



Science

## **FINITE ELEMENT ANALYSIS OF AN RCC STAIR USING STAAD-PRO: A REVIEW**

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### **Abstract**

Our primary goal is to finish layout of stair is to ensure that the shape is safe and most economical in opposition to all feasible loading situations and to fulfill the feature for which they've built. Safety necessities should be in order that the structure is able to serve it cause with the hold fee. Detailed planning of the shape normally comes from several studies made by using city planners, investors, users, architects and different engineers. All the demanding situations faced via structural engineers had been taken as opportunities to develop software program's together with STAAD-PRO, ETABS & SAFE, SAP etc., with ease of use. Software consisting of STAAD-pro is main commercial software program global for structural evaluation. The design outcomes the usage of STAAD PRO of a Stair case, for each regular and abnormal plan configuration, are used. Reinforced Concrete (RC) building frames are most common sorts of constructions in city India.

**Keywords:** Stair; Finite Element Analysis; Reinforced Concrete; STAAD Pro.

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### **1. Introduction**

Stairs is a set of steps which give access from floor to floor. Stair is an important functional element of a building. Presently, Stairs are gaining popularity because of their attractive appearance. However, design of the stair and its analysis is very difficult Due to the complex geometric configuration of this structure, the present methods of analysis are based on various idealizations and assumptions. Under this background, finite element approach has been applied to study the validity of the current methods in use. The study has been extended further to determine the stress resultants of the stair slab including an intermediate landing for the development of a simplified design process. Stairs are essential features of all residential and commercial buildings. A staircase is constructed with steps rising without a break from floor to floor or with steps rising to a landing between floors, with a series of steps rising further from the landing to the floor above. Although

many types of stairs can be planned and designed in concrete, steel or timber. It must be designed to carry certain loads, which are similar to those used for design of the floors. The design is generally based on the guidelines provided in different codes of practices, considering no special treatment for varying support conditions and shape of the stair slab. Specially, the behavior of helical stair slab has not been well understood due to its inherent geometry. Individual attempts made by few researchers claim drastic change in the behavior due to varying support conditions and the specifications provided by codes of practices are insufficient for the designers to help in rational design of stair slabs of different types. The real behavior of the stair slab may be established by comprehensive theoretical analysis with different support arrangements and experimental tests conducted on full scale or prototype staircases. Stair is an important functional element of a building. Presently, Stairs are gaining popularity because of their attractive appearance. However, design of the stair and its analysis is very difficult. Due to the complex geometric configuration of this structure, the present methods of analysis are based on various idealizations and assumptions. Under this background, finite element approach has been applied to study the validity of the current methods in use. The study has been extended further to determine the stress resultants of the stair slab including an intermediate landing for the development of a simplified design process.

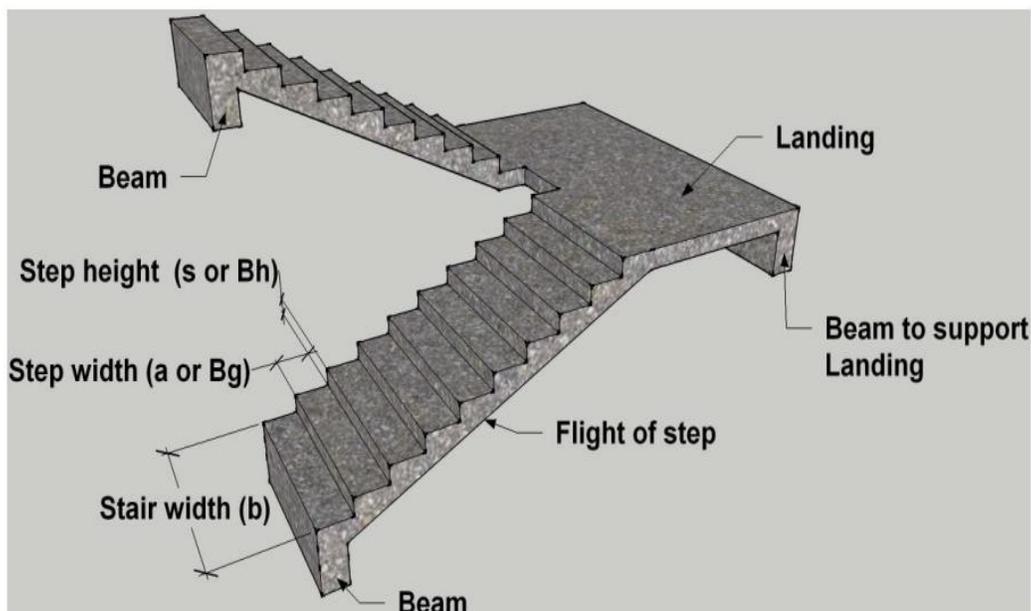


Figure 1: Design of Staircase

## 2. Technical Terms

The definitions of some technical terms, which are used in connection with design of stairs, are given.

- Tread or Going: horizontal upper portion of a step.
- Riser: vertical portion of a step.
- Rise: vertical distance between two consecutive treads.
- Flight: a series of steps provided between two landings.
- Landing: a horizontal slab provided between two flights.

- Waist: the least thickness of a stair slab.
- Winder: radiating or angular tapering steps.
- Soffit: the bottom surface of a stair slab.
- Nosing: the intersection of the tread and the riser.
- Headroom: the vertical distance from a line connecting the nosings of all treads and the soffit above.

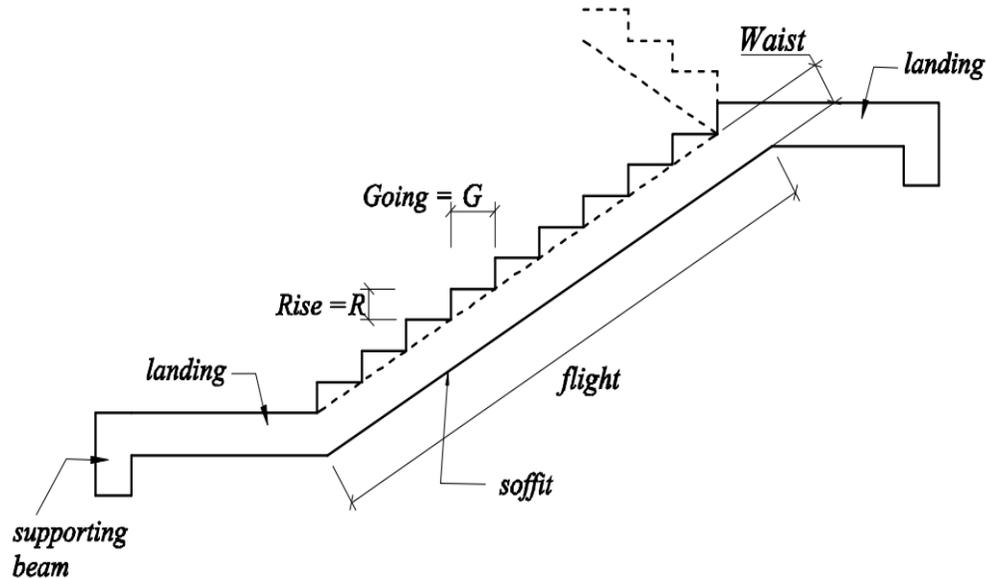


Figure 2: Stairs main technical terms

### 3. Types of Stair Case

For purpose of design, stairs are classified into two types; transversely, and longitudinally supported.

1) Transversely supported stairs include:

- Simply supported steps supported by two walls or beams or a combination of both.
- Steps cantilevering from a wall or a beam.
- Stairs cantilevering from a central spine beam.

2) Longitudinally supported (in the direction of movement):

These stairs span between supports at the top and bottom of a flight and unsupported at the sides. Longitudinally supported stairs may be supported in any of the following manners.

- Beams or walls at the outside edges of the landings.
- Internal beams at the ends of the flight in addition to beams or walls at the outside edges of the landings.
- Landings which are supported by beams or walls running in the longitudinal direction.
- A combination of (a) or (b), and (c).
- Stairs with quarter landings associated with open-well stairs.

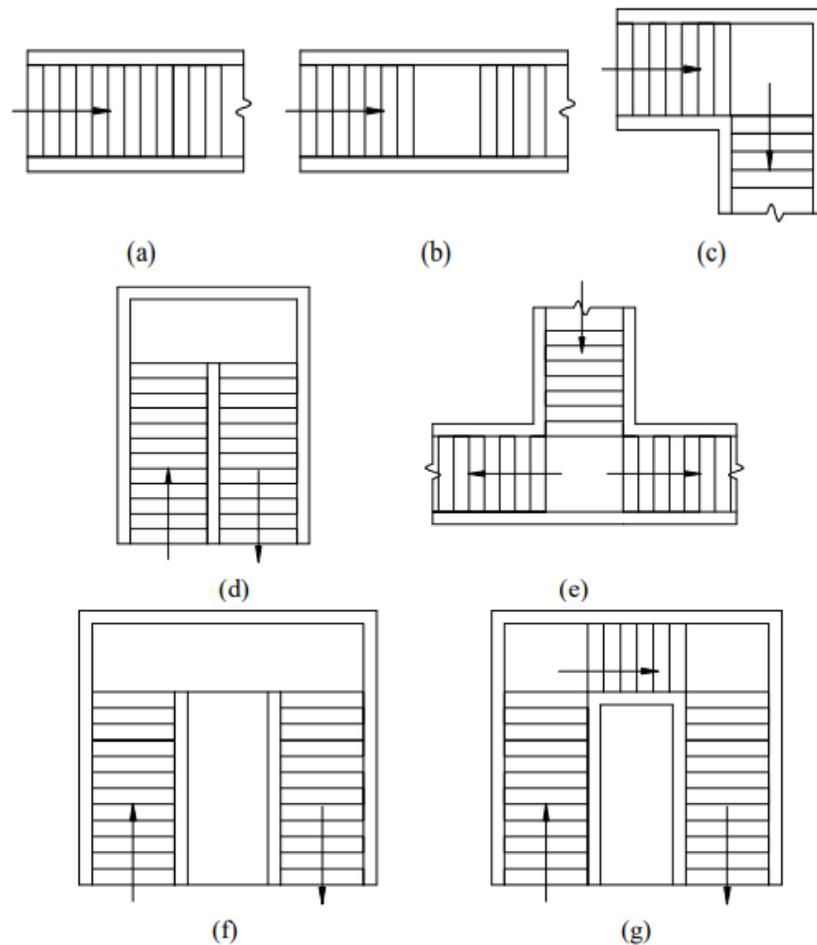


Figure 3: (a); (b) Straight flight stairs; (c) Quarter-turn stairs; (d) Half-turn stairs; (e) Branching stairs; (f) Open-well (half turn); (g) Open-well with quarter turn landing.

#### 4. Literature Study

The geometrical properties of stairs vary many a times. This variability is a consequence of inaccuracies in construction of Stair slab. In some cases, the variability is of a more systematic type but most frequently it is random. These variations must be considered when dealing with structural safety aspects because they could present major uncertainties in a stair design. The geometrical variations of reinforced concrete members can also greatly influence the cost of construction. In this chapter an extensive review of the literature connected with several aspects, such as construction errors, tolerances, deterioration of Stair slab, structural safety and reliability aspects, is presented.

**Raj Kumar et. Al. (2017)** they studied RCC Building is considering and analysis and layout is achieved for each Gravity and lateral (earth quake and wind) hundreds. And that is as compared with the flat slab. The graph truly shows the story waft, lateral displacement and term. It is also discovered that the outcomes are extra conservative in Static evaluation in comparison to the dynamic method resulting uneconomical shape. Because of the Box impact of modular kind scheme, it's miles increasing overall stiffness of the constructing for that reason, lowering the sway

problem within the shape. As building is in abnormal the behavior in both instructions isn't always comparable. Further, the assessment between regular and modular kind indicates the general feasibility of the scheme without affecting its stability in gravity in addition to lateral loads.

**Deshpande et. Al. (2017)** studied to understand the structural conduct of diverse components within the multi-storied constructing. Analysis, designing and estimation of multi-storied building has been taken up for Basement G+2 Building, thereby depending on the suitability of plan, format of beams and positions of columns are constant. Dead loads are calculated primarily based on fabric properties and live loads are taken into consideration consistent with the code IS875-component 2, footings are designed based totally on secure bearing capacity of soil. In this task, analysis and layout of shape turned into carried out with the resource of software referred to as ETABS which is quiet possible in the use of and gives extra green designs and versatility.

**Amanet. Al. (2016)** Analyzed multistory building by using the use of STAAD Pro, for this cause an on-going project has been selected. This project belongs to the unity developers to be accomplished in the Gulbarga City. The call of the mission is Bharat pride. For the duration of evaluation discovered Short term deflection of all horizontal participants is within 20mm. The structural additives of the building are safe in shear and flexure. Amount of steel furnished for the structure is economic. There is not any such massive difference in analysis consequences of STAAD Pro and Kanis technique. Proposed sizes of the factors may be used within the shape.

**Hugaret. Al. (2016)** optimized business cum residential constructing through using STAAD Pro. Computer Aided Design of Commercial cum Residential Building involves analysis of constructing frames by way of the use of STAAD Pro and guide design of the frame elements. Conventional approach of evaluation entails lot of complications and tedious calculations such evaluation is a time ingesting assignment. Analysis may be made quick by way of using software's.

**Mounikaet. Al. (2016)** they studied approximately residential constructing and evaluation with STAAD Pro. The layout of residential building is accomplished with restrict country evaluation. Limit nation technique is a good manner to acquire power of shape with low price while examine to different design synopsis. The plan, phase and elevation are generated in AUTOCAD software program as in step with required area of two hundred sq meter. Then the design follows with specific kinds of loading situations with extraordinary cases of rooms and position of rooms. After plotting the layout, evaluation is made with the assist of STAAD Pro software and the effects found out to be identical.

**Shelotkaret. Al. (2016)** the consequences of staircase at some point of the seismic overall performance of Multistoried Frame Structure at Center location in plans were studied. Generally, the staircase is a part of secondary gadget of the systems and it's far one of the important parts of a constructing because of its practical significance. In the prevailing take a look at, the effect of staircase role on RC frame systems has been done by way of adopting various building fashions with and without staircase in longitudinal and transverse course. Story Drift and Story Displacement have been as compared with the seismic traits of models with and without a staircase. Further, the impact of alternate in vicinity of the staircase at the conduct of the building has also been found.

**Nandyet. Al. (2016)** Using the final load values, the designing of important structural individuals has been studied. The structural elements used as a foundation for carrying out the design calculations include beams, slabs and staircase. The paper affords the numerous steps of calculations required for computing the perfect values. The necessary parameters and design standards were proven so as to facilitate the design in addition to evaluation of the structures. A base plan has been used as an illustrative instance to conduct the calculations on.

**Jayasidhanet. Al. (2015)** designed and studied multistory commercial constructing. The venture became undertaken for K Infra Park. It is a Basement+Ground+3 storied constructing, located at Koratty. The evaluation and designing become achieved consistent with the standard specification to the viable enlarge. The evaluation of shape turned into achieved using the software bundle STAAD PRO.V8i. All the structural additives were designed manually. The detailing of reinforcement was accomplished in AutoCAD 2013. The use of the software program offers saving in time. It takes price on more secure aspect than guide work. The analysis changed into performed the usage of the software program package STAAD Pro V8i, which proved to be top class software of incredible capability in analysis and design sections of construction industry. All the structural additives had been designed manually and designated the usage of AutoCAD 2013. The analysis and design turned into done according to conventional specs to the viable expand.

**Ahadet. Al. (2015)** building shape is designed and analyzed the use of E-tabs software. Located in Latur, Maharastra with (B+G+10) storeys having a car parking facility provided at basement ground. The building has a shear wall across the lift pit. The modelling and evaluation of the shape is done by using ETABS and the designing become performed. Design of slab, stair case and an isolated footing are finished manually. The layout methods involve load calculations manually and reading the complete structure by way of ETABS. The layout techniques utilized in ETABS are restriction kingdom layout confirming to IS code of exercise. The analysis and layout turned into completed according to conventional specs to the possible enlarge. The numerous problems encountered within the layout manner and the diverse constraints faced by the structural engineer in designing as much as the architectural drawing had been also understood.

**Vahidet. Al. (2015)** an intensive numerical look at the behavior of unfastened-status staircases changed into done the use of the finite element bundle SAP2000. A sensitivity looks at on the unique geometric parameters and material homes that affect the design pressure and moments became additionally performed. As an end result of this have a look at, semi-empirical equations are proposed from which the design forces and moments may be calculated in a single step. The accuracy of the equations within an acceptable limit is established with the aid of evaluation with the consequences of rigorous FE analyses. Finally, the proposed layout equations result in a simple, straightforward and secure layout while concurrently representing the genuine conduct of 3D free-standing stair slabs. The test outcomes of 23 unfastened-status staircases with numerous geometries have been offered.

**Liu et. Al. (2015)** this observe designs 3 reinforced concrete frame fashions: one including stairs, one except stairs and one together with the steps with the use of isolation measures. And the authors use the reaction spectrum approach for each version to calculate and analyze, the results show that the staircase had an impact at the lateral stiffness of the shape, and the seismic overall performance had an obvious distinction between the version such as stairs and the version except stairs. The

format of stairs can trade the shape stiffness middle, accordingly affect the torsion consequences of the shape. The stairs, the staircase frame column force and the sway had been increased and shaped the vulnerable parts of pressure.

**Ajagbeet. Al. (2014)** Studied approximately the variant of stress resultant throughout a phase is non-uniform, which is in any other case now not identified with the aid of the analytical strategies. This suggests that the results of axial forces in flights are greater than offset by means of the impact of in aircraft moments which reasons lateral sway of the entire stair toward the top flight. Moment is more concentrated close to the periphery at aid and close to the inner part at kink and at mid touchdown section. Of route, the specimen used was a simple plate flexural member, however the observations made in this examine can observe to even complex structures with minor modifications but related elements and boundary conditions.

**Cao et. Al. (2014)** studied the pc version with staircase and the reaction spectrum analysis ought to be used first of all within the seismic design of concrete body with staircase. The results display that including staircase into fashions will exchange the seismic overall performance of body shape drastically. Experimental look at at the strengthened concrete structure with staircase ought to be carried out within the destiny due to the complexity of earthquake action and structure reaction as well as the restrict of calculation software program, as a result revealing the seismic performances of the whole structure and partial stairwell greater objectively and absolutely and imparting extra affordable and feasible technical advice for the structural design.

**Baqiet. Al. (2013)** Studied and analyzed Effect of U turn in reinforced concrete dog legged stair slabs. The results acquired for stresses, strains and deflections are used to describe the behavior of such stair slabs, along with locations of critical moments and deflections. Values of crucial moments acquired by using F.E. Evaluation have additionally been compared with that obtained from conventional analysis. Analytical outcomes display that the moments also are crucial near the kinks i.e. Junction of mid-touchdown and willing waist slab. This trade within the behavior of canine-legged stair slab may be due to continuity of the fabric in transverse direction in landings adjacent the waist slab, hence additional stiffness accomplished. This trade within the conduct is usually not taken care of in traditional method of layout.

**Wang et. Al. (2013)** the stair to participate in common shape calculation and putting sliding connection are mentioned. Evacuation feature, in the complete structural seismic calculation, additionally don't do not forget stair member stiffness impact. Stair additives also can in keeping with the conventional layout technique, handiest consider interplay below the vertical load for reinforcement calculation. The approach of the illness is underneath the results of earthquake forces, horizontal joint decorate cloth to exist the partial damage might also, after the earthquake need in local embellished processing. In view of stairwells as evacuation and relief channel, the importance of this disorder has to be in the acceptable range.

## 5. Conclusion

The primary objective of study is to design and build a structure of stair case in such a way that the damage to the structure and its structural component during an investigation is minimized. Dynamic analysis shall be performed to obtain the stair case behavior, and its distribution to

different levels along the height of the building. The design of slab, beam, column, rectangular footing and staircase are done in limit state method which is safe at control of deflection and in all aspects. From the above review I have concluded that lot of research have carried on the dynamic effect on the stair with dead load and live load conditions. for the analysis purpose basic parameter taken are lateral force, base shear, storey drift, storey shear and results are interpreted on the bases of this parameter.

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