformation theory to study the free vibration behavior of the functionally graded materials. In this study they are enforcing the zero transverse shear stress on the top and bottom of the functionally graded laminated composite plates. The Hamilton’s principle is used to derive the governing equations of motion and the solutions are obtained by Navier’s method. The transverse effects caused by the transverse inextensibility are mainly considered in the developed model. The effect of side to thickness ratio, effect of anisotropy and aspect ratios on fundamental non dimensional frequencies is studied.

A.J.M.Ferreira et al [42] are developed a layer wise theory for laminated composite plates. The static deformations and free vibration of isotropic laminated plates are presented. Pseudo spectral methods are used as solvers for partial differential equations. They also proposed layer wise theories and radial basis functions to analyze the static behavior of laminated plates in early studies. The equations of motions were derived and solved by collocation method. The different modes of vibrations are studied for three and four layer square laminated plates with respect to aspect ratios under sinusoidal loading.

F.Ebrahimi and A.Rastgo [43] have performed free vibration analysis on FGM plates subjected to electro-mechanical loading. The displacement field is developed by classical laminate plate theory (CPT). The governing equations are obtained by using Kirchhoff assumptions. The properties of the FGM plate material changes in the direction of thickness of plate when subjected to smart loading. The results are obtained for free vibration frequencies with different power indices of FGM plate.
Tran Ich Thinh and Le Kim Ngoc [44] have done the research on static and dynamic response of composite plates. They investigated that the induced natural frequencies of vibrations are depends on the position of sensors and actuator on the plate. It is also observed from their study, the shape control of piezoelectric laminated plates can be successfully achieved by the active and passive control of actuators. In this work a first order shear deformation theory was developed and a nine node rectangular element is considered. The influence of ply angle, stacking sequence, piezoelectric layer location and also the influence of sensor/actuator location on plates has analyzed.

Yunying Zhou and Jun Zhu [45] are proposed a new third order shear deformation theory to investigate the vibration and bending characteristics of magneto-electro-elastic rectangular plates. The present theory is suitable for both thick and thin plates. The obtained results convey that in the thickness direction of plate only the arbitrary properties of material can varied. A sinusoidal spatial load is applied on the top of the plate in this study and the results are obtained for varying material gradients profile and length to thickness ratios.

Ajay Kumar et al [46] are investigated for induced vibrations in laminated composite cylindrical shells with cut outs using a higher order theory. The main aim is analyzing the parabolic distribution of transverse shear strains through the thickness of the plate shell. A C^0 continuous finite element is formulated based on the higher order theory and it is having nine nodes with seven unknowns per node. The governing equations are developed and the linear strain displacements are obtained by Sander’s approximation method. The fundamental natural frequencies of free vibrations for various aspect ratios, thickness ratios for first four modes are computed.

Chen cc et al [47], have considered thick laminated rectangular plates for investigation of vibration characteristics in their proposed theory. The mathematical formulation is derived for admissible displacements and rotation functions by using p- Ritz method. The integral energy equations are obtained by higher order shear deformation theory. The Free vibration analysis is solved by using higher order shear deformation theory has been integrated by p- Ritz method with various boundary conditions. The effect of degree of orthotropy, boundary conditions, plate aspect ratio, length to thickness ratio, lamination angle on fundamental natural frequency is investigated. It has been observed that the fundamental natural frequencies increases with aspect ratio in case of simply supported plates and decreases in case of cantilever type supported plates.
Deepanshu Bhatt et al [48], are reviewed a static and free vibration analysis of laminated composite plates using finite element method. The review is based on the various proposed higher order theories in the literature. A finite element model is developed by using ANSYS software. The static and free vibration analysis of orthotropic laminated composite plates for different material is investigated. The SHELL 181 and 281 element models are used in this analysis.

Ognjen Pekovic et al [49] are performed vibration and buckling analysis on laminated composite plates. A third order shear deformation theory has been developed and the formulation is completely based on the NURBS functions varying degree. The isogeometric approach is followed in formulation of the model. In this the purpose of using NURBS is to provide a good control over the shape with low memory consumption. The governing equations for displacement field are obtained by using conventional principle of virtual work. In this theory the field variables are in plane displacements, transverse displacements and rotations. In the free vibrations analysis, the performance of the cubic and quadratic isogemetric elements is investigated. In this theory the usage of shear correction factors are completely avoided.

G.P.Dube et al [50] are expanded the transverse displacements in the thickness direction of laminate plates. In this investigation a unified non linear formulation of all higher order theories are proposed for cross ply laminates. The kinematic hypothesis is obtained by using principle of virtual work and the solutions are by Navier's method. The linear static and free vibration analysis is done on the plates under in plane loading conditions. A common usage programmed has been developed for all higher order theories.

Chuanmeng Yang et al [51], are introduced an accurate modified Fourier method particularly intended first order shear deformation theory to investigate the vibration and damping characteristics of laminated sandwiched composite plates. The displacement field is formulated in developed theory, in which the displacements at the middle of plate has expanded by using Fourier series and auxiliary functions. This method can be suitable for any kind of boundary conditions and it is an efficient and accurate one. In the present work classical boundary conditions, elastic boundary conditions and their combinations are studied. The natural frequencies of clamped sandwich plates with different aspect ratios, thickness ratios under various boundary conditions are computed. Also the effect of core thickness on the induced frequencies is studied.
Asghar Noiser et al [52] are developed a layer wise theory for laminated plates for analyzing its free vibration characteristics. The equations of motion are solved by using state space variables and transfer matrix and the clear analysis is carried by uncoupling the Navier’s equation. The results obtained are compares with CLPT, FSDPT and THSDPT. The various mode shapes and Natural frequencies of the composite plates are studied.

M.A.Askari Farsangi et al [53] are presented an analytical solution for moderately thick hybrid piezoelectric laminated plates to study the free vibration characteristics. The plate deformations are obtained by Mindlin plate theory and the electrical potential is by Maxwell’s equation. The governing equations are derived by Hamilton’s principle and the solutions are by Levy’s principle. The laminate frequencies are analyzed for various thickness ratios and aspect ratios. M.A.Askari Farsangi et al [54] have developed a Levy type solution for free vibration analysis of functionally graded rectangular plates with piezoelectric layers. The transverse distribution of electrical potential for piezoelectric layers under electrical boundary conditions satisfies the Maxwell’s principle. The developed first order shear deformation theory involves the formulation of governing equations and the solutions are by Hamilton and Maxwell’s equations. For the assumed Levy type boundary conditions, the natural frequencies are obtained for different plate sizes, power law indices under mechanical and electrical boundary conditions.

Rajan L.Wankhade and Kamal M.Bajoria [55] are presented a paper on stability of piezo laminated composite plates with simply supported boundary conditions by using finite element method. The formulation of this model is based on the higher order shear deformation theory. The stability, vibration, shapes and buckling of smart structures are analyzed in this study. The strain displacement relations are obtained. An eight node degenerated quadrilateral shell element and its shape functions are developed the natural frequencies are computed by solving Eigen value problem. The stability problems, the natural frequency become zero and the equation for stability will be achieved.

A.Chattopadhyay et al [56], are studied a nonlinear vibration analysis of smart composite structures using a refined layer wise theory. They investigated the dynamic response and multiple delaminations in the piezoelectric laminated plates. The main aim of this study is to predict the sensor output in the time domain. The governing equation of motion is derived by using bi-coupled electro-mechanical formulation. The existence of delaminations in the plates is
analyzed by implementing an adaptive non linear transient algorithm. This proposed frame work will be useful in structural health monitoring applications.

Namita Nanda [57] was investigated nonlinear free and forced vibration characteristics of piezoelectric laminated composite shells in thermal environment. A C^0 type isoparametric element with eight nodes is considered in the analysis. A first order deformation theory is used and displacement field is by using the Von Karman equation. The solutions for free and forced vibrations by Eigen value method and the transient characteristics are obtained by Newmark’s method. The influence of temperature, number of layers, voltages, curvatures, and thickness ratios are analyzed on vibration and transient response of piezoplates.

P.Phung-van et al [58] are presented a computational approach for piezolaminated composite plates to analyze its non linear characteristics. The derived formulation is based on the isogeometric finite element and the FGM plate with attached piezo actuators and sensors is considered for this study. The theory is formulated for two variable fields, as mechanical displacement field and electrical field. The NURBS basic function is used for smart plate formulation. The electrical potential and material properties are assumed to be varied in the thickness direction of smart FGM plate. The variation of frequency with different modes and the central deflection with time is analyzed in the investigation.

A.A.Jandaghian et al [59] have presented an exact solution on vibration response of FG circular plates embedded with piezoelectric layers. The object is to study the harmonic vibration of FG plates embedded with piezoelectric actuators on its top and bottom surfaces. The material properties are graded by power law and the electric field are varies with the thickness direction of the plate. The governing equations are obtained by using Bessel functions. The deflections and natural frequencies are influenced by the power law index and the thickness of the plate.

J.N.Reddy [60], has submitted an exact solutions of moderately thick laminated shells to investigate its vibration characteristics. A shear deformation theory of laminated shells in extension form for doubly curved shells is developed. Exact solutions of equations are presented for different loadings in this analysis. The transverse shear strains and rotations at the mid surface of the plate are analyzed and the natural frequencies are computed.

Liu Yanhong et al [61] have investigated interfacial imperfections in the composite laminated plates. A three dimensional semi analytical model is developed by using a state space method and linear spring layer model. The free vibration analysis is carried out for stiffed plate
composites in this work. The compatibility of out plane stresses and the displacement discontinuities on the interfaces between the plate and stiffeners, the transverse shear strains, the rotary inertias are to be analyzed by this model. The results are obtained for the study of interfacial stiffness on the four lowest natural frequencies. M. Ganesh Raja et al [62], are formulated a multi objective problem to minimize the residual energy and control the energy of tensegrity structures subjected to vibrations. The optimal placing of the actuators is important in the vibrating structures. The amplitude, displacements of vibrating structures is studied with frequency, time response respectively.

Shankar Ganesh et al [63] are proposing an equivalent single layer theory based on the first order shear deformation theory. The main object is to investigate the free vibration behavior of the delaminated composite plates using the FEM. The SS type and Cantilever type boundary conditions are taken to analyze the problem. The deformations in the composite plates at different locations are computed. Priyanka Jadhav and Kamal Bajoria [64], have presents the stability analysis of piezoelectric FGM plates using FEM. The assumed displacement components of the model are expanded in Taylor’s series in terms of thickness co-ordinates. The model is developed by Von Karman hypothesis and first order shear deformation theory. The effects of power law index and the applied mechanical load are mainly studied in this stability analysis. It is analyzed that the buckling strength of plates are increased with the increase in piezo effects and volume fractions of the materials.

A.M.A. Neves and A.J.M. Ferreira [65], presented an article on free vibrations and buckling strength of laminated plates by using oscillatory RB functions. The present analysis is based on the CLP theory and FSDT theory. The oscillating Gaussian function is the basis of the present work with radial basis function. The fundamental natural frequencies for various modular ratios for simply supported cross ply laminates are studied. Shihao Wu et al [66] presented a free vibration analysis of laminated conical shell by using a domain decomposition method. The theoretical model is developed by modified variation approach and the energy due to Pasternak foundation. The effect of elastic foundation, boundary condition and stacking on the natural frequencies are investigated.

Jinquan Cheng et al [67], are utilized the assumptions of the higher order shear deformation theory to model and analyze the composite laminated plate attached with random poled piezo layers. The governing equations and boundary conditions are obtained by using the
Hamilton’s variation principle. The large amplitude deflection of smart laminated structure is accounted by using Von Karman strains.

A.Chakrabarti et al [68], are pursued the thermal vibrations of composite and sandwich plates by using higher order zigzag theory. The aim of the work is to avoid the stress oscillations in the implemented displacement field. The formulation is made and the thermal loads are applied for various boundary conditions. The thermal vibrations are analyzed for various ply angles, aspect ratios and thickness ratios.

R.C.Batra and S.Aimmanee et al [69] have analyzed the vibration characteristics of thick isotropic plates. The present study is for transverse shear, normal stresses and strains induced in the plate with transaction boundary conditions under loads. A finite element method is based on the HOSNDT plate theory is employed to examine the free vibrations and distribution of stresses in the thick isotropic and homogeneous plates. The numerical solutions are found by using triangular or quadrilateral elements with Lagrange basis functions. The natural frequencies of different mode shapes and stress in the thickness direction are computed for various aspect ratios for simply supported or clamped conditions.

K.Swaminathan et al [70] are presented a state of the review of several methods to analyze the static, dynamic and stability behavior of FGM plates. The present approach investigates the influence of material property variations through the thickness, different loadings, various boundary conditions, side to thickness rations and the effect of nonlinearity on the performance of FGM plates. The complete work is based on the already developed theories and the main aim is to create an interest in the upcoming researchers and scientists in the field of engineering technology.

2.4. Transient analysis:

M.Ganapathi et al [71] have developed a higher order theory by using a $C^0$ eight nodded serendipity quadrilateral plate element to investigate the non linear dynamic analysis for thick composite laminated plates. It is noticed in the work, thirteen degrees of freedom given to the plate. In this analysis the variation in the transverse in plane and transverse displacements are studied. The Green’s strain vector is used in the formulation of geometric non linearity. The Eigen value problem method is used to determine the frequencies of vibrations and the transverse characteristics using Newmark’s integration scheme coupled with Newton Raphson iteration scheme... The non linear forced vibration and flexural deflections of thick laminates are studied
among the separate models of cross-ply and angle-ply laminates. The numerical results are computed for non-linear frequency ratios for various aspect ratios, layer angle and number of layers.

T.Kant, J.R.Komminene [72], have used a $C^0$ continuous finite element in their proposed higher order shear deformation theory. The non linear transient analysis for laminated composite plates and shells is predicted by using the developed theory. The non linear cubical variation in the displacement through the thickness of the shell is analyzed by the investigated theory. The Von Karman assumptions are considered in the formulation to get the effect of geometric non linearity. A nine node iso-parametric quadrilateral element is used in FEM. A symmetric and unsymmetrical cross-ply shell with simply supported boundary conditions is used. The result is computed to time response with stresses, displacements under different loads.

Ilwook Park and Usik Lee [73], have proposed spectral method in the design of smart composites. To study the dynamic response of smart laminated composite structures for the active control of sound and noise of vibrations. In their work a mathematical model has developed and the axial –bending coupled equations of motion and corresponding boundary conditions are derived for two layered smart composite beams by using Hamilton’s principle. The spectral element model is formulated by using variation approach. They are investigated the effect of lay-up technique and bonding of piezo layer on the transverse response of smart composite beams.

P.Ravikant Raju et al [74], are investigated the new smart materials for laminated composites. The transient response of laminated composites is an essential in failure mechanism of laminated plates. The temperature, moisture, electrical and magnetic field, external loads are the main causes the stimulation of smart materials. A higher order theory has developed and the governing equations of motion are obtained, using the Navier’s technique the solutions are obtained for both cross-ply and angle-ply laminates. The transient characteristics are investigated by using the Newmark’s integration scheme. The position of piezo layer is analyzed and it is suggested that the position of piezo layer at the top will give the better effect than other positions. It is observed that the deflection in the plates is reduced if the thickness of plate increases, this is due to the reduction in the induced vibrations.

D.P.Makhecha et al [75] have submitted a paper in which a new higher order theory for dynamic response of several layered laminated composite plates. In the formulation of the
theory, an eight node $C^0$ serendipity quadrilateral element is employed. The in plane and transverse displacements are assumed in the powers of $-z$- axis direction. A multi layered antisymmetric plate is considered for this study. The governing equations are obtained. The solutions are computed by using Newmark’s integral scheme. The influence of higher order terms and zigzag terms on the dynamic response is analyzed. The variation in the in plane and transverse displacements with respect to time are accounted for various mechanical and thermal loads.

M.A.R.Loja et al [76] have presented a new approach of kriging based higher order models for the analysis of sandwich beam structures. The main object the study is investigating the transient characteristics of proposed models. The transverse shear strains varies in the thickness direction of the models with the increasing the power law of the material. The properties of the sandwich plates are estimated by using Mori-Tanaka method and the dynamic analysis is with higher order shear deformation theory based on kriging finite element model. The resultant transient response is by Newmark’s method.

Ali Asghar Jafari et al [77] are investigated transient bending analysis of functionally graded circular plate with integrated surface piezoelectric layers. It is observed from this analysis the power law index and the thickness of the plate have the significant role on the deflection amplitude and the fundamental natural frequency of the functionally graded materials.

S.Pradyumna et al [78] have presented a geometrically non linear transient analysis of FGP using higher order theory. A $C^0$ continuous nodded finite element with eight degree of freedom per node is considered in the formulation of the theory. The transverse shear strain by neglecting the shear correction factor is distributed in parabolic manner in the direction of thickness of plate is assumed. The transient response is analyzed by using power law and volume fraction index of FGP material.

Tasneem Parvez et al [79], are investigated the new refined theory to analyze the transient and damping characteristics of the laminated anisotropic plates. The damped transient response is obtained by using a viscous damping approximation. The effects of transient shear deformation, aspect ratio, anisotropy, lamination scheme, fiber orientations and damped transient response are investigated.

P.Phung Van et al [80] have presented an efficient computational approach for nonlinear transient responses of piezoelectric laminated plates. The geometric elements are used to develop the displacement field and the formulation is by using Lagrange approach and Von Karman
Anindya Ghoshal et al [81] have investigated the effect of delamination on transient history of smart composite plates. In this approach, a new improved layer wise laminate theory contains large deformations and inter laminar contact in the delaminated zone is studied. The governing equations are obtained by electro-mechanical coupled theories. The existence of multiple and discrete delamination s are developed with the Heaviside step functions. The interlaminar stresses which are causing the delamination in the plates are completely arrested by using this theory.

Ming-Hung Hsu [82] has presented a paper on analysis piezoelectric laminated beams subjected to electro-mechanical loading. A differential quadrature method is used for the study on performance of piezoelectric plate beams. The Lamina constitutive equations are obtained by using the conventional theories. The Euler Bernoulli beam is considered and the transverse shear effect is neglected. The transient responses are analyzed by using the Wilson method.

Heung Soo Kim et al [83], are investigated a transient analysis of smart composite structures. The improved layer wise laminate theory is employed in the study. The interlaminar shear stresses are responsible for the composite plate delamination. The present developed theory uses the Fermi-Dirac distribution function to model a displacement field of the delaminated interfaces during the breathing of delaminated layers. The investigation is also involves the study the transient effects due to different sizes and sites of delamination. Yiming Fu et al [84], are carried a non linear dynamic response of piezo laminated plates considering the damaging effects. The Talreja’s damage model is based for computing the internal state variables. The constitutive relations are developed by the classical nonlinear geometric plate theory. The equations are solved by finite element method and Newmark’s integration scheme. The nonlinear response of central deflection with and without damage under different electrical loads is studied.

Namita Nanda [85] has analyzed transient, vibration characteristics of piezoelectric laminated shells in thermal environment. A C^0 continuous eight nodded isoparametric element is employed in the analysis. The displacement field is developed by first order shear deformation theory and the kinematic hypothesis is by using Von Karman equations. The governing nonlinear solutions are solved by using Newmark’s scheme in conjunction with Newton –Raphson method for transient analysis and Eigen value problem solution for vibration analysis. The effects of
voltage, temperature, no of layers, boundary conditions, and thickness on the transient and vibration response of laminated shells are investigated.

Z.Aslan and R.Karakuzu [86], have studied the transient response of laminated composites. The impact characteristics of the composite plates under low weight impact load are investigated. The contact force during the impact is measured by using the piezoelectric transducer. The effect of contact force and transverse displacement at the centre of the plate is analyzed as the time function. The predicted delamination areas for different velocities are observed.

Dharma Raju.T and Suresh Kumar.J [87], are investigated the transient response in smart laminated composite plates subjected to piezoelectric loading. The displacement field is developed by using higher order theory with zigzag function. The kinematic hypothesis is by Hamilton’s principle and the solutions are by using Navier’s technique. The transient response of the solutions is computed by using Newmark’s integration scheme. The presence of zigzag functions in the displacement field can improves the slope discontinuities at the laminate interfaces. The effect of coupling on the transverse response is increases the amplitude and time period of the oscillation.

Mallikarjuna and T.Kant [88] are developed a simple isoparametric finite element formulation for dynamic analysis of laminated composites based on the higher order shear deformation theory. The present developed theory is more accurate than the Kirchhoff’s and Mindlin plate theories. The effects of time, finite element mesh, lamination scheme and orthotropy on the transient response of the laminate plate are investigated. A.K.Naik et al [89] have investigated the transient response of laminated composite sandwich plates based on the Reddy’s refined higher order theory. A C⁰ continuous isoparametric element with four and nine nodes is used in the formulation of the model. The developed theory intended for parabolic variation of transverse shear stresses by neglecting the shear correction factors. The conventional governing equations are employed and the transverse solutions are by using the Newmark’s integration scheme.

J.K.Chen and C.T.Sun [90] are presented a finite element method to investigate the non linear transient response of initially stressed composite plates. The developed model contains the nine node isoparametric quadrilateral element with preloaded and pre stressed. The constituent equations are formulated by using the Von Karman principle and the Mindlin plate theory. The
transient solutions are achieved with the Newmark’s scheme. The results are for deflections and moments with respect to the function of the time are analyzed.

A.Mahamoud et al [91] are proposed a three dimensional transient response of transversely isotropic composite plates to a time dependent point load. Discrete equations of semi analytical finite element model are solved for the thickness parameters and the transient solutions are by the Eigen value method and the numerical integration of inverse Fourier time transform.

Miroslav Marjanovic et al [92] are explained the transient response of laminated composites and sandwich plates with embedded delaminations. An analytical model is developed by using the Reddy’s generalized laminated plate theory. The Heaviside step functions are used in the displacement formulation to control the discontinuities in the delaminations. The constituent equations of motion are derived by using the Hamilton’s principle. The transverse response is computed with Newmark’s integration scheme. Effect of delamination size and the position through the plate thickness on the transient behavior of the plate is investigated.

T.Kant et al [93] are developed C⁰ continuous finite element for finite element analysis of laminated composite and sandwich plates based on the higher order displacement model. The theoretical formulation is done and the stress strain relations are obtained by using the generalized Hook’s law. The equations of motions are by using the Hamilton’s principle and the equilibrium conditions are by potential energy principle. The Newmark’s and Wilson –theta schemes are used for transient response.

J.N.Reddy [94] was proposed a geometrically nonlinear transient analysis of laminated composite plates by finite element method. The transverse shear strain, rotary inertia and large rotations were accounted by using the developed finite element. The effects of the thickness, lamination scheme, boundary conditions and loads on the deflections and stresses on the laminates are investigated. C.K.Kundu and P.K.Sinha [95] are presented a geometrically nonlinear transient response of the laminated composite doubly curved shells by using FEM. A nine nodded isoparametric shell element is developed and the displacement model is by using the FOSDT. The formulation is based on the total Lagrangian method. The constituent equations are solved by Newton –Raphson method and the transient characteristics are solved by Newmark’s approach. Zafer Kazanci [96] has presented a dynamic response of orthotropic sandwich composite plates impacted by blast pulses. The developed theory includes the large deformation
effects, in plane displacements, inertias and shear deformations based on the CPT theory. The governing equations are obtained by using the principle of virtual work. The non linear equations are solved by the Galerkin method. The various pressure pulses are used to study the behavior of plates for dynamic response.

D.P. Makhecha et al [97], are used the new higher order theory to study the changes in the in plane and transverse displacements through the thickness direction of plate to investigate its dynamic characteristics. AC$$^0$$serendipity quadrilateral element with 8 nodes is taken for this study. The influence of ply angle, aspect ratio, number of layers on the laminated composite plates under thermo-mechanical loads is investigated.

Hasan Kurtaran [98], is adopted a geometrically nonlinear transient analysis with generalized differential quadrature method for the composite shallow shells. The analytical model is developed by the FOSDT of doubly curved shells. The geometrical nonlinearity due to large deflections is formulated by using Von Karman relations. The governing equations of motion are forming with the principle of virtual work. The transient analysis is carried through the involvement of Newmark’s average acceleration method.

Chun-Ying Lee et al [99] are developed a Non linear analysis of composite plates using interlaminar shear stress continuity theory. The nonlinear bending and buckling behavior of the composite plates are investigated in this study. The present is based on the interlaminar shear stress continuity theory. H.Ngu et al [100], presents an enriched finite element model using flat four node element to study the geometrically non linear behavior of the composite structures. The formulation is based on the Von Karman large deflection theory and Lagrangian approach. The FSDT is used to describe the nonlinearity in small strains with the large deformations.

After complete review of the above literature presented, it is concluded the use of higher order theories in the analysis of piezoelectric laminated plates gives a better results in the investigating the characteristics of smart composite. In the past and recent papers it is observed that the transverse shear stresses are assumed as zero at top and bottom of the plates. The prediction of the characteristics of the smart composite plates is mainly based on the classical laminate plated theory, first order shear deformation theory, Second, third order shear deformation theories, higher order theories are used. Most of theories are investigated the behavior of the plates under the combined electro mechanical loading.