

# Construction Mechanics and Time-Varying Mechanics in Civil Engineering Analysis

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**Abstract.** With the development of city construction, civil engineering construction scale becomes bigger, safety problems is gradually serious. This paper introduces the main contents of construction mechanics and time-varying mechanics in civil engineering. We hope to analysis the safety problems in civil engineering construction from the angle of science, and reduce the risk of civil engineering construction.

## Introduction

At present, many construction projects have such characteristics as long construction period, complex engineering and the large scale, which results in a variety of frequent safety accidents, serious reduction of the whole project construction schedule. Safety accident in civil engineering construction, is not only because of the human accident, but also there is no scientific and effective analysis principle of civil engineering construction process [1]. Safety accidents greatly affect people's lives and property safety. It is imperative to analyze and study civil engineering construction.

## The Content of Construction Mechanics in Civil Engineering

**The Variation of Gravity Loads.** With the increasing progress of the project, the construction of civil engineering construction is a change process, and the gravity load of the building is also changing constantly. The first thing to consider is the bearing, such as building construction, with the increasing height of the building, the pressure on the foundation and the bottom building is increasing. In the construction, reinforced concrete structure is a common situation, the increasing height of the building bring a huge test to the steel, concrete bearing capacity [2]. Another to consider is the structure aspect, the structure involves two aspects the content, the building structure change as well as the material structure change. In the building structure, such as the construction of the bridge, with the continuous construction process, the constant changes of the bridge gravity results in its gravity load changes. In the material structure, due to the special needs of the building, materials are needed for further processing, such as the tube into a flat from the circular shape, its bearing capacity, gravity load will also change. The construction mechanics analysis needs to carry on the theory analysis to the various parts of the building and under gravity load changes of the components under various circumstances, and then rely on scientific principles to do the adjustment, to prevent some components to result in accidents because of the load too large and even result in a problem to occurs [3]. In the analysis and calculation, it is necessary not only to take into account in the construction, also to calculated the gravity load after the completion, and the actual gravity load and theoretical gravity load need have a safe value, avoiding the gravity load of the structure changing because of internal factors of structure in construction.

**Engineering Safety Analysis.** Because the construction cycle of the entire civil engineering project is relatively long, the accidents at any time may occur in the construction process [4]. For example, heavy rain, earthquakes and other natural disasters will seriously affect the stability of the entire foundation, and then result in some problems such as ground subsidence. Winter too cold or summer exposure will change the performance of the material leading to the emergence of security problems. In the preliminary construction planning, we must grasp the local actual situation,

analyze potential safety hazards ahead of time and do preventive actions.

**Material Property Analysis.** Construction materials used in civil engineering, such as steel and concrete, will change with the increase in service life, and the material will accelerate the change of its properties with other factors [5]. For example, steels used in engineering construction, generally are deeply buried in concrete, that can be very good to prolong the service life, but when the building in the long-term moisture environment, water will gradually penetrate to the steel reinforcement, resulting in steels oxidation and reducing the service life. After the oxidation of steels, the steel itself will react with the oxide layer of the outer surface, that will once again exacerbate the oxidation rate of steels, and then use for long time will result in accidents to occur easily. In addition, the acid-base property of environmental acid-base also affects the corrosion rate of steel. (as shown in Fig.1). Now people in housing renovation, usually like to choose wood materials, although certain attractive appearance, but with the time increasing, the wood materials will be corroded, gradually broken, when the housing accident such as water, will accelerate the corrosion rate of materials, and wood materials may cause the worms to damage the use of materials, adding the risk.

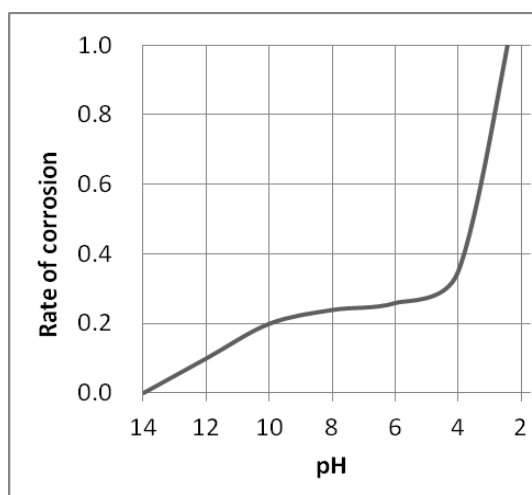


Fig. 1 Relationship between corrosion rate of rebar & pH

**Impact on other Buildings.** Any civil engineering construction project must lay the foundation before construction and the construction easily affect other buildings. First of all, other building foundations will be influenced because the new buildings in the foundation construction, bridges, buildings surrounding roads, houses will be affected by different degree of vibration, waterproof layer of foundation, foundation reinforcement belt will be caused a certain degree of damage, and the damage often do not come out on the surface, but if there is no good the maintenance work, it will exist a huge security risk. In addition, it may affect other underground facilities, such as it often is reported that in the news on a construction underground lines are damaged leading to power outages, underground pipelines damaged leading to massive accumulation of water and the situation of natural gas pipeline damaged leading not to use gas for a large number of residents [6]. If there is no understanding of the pipeline, line distribution in advance, the damages caused by construction will not only delay the construction period, but also may cause huge economic losses and waste of resources.

### Construction Mechanics in Civil Engineering Analysis

**Mechanics Foundation.** Traditional mechanical analysis is only for constant units, structures, but in civil engineering analysis, the object of the analysis is no longer constant, many structures will change with time. The traditional mechanics research object even if external conditions will be changed as the time change, but people regard change for the internal parameter as constant, usually on the premise of defaulting for interior the constant, mechanical analysis is done, and the establishment of many research theory is also the premise. For example, in the force analysis of the spring, the elastic coefficient of spring tends to be considered as the constant, but the elastic

coefficient of spring will change gradually with the actually number of spring use, many force analysis on the spring object, such as the swing, all default the elastic coefficient of spring be constant and then do analysis to get conclusion, but in the actual application error will appear. With the deepening of the study of mechanics, new theories are constantly created and some original theories continue to be overridden. The traditional theory of mechanics has been difficult to keep up with the pace of the time development. On the analysis of the research object, its internal parameters are taken more and more attention, time-varying mechanics theory used in civil engineering has been developed greatly, we can effectively analyze the changes of physical properties with time, that can greatly improve the safety of civil engineering construction and promote the development of civil engineering construction.

**Mechanical Effect.** The mechanical effect of the civil engineering mainly includes three aspects, the first is the road effect, that referring to the same structure the last mechanical state change as the construction process is not the same, mainly in the use of materials, because the physical properties of materials different, different processing methods in time-varying phenomena change. Followed by aging, aging refers that the last mechanical state of the same structure will change because the construction scheme is not the same, mainly due to the properties of materials will change with the time varying after treatment. The last is to eliminate the road effect, aging effect, the material itself characteristics will be analyzed.

**Mathematics Foundations.** The analysis of civil engineering is not enough only based on the mechanics foundation, but also needs to be analyzed based on the mathematical theory. In the analysis of the construction process of civil engineering, we must do a good analysis of material, foundation, surrounding rock and other physical structural parameters, which tend to change with time. Construction control equation is just variable differential equations with varying parameters or the time-varying mathematical content. The time-varying mathematics is the change of mathematics theory that is proposed based on the time-varying physical, its change of parameters is not just the time variable, but also a space variable aspect. So doing a good analysis job of civil engineering, it is needed that grasping the variable coefficient partial differential equations or ordinary differential equations of changing parameters into variable coefficient.

### **Time-Varying Mathematics in Civil Engineering Analysis**

**Time-Varying Dynamics.** In the construction of mechanical analysis, if the component parameters and the geometric domain have great changes, the inertial force need be taken into account, due to the computational difficulty of the time-varying dynamics is very large, so it is usually calculated by numerical method. The calculating of numerical methods are used to calculate with discretization and numerical discretization equation, and the topological variation method and the time-varying method. In the numerical calculation of discrete equations, we can take a variety of computing methods, the first method is the integral method and can take the successive integration based on the time of, the practicality is relatively high, but can not effectively guarantee the stability. The second method is the Legendre series method, although the calculation is simple, but its stability is not guaranteed. The third kind is symplectic algorithm, which can effectively guarantee the stability, but the calculation process is very complex, the requirements for the computing staff is relatively high, while the application field is not very extensive.

**Linear Elastic Time-Varying Mathematics.** In the construction of civil engineering projects, if the cable elastic material used and no thermal effect, and in the construction process, the system self seismic period is far less than the construction period, the inertial effects of its own can be ignored when variable mechanical analysis, using the static analysis method to analyze, the analysis method can be named the linear elastic time-varying mathematics. In the past, those problems are used the space variable equation to analyze, according to the characteristics of material physical parameters change with time, the time variable parameters introduced in the actual calculation, only the physical parameters of the conclusion will become a function of time the corresponding in the conclusion.

**Nonlinear Time-Varying Mechanics.** If the materials used have nonlinear characteristics,

nonlinear analysis is needed when the construction is analyzed. common sand and concrete all belong to the material of the nonlinear characteristics. In the calculation process of nonlinear time-varying mechanics, because of the nonlinear including not only boundary, physical nonlinear, but geometric nonlinearity, its result is affected by many factor and can use the partial differential equation to do variable coefficient nonlinear calculation.

**Thermo Elastic Time-Varying Mechanics.** In the process of civil engineering construction, some materials have thermal effect, in the analysis of this part of the material, can use thermo elastic time-varying mechanics. Such as lime, lime with water will release a lot of heat, can use the thermo elastic time-varying mechanics to construction analysis of lime, because of its physical properties changing with time, so we can transfer the original partial differential equation of heat conduction to variable coefficient equations a, and then calculate.

**Physical Property Time-Varying Mechanics.** In the construction process of whole project, due to construction period quite long, the physical properties of many materials will gradually change, the construction analysis of these materials can be used the idea of time-varying physical properties. Such as concrete gradually become solidified hard along with construction, physical properties are changed. In the physical properties analysis of time-varying mechanical, it should be noted that whether there is time function, can be directly calculated using mechanical equations when there is a time function.

**Viscoelastic Time-Varying Mechanics.** In the construction process, not all materials are solid form, and some fluid has rheological characteristics. For example, asphalt in the construction of highway, its performance will change with the change of time. The construction mechanics analysis with this material of rheological property can make use of viscoelastic time-varying mechanics. In geometrical fields and the physical parameters change with time as reference, the original variables are transformed into equations with time-varying properties to calculate.

## Conclusion

In the civil engineering construction process, the analysis for the construction mechanics and time-varying mechanics is particularly important. Using scientific and reasonable analysis methods to do the construction mechanics and time-varying mechanics analysis well, can improve the quality of the design scheme and improve the safety of the whole construction to ensure the quality of construction. With the rapid development of China's construction industry, safety requirements of civil engineering continue to increase, researchers need to continue to strengthen the research of construction mechanics, to provide adequate theoretical basis for civil engineering construction analysis, to promote the healthy and stable development of China's construction.

## Reference

- [1]ZHANG Haibing. Analytic construction mechanics and time-varying mechanics mechanics foundation of civil engineering analysis[J]. China House, 2014,01:228-231.
- [2]ZHANG Wei. Foundation of construction mechanics and time-varying mechanics mechanics based on civil engineering analysis[J], Heilongjiang Science and Technology Information, 2016,25:219.
- [3]TIAN Feng. Discussion on construction mechanics and time-varying mechanics in civil engineering mechanics analysis[J], Doors and Windows,2016,09:237.
- [4] Namow, V.E.. Mechanics of growing deformable solids -A review . J.of Eng. Mech , ASCE, 1994, ( 2)
- [5] Arutyunyan, N.K.. Mathematical model of a dynamically accreted deformable body . Mech.of Solids, 1990, 25 ( 6):80 ( Part.I);1991, 26 ( 1):67 ( Part.II)
- [6] Majid, K.I. Forces and deflexions in changing structures .The Structural Engineer 1972, 51 ( 3):108