



A Brief Review on the Static and Dynamic Analyses of Beams and Plates via ANSYS

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Abstract

While structural calculations for materials used in human use were previously possible with complex formulas and equations, technological advances have now made it possible to perform these calculations easily and quickly. Computer-aided calculations provide significant benefits to today's engineering and contribute to our future. Finite element method (FEM)-based computer programs are used in many engineering disciplines and eliminate significant disadvantages such as time and cost in projects. This brings FEM-based computer programs to the forefront of engineering calculations. With its numerous features, ANSYS allows us to conduct studies on the behavior of materials under analysis, including buckling, bending, vibration and temperature. This study examines the benefits of using ANSYS for static and dynamic analyses of structural elements such as beams and plates, its contributions to calculations, and its potential contributions to the future of engineering.

Keywords: ANSYS; Static Analysis; Dynamic Analysis; Beams; Plates.

1. Introduction

With developing technology, the solution of problems that involve complex formulas can now be done easily [1, 2]. This contributes to creating safer and more efficient engineering solutions for society [3]. Technology paves the way for safer and more modern designs of structures and vehicles that serve humanity in daily life where people live, travel, study, and receive healthcare. Human life continues to evolve and improve through technological development. Problems involving complex formulas can now be easily addressed with finite element method (FEM) based computer programs such as ANSYS, ABAQUS, COMSOL Multiphysics, and SOLIDWORKS [4, 5]. The use of computer-aided calculations is increasing day by day and provides great convenience to engineers, researchers, and industrialists. ANSYS, which is a popular FEM-based program that can be used for analysis and simulations in engineering applications, provides convenience in many ways. It may be noted that SOLIDWORKS is more powerful in modelling and assembling, ANSYS is good at its comprehensive analysis, and ABAQUS shows the abilities to analyze complex problems. The simulation consists of three phases: preprocessing, solution and post processing. The most important of these are that there is no need to make a prototype of the system analyzed and that it provides preliminary information about the system to be analyzed [6, 7].

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2. Static Analysis

Elasticity, a branch of continuum mechanics, deals with the determination of stress, strain, and displacement in elastic materials under external loads. In the theory of elasticity, stress and strain analyses of structures composed of bars, beams, plates, and shell elements are extensively utilized in civil engineering calculations. The use of computer-aided analysis programs further simplifies engineering calculations. Static analyses for stress, bending, and buckling can be readily performed using ANSYS. A comprehensive review of the literature indicates that numerous studies have been conducted on this subject, among which the most prominent are:

2.1. Beams

Sabat and Kundu [8] investigated the torsional behavior of beams with different cross-sections using the ANSYS program. Asif et al. [9] studied the structural analysis of composite beams using the ANSYS program. Al-Raheem et al. [10] analyzed the static deflections of five pre-twisted beams both experimentally and numerically. The twisting angles and deflections of the pre-twisted beams are shown in Fig 1 and Fig 2. It is observed from the results that there is an excellent agreement between the displacements of pre-twisted beam evaluated by experiments and ANSYS simulations.

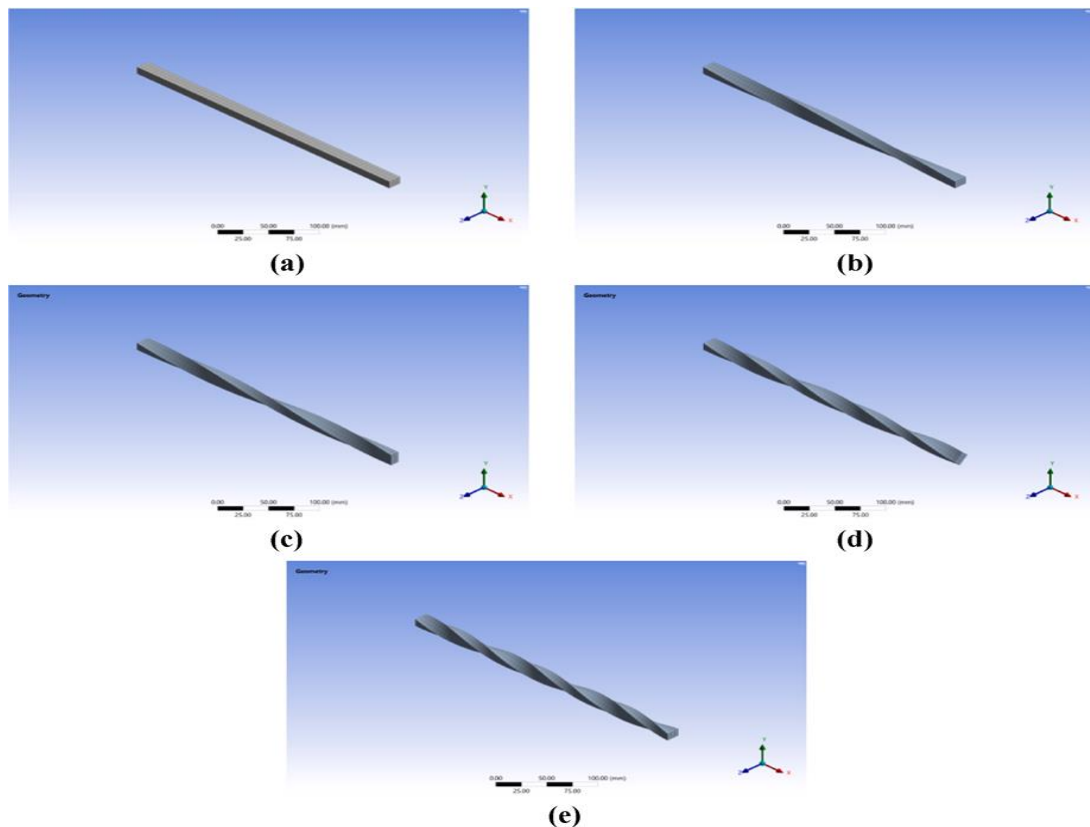


Fig 1: ANSYS view of pre-twisted beams (a) 0° , (b) 180° , (c) 270° , (d) 405° , (e) 540° [10]

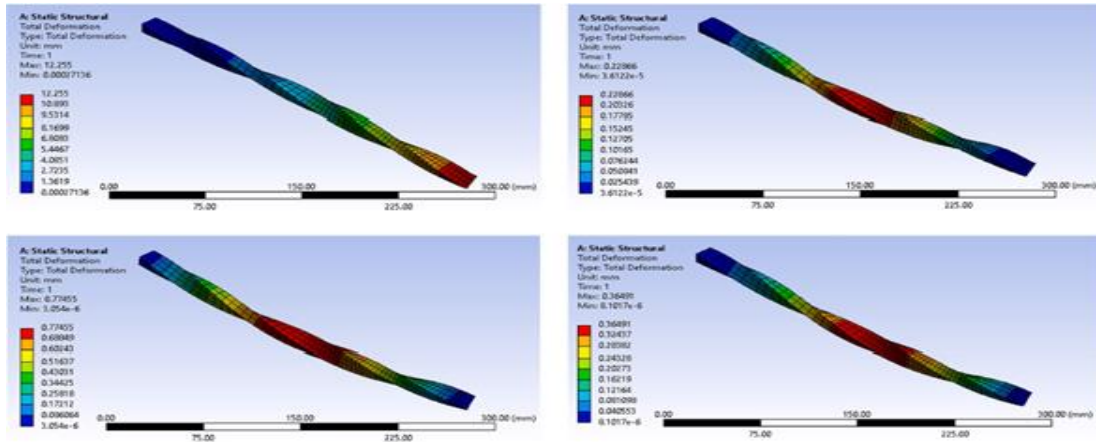


Fig 2: Deflections of pre-twisted beams according to ANSYS program [10]

Saber [11] investigated the stress distribution of a composite thermoplastic cantilever beam using the ANSYS program. Pidgurskyi et al. [12] examined the stress intensity factors for cracks propagating in the flange of the I-beam under bending moments at the ends by theoretical and simulation modeling. The meshing and deformation of the I-beam with an edge transverse crack are seen in Fig 3 and Fig 4. A comparison between the results of theoretical studies and ANSYS showed that the discrepancies do not exceed 12% when the length of the major crack in the flange is up to 30 mm.

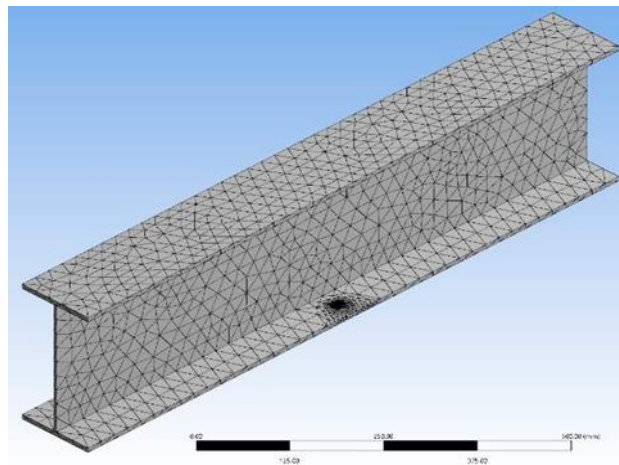


Fig 3: Modeling of an I-beam with a crack on its edge using ANSYS [12]

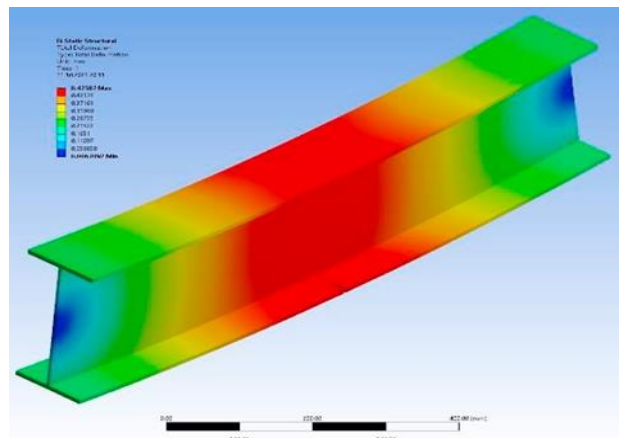


Fig 4: ANSYS view of deformations in I-beam [12]

Tahera et al. [13] investigated the performance of reinforced concrete beams with various spans in the shear zone by using the ANSYS program. Manharawy et al. [14] studied the torsion of hollow concrete beams reinforced with bars and stirrups and compared the findings with the help of ANSYS program. Waqas et al. [15] analyzed the strengthening of reinforced concrete beams with low shear strength with carbon fiber reinforced polymer plates with the help of ANSYS program. Al-Jasmi et al. [16] investigated the blast-induced response of concrete beams with composite materials using the ANSYS program. Al-Rukaibawi [17] investigated the behavior of a laminated bamboo-steel hybrid composite I-section beam under bending using the ANSYS program. Patane and Vesmawala [18] analyzed the torsional behavior of reinforced concrete beams with basalt fiber reinforced polymer fabric and compared their findings with the help of ANSYS program. Promsatit et al. [19] studied the buckling resistance of steel beams with the help of ANSYS program. Silva and Mesquita [20] investigated the lateral buckling of cellular beams with the help of ANSYS program. The elastic critical moment of cellular beams is numerically evaluated by ANSYS and compared with analytical results according to European standards for various the torsional constants. The appearance of the cellular beam under various loadings is shown in Fig 5. It is revealed from this work that the height of the cellular beam is what most influenced the elastic critical moment of the cellular beams from all the geometric parameters.

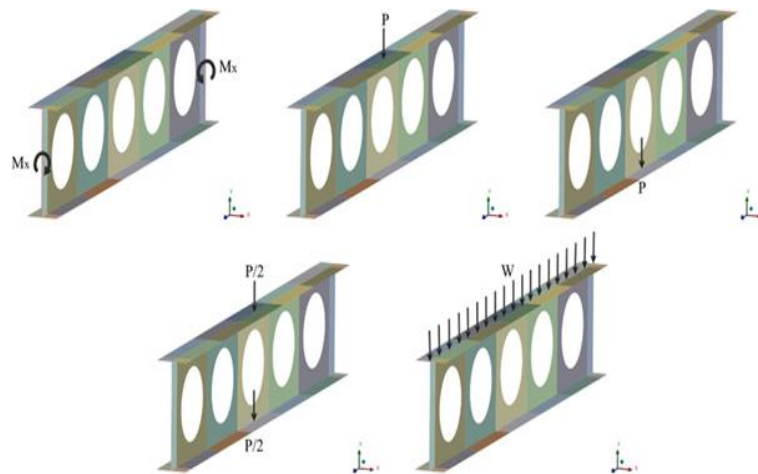


Fig 5: Loading conditions of cellular beam [20]

Zaboon and Jassim [21] studied the behavior of a simply supported beam under various loading conditions and compared the findings with the help of ANSYS program. Bajaj et al. [22] searched the mechanical properties of magnetorheological elastomer core sandwich beams with the help of ANSYS program. Manibalan et al. [23] analyzed the fatigue behavior of a reinforced concrete beam bonded with basalt fiber reinforced polymer and subjected to cyclic loading and compared the findings with the help of ANSYS program. The deformations of the reinforced concrete beam under various loadings are seen in Fig 6 and Fig 7. It is found that comparison between experimental and numerical investigation is satisfactorily correlated with a maximum error percentage of 4.65% and 8% for load-carrying capacity and deflection, respectively [23].

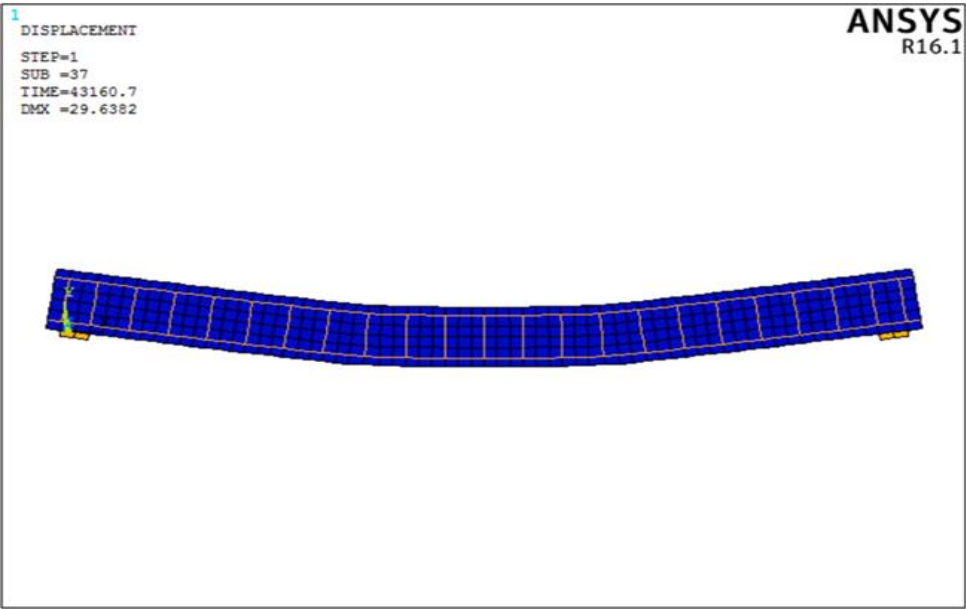


Fig 6: Deformed shape of reinforced concrete beam according to ANSYS program [23]

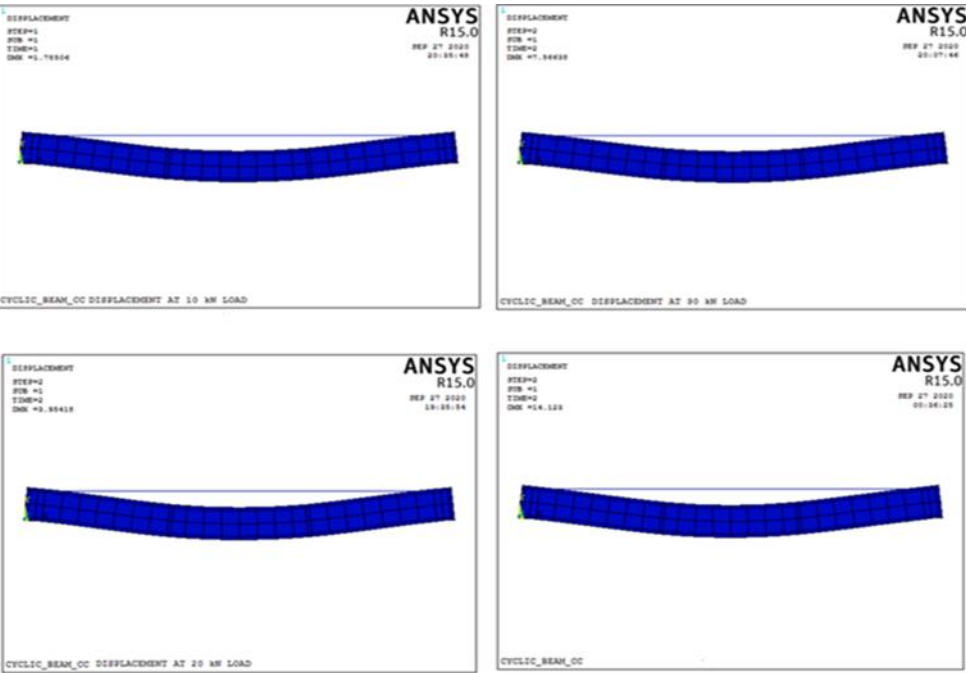


Fig 7: ANSYS view of deformations of reinforced concrete beam under different loads [23]

Wadi et al. [24] analyzed axial functionally graded cantilever beam using ANSYS program. El-Sayed and Algash [25] investigated the flexural behavior of geopolymer ultra high-performance concrete beams reinforced with glass fiber reinforced polymer rods and compared the findings using ANSYS. Bui et al. [26] studied the analysis of reinforced concrete beams strengthened with functional plates using ANSYS. Barour and Zergua [27] analyzed reinforced concrete beams strengthened with carbon fiber reinforced polymer plates using ANSYS. Barour et al. [28] performed analyses using ANSYS for a model predicting the behavior of reinforced beams. Jindra et al. [29] studied the behavior of a stainless-steel beam using ANSYS. Ibrahim et al. [30] studied the torsional capacity of reinforced concrete beams using ANSYS. Hassan et al. [31] investigated the fire resistance of reinforced concrete beams and compared the findings with the help of ANSYS program. Fajri et al. [32] studied the fatigue behavior of a cantilever beam with the help of ANSYS program. Wan et al. [33] investigated the structural behavior of cold-formed steel beams and compared the findings with the help of ANSYS program. Pandimani et al. [34] studied the analysis of high-strength concrete beams with the help of ANSYS program. Mahmoud et al. [35] analyzed the behavior of reinforced concrete beams embedded in slabs and compared the findings using ANSYS. Liu et al. [36] investigated the behavior of steel-concrete composite beams under hogging moment and compared the findings using ANSYS. Hassanin et al. [37] investigated the behavior of simply supported composite beams with the help of ANSYS. Ghoniem [38] analyzed recycled aggregate concrete beams bonded with carbon fiber reinforced polymer with the help of ANSYS program. Kumar et al. [39] studied the behavior of high strength concrete beams under load by using ANSYS program. Jagtap and Pore [40] performed the reinforcement analysis of corroded I-beam by using ANSYS program. Tahenni et al. [41] analyzed the shear behavior of normal and high strength reinforced concrete beams in reinforced and unreinforced conditions both experimentally and numerically. It is emphasized that there is a good agreement between the crack patterns of experimental and ANSYS simulation and the FEM modeling with ANSYS can predict the shear response of reinforced concrete beams with good accuracy. Said et al. [42] analyzed the concrete beams strengthened with hybrid bars and schemes reinforcements using the ANSYS program. El-Basiouny et al. [43] investigated the behavior of externally prestressed high-strength concrete beams using ANSYS. Zhang et al. [44] analyzed an ultralight beam made of carbon fiber reinforced polymer composite using ANSYS. Rex et al. [45] studied the performance of steel fiber reinforced concrete beams bonded with glass fiber reinforced polymer laminates and compared the findings using ANSYS. Farouk et al. [46] performed structural analysis of deep beams with web openings and verified the findings using ANSYS. Nayak et al. [47] investigated the effects of using V-shaped reinforcement in reinforced concrete beams and verified the findings using ANSYS. Yosri et al. [48] analyzed the behavior of laminated composite carbon fiber reinforced thin-walled I-beams and verified the findings using ANSYS. Tang et al. [49] analyzed beams based on absolute nodal coordinate formulation and compared the findings using ANSYS. Bykiv et al. [50] analyzed the use of a 3D printing-based method in reinforced concrete beams with the help of ANSYS program. Liu et al. [51] developed a model for determining the behavior of prestressed, high-strength and web reinforced concrete beams using ANSYS. Soltani and Soltani [52] investigated the relationship between the resisting transverse buckling loads of multilayered fiber composite and fiber-metal laminate beams and checked the results with the help of ANSYS program. Elizalde et al. [53] studied the analysis of a composite thin-walled beam using the ANSYS program by creating an alternative equation for the in-plane shear force that effectively combines the axial and shear in-plane strains. Quang et al. [54] performed the analysis of multi-span continuous beams with the help of ANSYS program. Chudzik [55] investigated the behavior of a sandwich beam with a viscoelastic core under temperature conditions. Atea and Al-Ansari [56] investigated the critical buckling load of a functionally graded beam under mechanical and thermal loading with the ANSYS program. Krantovska et al. [57] investigated the stress-strain behavior of a continuous reinforced concrete beam using the ANSYS program. Kamel et al. [58] performed the analysis of a cracked beam under constant load using the ANSYS program. Osman [59] investigated the analysis of preloaded reinforced concrete beams strengthened with aramid reinforced polymers with the help of ANSYS program. Džolev et al. [60] investigated the behavior of a steel beam protected with a water-based intumescent coating using the ANSYS program. Van-Phuc [61] presented a numerical method to determine the structural strength of reinforced concrete deep beams with the help of ANSYS program. Shen et al. [62] investigated the bearing capacities of normal beams and circular cross-section hole beams using the ANSYS program. Deraman et al. [63] investigated the use of rectangular flexible piezoelectric cantilever beam as energy harvester using ANSYS program. Khong et al. [64] investigated beams strengthened with different fiber-reinforced polymer composites using the ANSYS program. Charan and Rao [65] investigated the dynamic behavior of T-section cantilever beam using ANSYS program. Moulika et al. [66] investigated the behavior of reinforced concrete beam under loading using ANSYS program. Lazzari et al. [67] investigated the nonlinear analysis of reinforced concrete beams in plane stress conditions with the ANSYS program. Ling et al. [68] analyzed the T-beam bridge under different load conditions using the ANSYS program. Romaszko and Wegrzynowski [69]

studied the analysis of a three-layered beam with a fluid middle layer using the ANSYS program. Anupriya and Jagadeesan [70] investigated the shear strength of castellated beams with the help of ANSYS program. Zhang et al. [71] investigated the nonlinear analysis of reinforced concrete beams with ANSYS program. You et al. [72] investigated the behavior of continuous beams using the ANSYS program. Liu and Zhang [73] analyzed the deep beams with simple supports using the ANSYS program. Jayajothi et al. [74] investigated the analysis of reinforced concrete beams strengthened with fiber reinforced polymer laminates against bending and shearing using ANSYS program. Li and Zhang [75] investigated the dynamic behavior of prestressed concrete beams with ANSYS program. Xu et al. [76] analyzed reinforced concrete deep beams with steel fibers using the ANSYS program. Tuohuti and Qi [77] studied the linear and nonlinear analysis of the wooden beam using the ANSYS program.

2.2. Plates

Hassan and Kurgan [78] investigated the behavior of a thin skew functionally graded plate resting on a Winkler elastic foundation using ANSYS. Karthic et al. [79] analyzed stiffened plates using ANSYS. Kim et al. [80] studied the behavior of cross-ply laminated composite plates with delamination and cracks and compared the findings using ANSYS. Huang et al. [81] analyzed functionally graded carbon nanotube reinforced composite plates and compared the findings with ANSYS. Verma et al. [82] studied isogeometric laminated composite plates and compared the findings with the help of ANSYS program. Ranji et al. [83] examined dimpled plates with transverse cracks with the help of ANSYS program. Singh and Agarwal [84] investigated the behavior of steel-concrete-steel sandwich plates with the help of ANSYS program. Jain and Azam [85] studied the behavior of functionally graded rectangular plates with tapered pores under loading and compared the findings with the help of ANSYS. Heo et al. [86] investigated the buckling analysis of cracked plates by using the ANSYS program. Rodríguez-Tembleque et al. [87] studied the electrical resistivity changes of carbon nanotube reinforced composite plates due to the presence of cracks and the propagation of cracks via ANSYS. Aabid et al. [88] analyzed fiber reinforced composite patch to be applied to cracked aluminum plates by using ANSYS program. Fotovat and Zaczynska [89] studied new closed form solutions for nonlinear equilibrium states of thin rectangular laminated plates and compared the findings by using ANSYS program. Wong et al. [90] analyzed the ultimate compressive strength of unsupported cylindrical curved plates by using ANSYS. Pathak et al. [91] investigated the buckling analysis of a composite rectangular plate under mechanical and thermal loading by using ANSYS. Vivek et al. [92] investigated the buckling behavior of simply supported functionally graded thin square plates with triangular cross-section subjected to mechanical loading with the help of ANSYS program. Gouse et al. [93] analyzed the friction clutch plate using the ANSYS program. Nallusamy et al. [94] conducted the analysis of steel plate composite car spring using ANSYS program. Srinivas and Basak [95] investigated boron reinforced epoxy and E-glass reinforced epoxy fiber reinforced polymer plates using the ANSYS program. Helal and Shi [96] performed the analysis of a functionally graded rectangular plate whose elastic modulus varies according to the exponential function using the ANSYS program. Huan and Li [97] performed the analysis of the honeycomb sandwich plate using the ANSYS program. Mei et al. [98] analyzed different types of perforated plates with different open pore numbers using the ANSYS program. Zhao et al. [99] investigated the integration shear weighing plate with ANSYS program. Liu and Sun [100] performed the analysis of the prefabricated skew-plate bridge with the ANSYS program. Yuan and Wu [101] performed the analysis of quenched aluminum alloy thick plates with ANSYS. Jankovski and Skaržauskas [102] performed the analysis of a circular reinforced concrete plate with the ANSYS program. Zhu and Qin [103] analyzed a thin plate with circular holes using the ANSYS program.

3. Dynamic Analysis

Using ANSYS, it's possible to determine dynamic behaviors of materials, such as vibration. When compared with laboratory experiments, ANSYS data are consistent. This has increased the use of ANSYS in dynamic analysis. Some of these include:

3.1. Beams

Ahiwale et al. [104] studied the vibration analysis of a mild steel cantilever beam for the cracked condition with the help of ANSYS. They used a 20-node solid186 element to describe the cracked beam and a hexahedral element to mesh the cracked model. It is indicated that the natural frequencies of an uncracked cantilever beam obtained by analytical model are in good agreement with those evaluated by ANSYS, especially in lower modes. The vibration mode shapes of the cantilever beam with and without cracks are shown in [Fig 8-Fig 11](#).

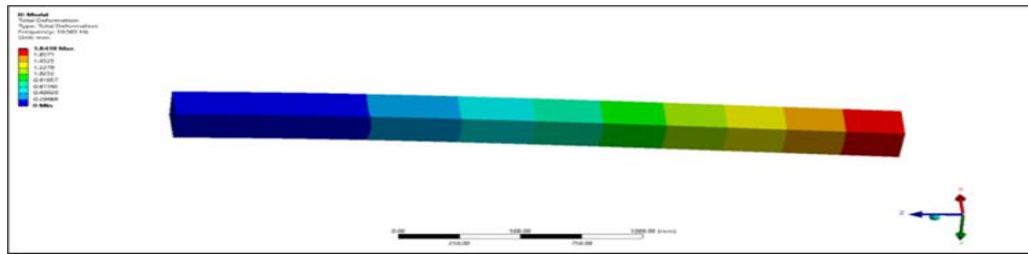


Fig 8: The first mode shape of uncracked cantilever beam according to ANSYS [104]

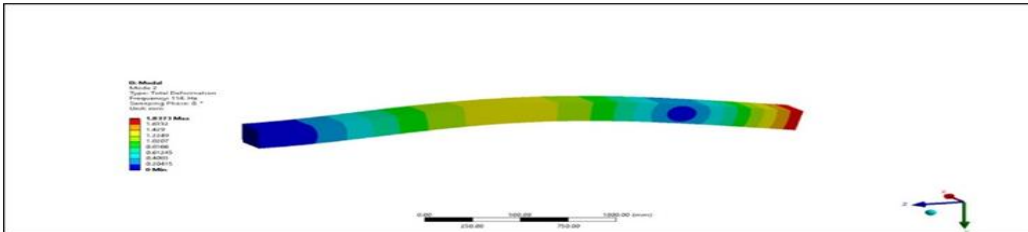


Fig 9: The second mode shape of uncracked cantilever beam according to ANSYS [104]

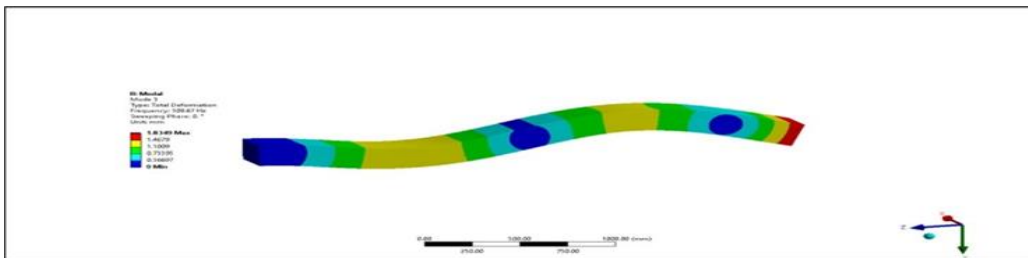


Fig 10: The third mode shape of uncracked cantilever beam according to ANSYS [104]

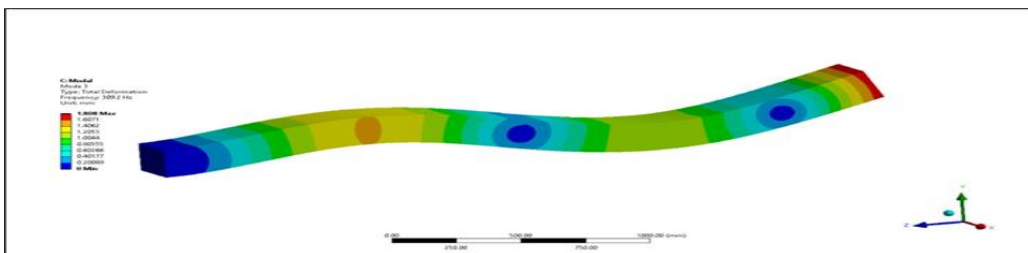


Fig 11: The third mode shape of cracked cantilever beam according to ANSYS [104]

Ouzizi et al. [105] investigated the nonlinear dynamic behavior of beams resting on Pasternak viscoelastic foundation under moving mass and compared the findings with the help of ANSYS program. Jujjuvarapu et al. [106] studied a new microcantilever beam design and compared the findings using the ANSYS program. Zhao et al. [107] investigated the analysis of curved beam bridges using the ANSYS program. Karthik et al. [108] examined the behavior of cantilever beams made of Kevlar fiber composite material with the help of ANSYS program. Asiri [109] analyzed two beams in contact with each other with the help of ANSYS program. Shukla and Barjibhe [110] studied a beam supported by springs made of shape memory alloy and compared the findings with the help of ANSYS program. Gantayat et al. [111] analyzed functionally graded beam with graphene nanoparticle reinforcement in epoxy matrix using ANSYS program. Kant et al. [112] studied natural fiber reinforced polymer composite cantilever beam using ANSYS program. Chen and Chen [113] investigated the model of cracked sandwich beam developed with spring refined zigzag theory and compared the findings using ANSYS program. Rajendran et al. [114] analyzed glass fiber reinforced polymer composite beams using ANSYS program. Singh et al. [115] investigated the damage analysis of concrete beams due to different crack types that may occur using ANSYS. Dung and Lam [116] studied the crack analysis of single and multilayer steel fiber reinforced concrete beams using ANSYS. Sahu et al. [117] performed analyses using ANSYS for the behavior of smart functionally graded beams. Saheb et al. [118] studied the forced vibration behavior of a Timoshenko beam and compared the findings using ANSYS. Selvaraj et al. [119] investigated the behavior of a double-core sandwich composite beam with the help of ANSYS program. Pathak et al. [120] studied the vibration behavior of a cracked cantilever beam with the help of ANSYS program. Shajid et al. [121] investigated the free vibration analysis of cracked and uncracked beams using ANSYS. Jafari-Talookolaei et al. [122] analyzed functionally graded porous doubly curved beams and intermediate straight beams and compared the findings using ANSYS. Jiang and Wang [123] investigated the behavior of functionally graded beams under thermal load and compared the findings using ANSYS. Li et al. [124] analyzed incompressible hyperelastic curved beams and compared the findings with the help of ANSYS program. Taima et al. [125] analyzed the behavior of tapered functionally graded rotating beams and compared the findings with the help of ANSYS program. Sivasuriyan et al. [126] studied the dynamic and static behaviors of reinforced concrete beams and compared the findings with the help of ANSYS program. Reinforced concrete beam and vibration mode shapes are shown in Fig 12 and Fig 13.

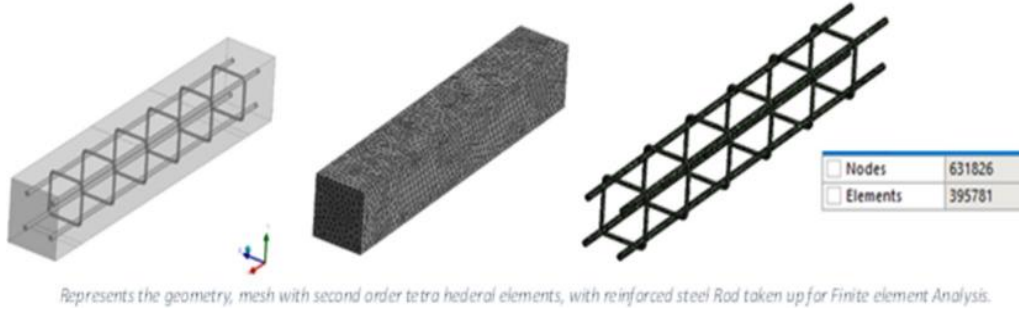


Fig 12: Mesh on reinforced concrete beam, integrated steel reinforcement ANSYS view [126]

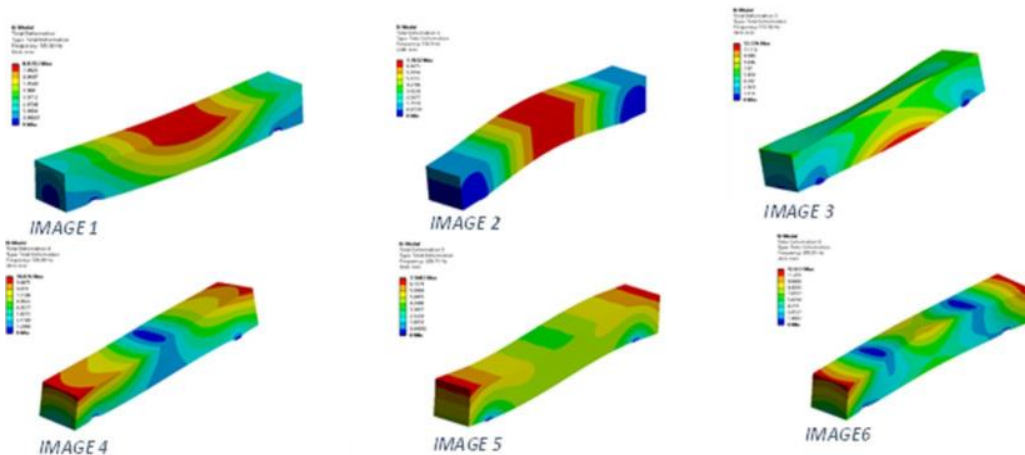


Fig 13: Modal shapes of reinforced concrete beams according to ANSYS [126]

Bachoo [127] analyzed elastically constrained laminated multi-span beams and compared the findings with the help of ANSYS. Sui et al. [128] studied the behavior of functionally graded plates resting on an elastic foundation and compared the findings with the help of ANSYS. Zhou et al. [129] investigated the behavior of axially functionally graded tapered Timoshenko curved beams and compared the findings with the help of ANSYS. Chu et al. [130] studied the temperature field of steel-concrete composite beams with the help of ANSYS. Kumar et al. [131] analyzed the behavior of aluminum cantilever beam and compared the findings by using ANSYS program. Yadav and Singh [132] studied magnesium alloy simply supported beam and compared the findings by using ANSYS program. Kumar and Sarangi [133] investigated the harmonic behavior of carbon nanotube reinforced functionally graded beams by using ANSYS program. Shukla et al. [134] analyzed the simply supported reinforced concrete beam using the ANSYS program. Jing et al. [135] designed a new type of vibration energy harvester for a cantilever beam using ANSYS. Soliman [136] studied an isotropic steel cantilever beam with double-sided cracks using ANSYS. Samal et al. [137] investigated the effect of fiber orientation on the behavior of a composite beam using ANSYS. Koo [138] analyzed quenched H-beams using ANSYS. El-Taly et al. [139] performed the strengthening analysis of concrete encased steel beams with and without openings using ANSYS. Al-Zahrani et al. [140] investigated the free vibration of axial and bidirectional functionally graded strip beam with the help of ANSYS program. Toke and Patil [141] carried out investigations using ANSYS program for damage detection of cracked cantilever beam.

3.2. Plates

Deepak and Shetty [142] analyzed the static and free vibration analyses of functionally graded plates by using the ANSYS program. They indicated that the structure is divided into number of layers, and each layer is assigned material properties governed by power law to model the functionally graded beams and plates. They used 11 layers and found that the results evaluated by ANSYS are in good agreement with the literature. The image of the deformed shape of the simply supported functionally graded plate along z direction on the ANSYS program is shown in Fig 14.

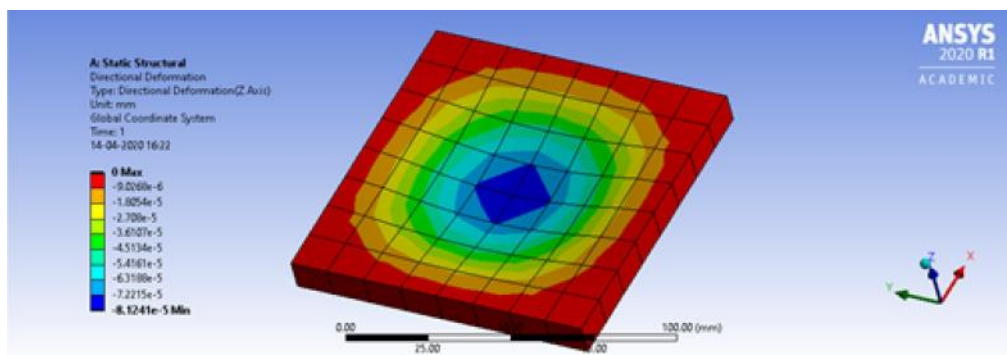


Fig 14: Deformation of simply supported functionally graded plate according to ANSYS program [142]

Kubiak and Fotovat [143] investigated the equation of motion for laminated composite plates under time-dependent compression by using the ANSYS program. Kumar et al. [144] analyzed the modal analysis of sandwich composite plates by using the ANSYS program. Shehab et al. [145] utilized the ANSYS program to investigate the linear free vibration of intact, cracked functionally graded material plates numerically and experimentally. Mohanty et al. [146] analyzed composite sandwich plates with different materials and geometries. They aimed to verify the accuracy of the study by comparing the findings with the output of the ANSYS program. Kareem et al. [147] studied a new displacement function for free vibration analysis of functionally graded plates by using ANSYS program. Singh et al. [148] investigated the acoustic and vibration behavior of thin plates made of functionally graded material and compared the findings by using ANSYS program. Zhang et al. [149] studied the thermal vibrations of carbon fiber reinforced composite plates and compared the findings by using ANSYS program. Wu et al. [150] investigated the dynamic analytical models of damaged laminated piezoelectric plates and composite plates including piezoelectric patches by using Extended Layers Method and compared the findings by using ANSYS program. Zhang et al. [151] performed vibration analyses of functionally graded graphene-reinforced composite plates and compared the findings using ANSYS. Hose and Krishna [152] investigated the natural frequency of graphene-reinforced polymer composite plates using ANSYS. Xiong et al. [153] used ANSYS to determine the crack propagation path in cantilever plates. Norman et al. [154] studied the effect of fiber volume on laminated composite plates using ANSYS. Tiwari et al. [155] used ANSYS for the analysis of plant fiber-reinforced laminated composite plates. Reddy et al. [156] investigated the vibration and acoustic behavior of solid and porous double curved plates by using ANSYS. Fotovat et al. [157] analyzed the behavior of thin rectangular plates under harmonic loading and compared the findings by using ANSYS. Kumar and Kar [158] studied the heat transfer analysis of multi-direction functionally graded plates by using ANSYS. Pradhan and Sarangi [159] investigated the damping behavior of nonlinear vibrations of functionally graded plates with piezoelectric composite material and compared the findings with the help of ANSYS program. Arab and Ganesan [160] analyzed the free vibration behavior of tapered laminated composite square plates and compared the findings with the help of ANSYS. Rahman et al. [161] studied the behavior of smart plates and compared the findings with the help of ANSYS. Agarwal et al. [162] investigated the behavior of layered composite plates with the help of ANSYS. Pandey et al. [163] studied the behavior of hollow glass cenosphere hybridized laminated composite plate with the help of ANSYS. Shen et al. [164] analyzed the vibrational behavior of a composite disc-shaft reinforced with multilayer functionally graded graphene platelets and verified the findings with the help of ANSYS. The first ten mode shapes of the functionally graded graphene platelet reinforced shaft-disc systems are shown in [Fig 15](#). They compared the ANSYS simulation results and the results available in the literature. It is emphasized that the natural frequencies and mode shapes of the homogeneous rotating disc are consistent with the ANSYS simulation results, while the error of natural frequencies increase with the growth of rotational speed.

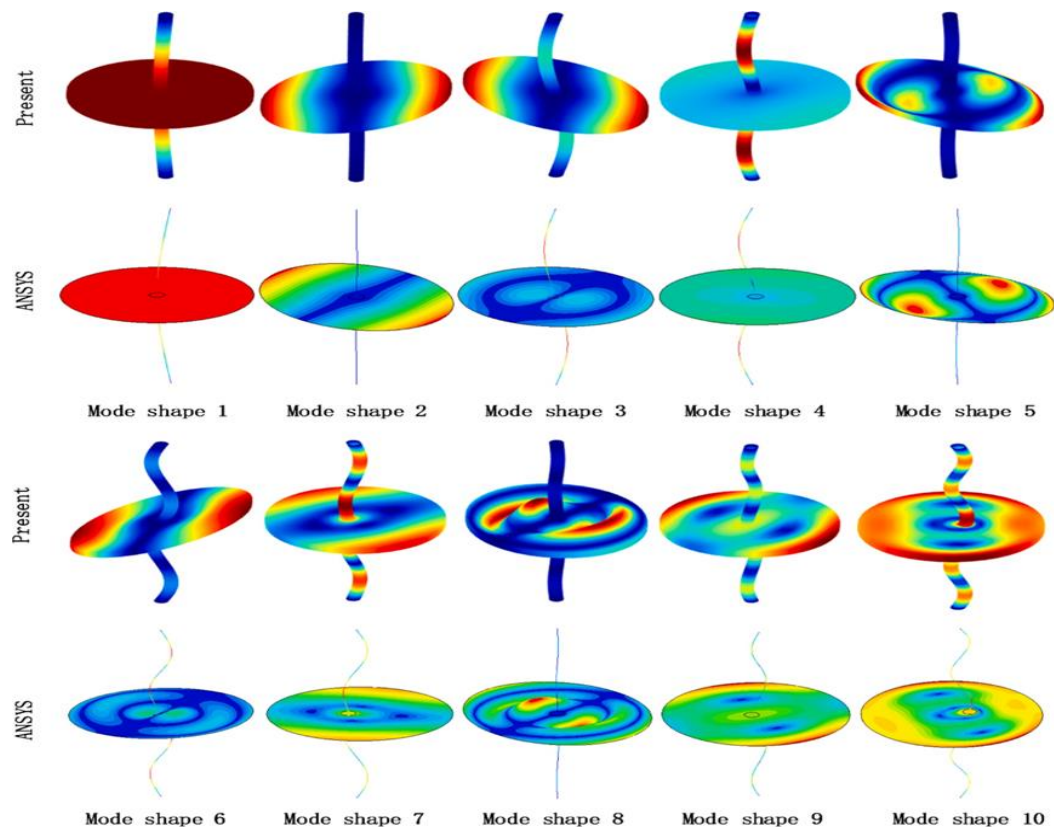


Fig 15: Mode shapes of shaft-disc system [164]

Srividya et al. [165] investigated the behavior of bonded metallic plates using ANSYS. Yousuf [166] investigated the bending behavior of a composite laminated plate using ANSYS. Naumova et al. [167] analyzed a square plate with variable parameters using ANSYS. Wang et al. [168] studied the behavior of a stiffened plate with holes and compared the findings with ANSYS. Yu et al. [169] performed the isogeometric flutter analysis of cutout laminated plates under thermal influence and compared the findings with ANSYS. The first four modal shapes of laminated plates with and without cutout under thermal influence are comparatively illustrated in Fig 16 and Fig 17.

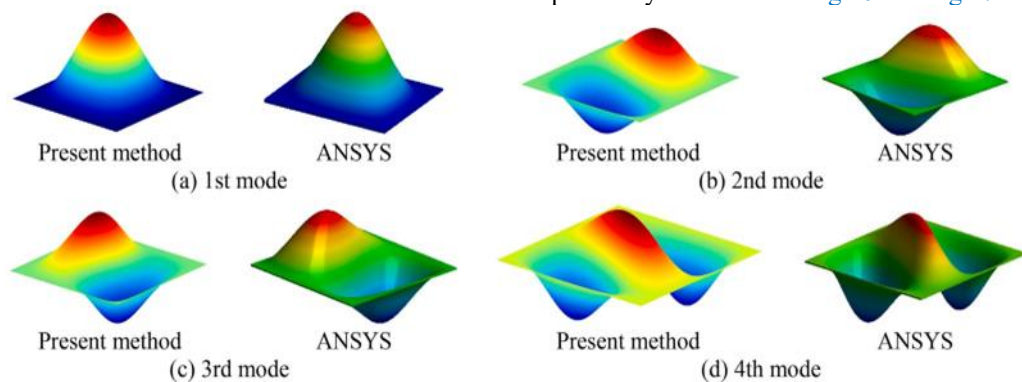


Fig 16: Mode shapes of laminated plate without cutout in thermal stress condition according to ANSYS [169]

Kumar et al. [172] analyzed sandwich composite plate with cutout via the help of ANSYS program. Narwariya et al. [173] investigated antisymmetric cross-ply laminated composite plates with the help of ANSYS program. Thakur et al. [174] studied single and double-fold folded laminated composite plates and compared the findings with the help of ANSYS program. Rafi et al. [175] performed vibration analysis of laminated sandwich plates with the help of ANSYS program. Kim and Lee [176] investigated rectangular Mindlin plates and compared the findings with the help of ANSYS program. Song et al. [177] analyzed the bond between steel plate and concrete using ANSYS. Wang et al. [178] studied orthotropic steel plates consisting of different numbers of ribs using ANSYS. Jarali et al. [179] analyzed fiber metal laminate plates with different compositions and compared the findings with the help of ANSYS program. Karumbaiah et al. [180] performed the analysis of coconut fiber reinforced composite plates with the help of ANSYS program. Raad et al. [181] investigated the free vibration behavior of the hybrid sandwich plate with the help of ANSYS program. Shinagam et al. [182] performed analysis to determine the location of cracks in composite plates with the help of ANSYS program. Patil et al. [183] analyzed the dimensional behavior of the composite plates during the curing process using the ANSYS program. Kalita et al. [184] investigated the behavior of isotropic plates with central cut using the ANSYS program. Klimenda and Soukup [185] studied the frequency and mode values of thin aluminum plate. Britto et al. [186] investigated the static and dynamic behavior of piezoelectric layered composite plates and compared the results with the help of ANSYS program. Dey et al. [187] analyzed the frequency behavior of laminated composite plates and compared the results with the help of ANSYS program. Arora et al. [188] investigated the angular distortion and temperature distributions of carbon steel plate with the help of ANSYS program. Khare and Mittal analyzed [189] the free vibration behavior of thick laminated circular plates with the help of ANSYS program. Nikhil et al. [190] studied the dynamic behavior of hybrid laminated composite sandwich plate with the help of ANSYS program. Jhung and Jeong [191] investigated the dynamic behavior of the perforated square plate with the help of ANSYS program. Gharaibeh [192] studied the dynamic behavior of rigidly supported rectangular plates with the help of ANSYS program. Al-Maliky and Alshakarchi [193] investigated the detection of cracks in stainless steel plates with the help of ANSYS program. Bendine et al. [194] analyzed a functionally graded plate with upper and lower surfacebonded piezoelectric layers using ANSYS. García-Macías et al. [195] investigated the dynamic and static behavior of functionally graded skew plates of thin and medium thickness and checked the results with the help of the ANSYS program. Zahariea [196] analyzed the eccentric orifice plate using ANSYS. Siddiqui and Shivhare [197] performed the analysis of stiffened plates using ANSYS program. Zhang and Huang [198] performed the analysis of magnetorheological fluid rectangular sandwich plates with ANSYS. Demir and Alapan [199] performed the analysis of a point-supported rectangular plate via ANSYS. Wang et al. [200] analyzed the piezoelectric smart plate using the ANSYS program.

4. Conclusion

Technological advancements have led to the growth of the software industry and the proliferation of simulation programs. However, the validation of these simulations remains limited, and it is still important to evaluate and discuss their consistency with experimental results. As can be seen with the help of finite element-based simulation programs, not only can they be used to verify the accuracy of the static and dynamic behavior of structural elements, but they can also be analyzed directly, eliminating the need for test equipment and prototypes. This opens a new window into the engineering world. Solving complex and difficult problems with computer-based analysis is now much easier. Finite element-based computer programs, which prevent time and financial losses, are now an indispensable part of today's engineering profession.

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