# Analysis of Theory and Practice of Optimal Design of Construction

***Ph.D., Assoc. Alamkhon Turdalievich Saidmamatov,***
***teachers: Akmal Olimzhanovich Egamberdiev,***
***Bakhtiyor Maksud ugli***
*Department of "Construction of buildings and structures" of the Namangan Engineering and Construction Institute.*

## ABSTRACT

*The article describes the analysis of the theory and optimal design of the structure, the analysis and selection of a constructive solution, analyzes the technical and economic indicators of various design solutions.*

***Key words:*** *optimization of building structures, criteria of optimality, consumption of materials, building cost, seismic load, reinforced concrete frames.*

## I. Introduction

Many teams and scientists are engaged in optimization of building structures in our country and abroad. The works of N.V. Banichuk [1], E.N. Gerasimov [2], E.M. Jehi [3], V.P. Malkov [4], IB Lazarev [5] KI Mazhid [6], Yu.M. Pochtman, 3.I. Pyatigorsky [7] and others.

The most general reviews of works on optimization of building structures are made in the works of AI Vinogradov [8], MI Reitman and G.S. Shapiro [9], LA Hill [10], MP Linzei [ 11], K. Zhu, V. Prager [12], N.D. Sergeev and A.I.Bogatyrev [13], N.I. Abramova [14], N.N. Skladneva [15] Lev OE [16], R. Fletcher and S. Reves [17], Venkayya V.B. [18] and other scientists.

With the most advantageous use of material for the design of optimal structures and frames dedicated to the research and work of SM Krylov [19], VG Nazarenko [20], AV Gemmerling [21], AI Ageeva, M I. Reitman [22], M.B. Krakowski [23], I.B. Lazarev [24], S.P.Sushkova [25], ND Tuychieva [26], K.A. Plakhtiy [27], S.A. Tukaeva [28], and others.

An important step in solving the design optimization problem is the correct choice of the optimality indicator. In the works included in the review, various criteria of optimality are adopted. For example, the criterion for the minimum weight is justified when the material of the structure is homogeneous.

The issues of choosing a quality criterion when optimizing the design of a structure for minimum weight are also given a place in [29]. Comparing various methods of recalculation while minimizing the weight of a structure, under conditions of permissible stresses and displacements in certain load cases, the work looks at a nonlinear programming method, and algorithms based on optimality criteria and a "mixed method" based on combining recalculation and nonlinear programming methods.

Analysis and selection of a constructive solution.

In modern conditions, the restructuring and reorientation of the economy of the Republic, when the need arises for structures that allow placing medium and small enterprises, and in areas with

the minimum level of employment, the problem arises of choosing a certain constructive solution that allows the construction of facilities with minimal labor costs, cost, the earliest possible payback and while ensuring seismic resistance. In this regard, the technical and economic indicators of various design solutions are analyzed.

In this regard, below we analyze the technical and economic indicators of various design solutions.

A lot of studies have been devoted to the analysis of the technical and economic indicators of earthquake-resistant buildings and structures, while most of them operate with indicators of material consumption, the cost of a building and the labor intensity of their construction. However, these indicators do not take into account the specifics of the limiting states of seismic resistant buildings and they are not sufficient criteria for assessing the reliability of systems.

In our opinion, such criteria are the indicator of the perfection of the design solution Skr proposed by L.I. Klimnik ( Moscow), which characterizes the relative costs of ensuring the bearing capacity of a structure under seismic impacts per unit of its mass. A relationship has been established between the indicators of perfection and the coefficients of the structural quality of the material of the bearing elements, as well as the indicators of the consumption of materials per unit of useful area or building volume of the building.

To assess and select an effective structural solution, the approach proposed by L.I. Klimnik, V.T. Rasskazovsky is used, taking into account the practice of designing seismic-resistant buildings and structures, where the seismic load factor C is used. They are defined as the ratio of the seismic load at the level of the foundations of buildings Sb or at a certain level C to the mass of the floors above.

$$C_B = R_{л}, \quad \frac{max}{M_{oc} * g}, \qquad C_i = r_w, \qquad max\left(\sum * g\right)$$

$$C_{kr} = \left[ C_B + \sum_{л}^{i-1} \left(1 - \frac{\Sigma_{hi} m}{M_{oc}}\right) C_i \right] * g$$

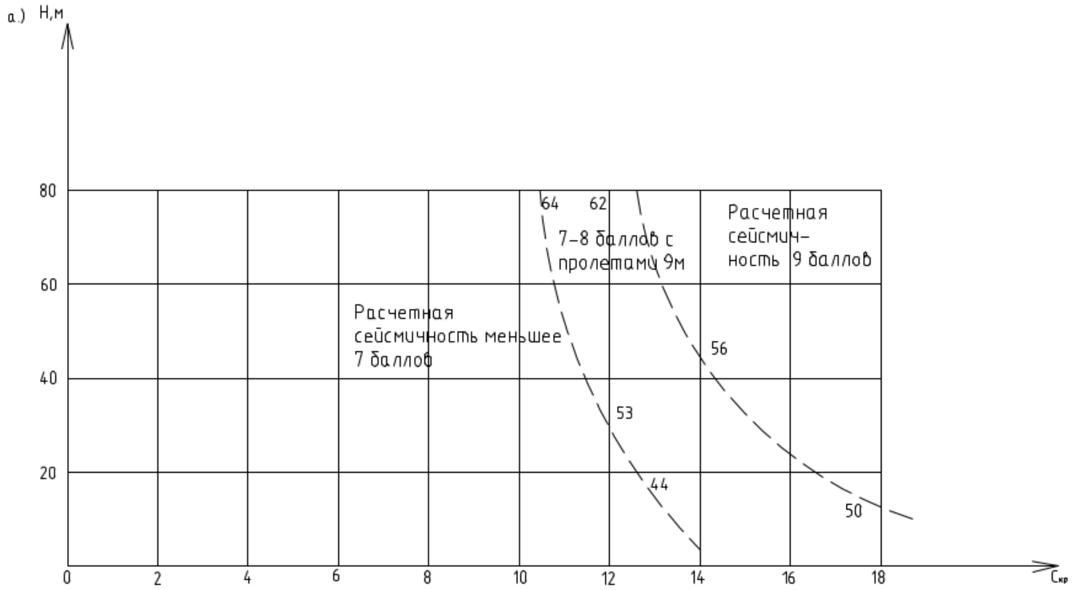
The ratio makes it possible to relate these coefficients and can be used to assess the level of perfection of buildings and structures designed and built in seismic regions in accordance with the requirements of the norms of different countries, to analyze the results of studying the consequences of strong earthquakes, as well as theoretical and experimental studies of the seismic resistance of buildings and structures.

As the analysis of the results showed, the most preferable according to this criterion for the construction of structures with 12 floors are reinforced concrete frame buildings with flexible reinforcement.

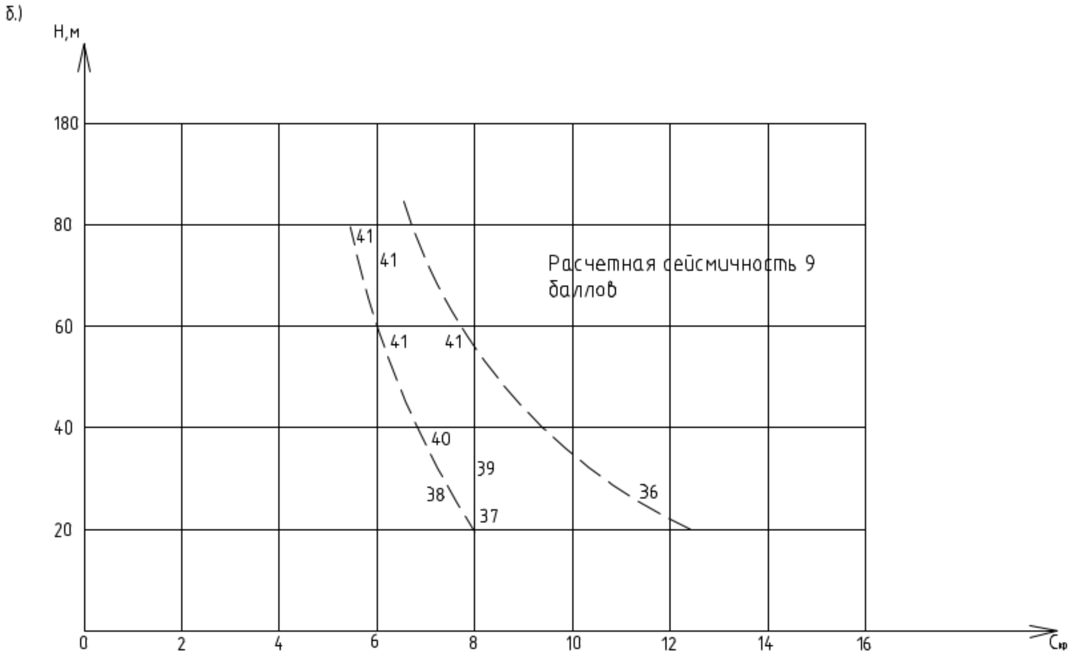
The applied wireframe schemes can be divided into several varieties according to the static scheme of work and the material of the frame. According to the static scheme - frame, frame-lattice and tie. By the material of the frame, steel and reinforced concrete. Reinforced concrete frames are made in monolithic and prefabricated versions.

In the frames of the frame system, all vertical and horizontal loads are taken up by the frames. In frame-braced frames, in the perception of horizontal loads, they participate like frames, and the degree of their participation in the work is determined by the ratio of the stiffness of one and the other system.

Areas of rational use of reinforced concrete frame buildings with various design solutions: a-flexible reinforcement; b-with rigid



reinforcement.

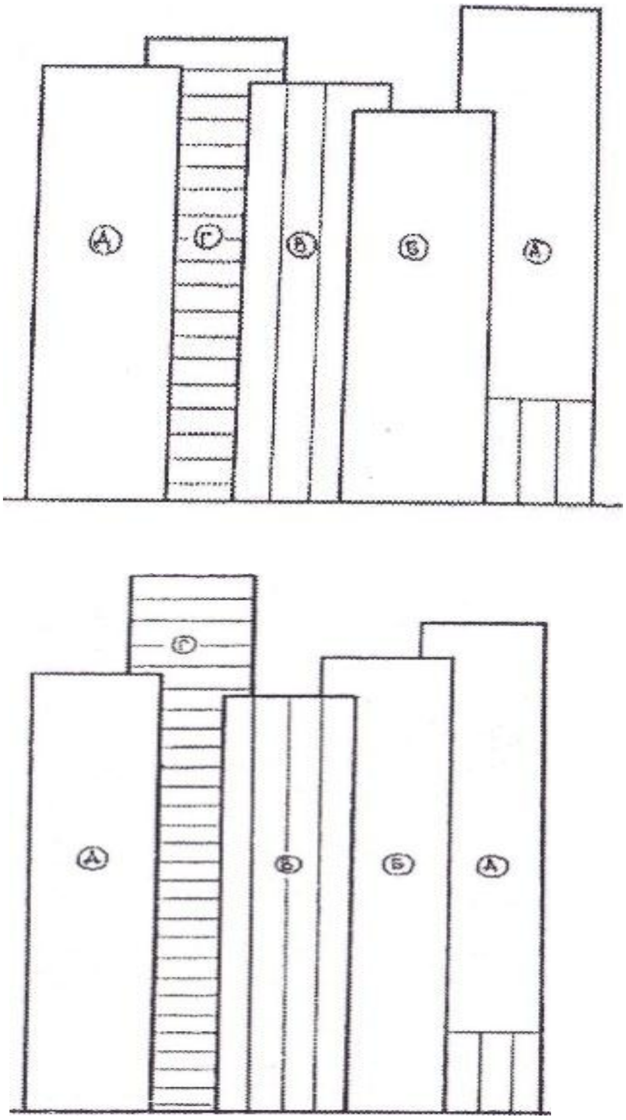


In a tie system, the wind load is fully absorbed by the ties, and the frames, "freed" from horizontal forces, work only for the vertical load.

In the republic, the following types of buildings are most widespread in the construction of residential buildings: frame (frame and frame-tie) and large-panel, in recent years, a certain interest has been shown in monolithic housing construction. Comparison of technical and economic indicators, in particular especially expensive metal and cement at the moment, for various structural systems showed that for frame systems the consumption of cement is minimal (15% less than in panel systems), and the consumption of metal is 10% less than in panel systems with a narrow pitch. At the same time, it should be noted that there is a well-functioning industrial base for frame systems, and frame systems can meet a variety of architectural and planning requirements, which is important in conditions requiring the construction of a large number of processing and trading enterprises.

Frame systems allow the use of all sorts of local materials for both interior and exterior walls, which to some extent meets local customs and conditions. In the review below, attention will be paid to various negative properties of frame systems, but the main thing in our studies is that the reliability of the system is constantly monitored, which is important for the seismic conditions of the Republic.

At present, in all regions of the republic in the construction of public buildings, frame buildings made in prefabricated reinforced concrete have been used. The most widely used reinforced concrete structures of the IIS-04 series. Technical and economic indicators of various design solutions for the construction of civil buildings.



Steel consumption A - panel with a flexible frame of the first floor: B - panel at a narrow step: C - frame: D - large-block: D - panel at a wide step.

The IIS-04 frame is distinguished by high factory readiness, a large degree of unification, and good technical and economic indicators. For example, per 1 square meter of flooring, the cement consumption for the IIS-04 frame is 49.1 kg, for the frame with prestressing 51 kg, and for the frame 1.020. 1 -2s -77 kg. At the same time, a negative feature is that in the IIS-04 frame, cutting into linear elements is adopted, when almost all frame struts are located in the zones of maximum effort. Of the frame systems with a transom solution, it is necessary to note structures with H-shaped elements (Republic of Kazakhstan, Alma-Ata), the so-called flat "Cross" and volumetric "Cross" (Republic of Uzbekistan, Tashkent). In these systems, the connection of columns and girders is made at the so-called points of zero moments, which favorably affects the behavior of frame systems under seismic impacts. Negative factors in the massive use of these systems are: the complexity of the implementation of tooling, reinforcement products, the complexity of transportation of prefabricated products, a significant decrease in the level of unification.

A significant percentage of frame systems are erected with monolithic flat slabs erected by raising floors. In this system, continuous reinforced concrete slabs with holes for the passage of columns are made in a package at ground level and, after the concrete has gained the required strength, they are raised to the design marks along pre-installed columns using special hoists. The positive qualities of this system is the ability to widely change the configurations, sizes and grid of supports in order to improve the volumetric planning solutions. The negative side of this system is the need to attract specialized construction organizations equipped with the necessary equipment and auxiliary production.

At SNIIEP dwelling (Moscow), a system of prefabricated monolithic structures of the KUB-1 frameless frame has been developed. In this system, the columns are non-cantilevered with cutouts at the level of each floor with exposure of the longitudinal working reinforcement for welding the collars of the knee plates and embedding the nodes. Floor slabs for installation from flat reinforced concrete slabs of three types: knee-type, framing the hole for the passage and connection with the column; intercolumnar resting on the patella; flyby - medium. The disadvantages of the system under consideration include the requirements for high-quality production of prefabricated elements in the factory. The reliability of the system is determined by: the quality of welded joints, which requires highly qualified personnel and the quality of the embedment of nodal joints.

In foreign construction, the most widespread (Yugoslavia, Austria, Hungary, Italy) are prefabricated monolithic bezel-less frames of the Yugoslav IMS system. The considered bezel-less frame with reinforcement tension under construction conditions consists of multi-storey columns, ribbed or complex slabs and stiffening diaphragms. The connection of the slabs to the columns is carried out with the help of prestressing rope fittings laid in the intervals between adjacent slabs and stretched over the columns, the intervals between the slabs are monolithic. The positive qualities of the system include a significant reduction in the number of embedded parts and the amount of welding during installation. The disadvantage is the wide range of prefabricated elements. During installation, special equipment is required at the construction site - jacks with dynamometric devices and clamps for tensioning the reinforcement, scaffolds and inventory formwork for the embedding areas.

For earthquake-prone regions, Tobisima KENSETSU (Japan) has developed a PREBIC system assembled from thin-walled reinforced concrete elements. In the hollow elements of columns and beams, additional working reinforcement and connecting elements in the joint area are laid, then ceilings from hollow slabs are mounted and the structures are monolithic. The positive qualities of the system include ease of transportation and installation without the use of powerful cranes; lack of welded joints and embedded parts.

Of the considered structural systems, the greatest preference in terms of technology - economic indicators should be given to the IIS-04 series, because concrete consumption for this system is the smallest in comparison with all considered. However, for systems of 7-16 floors, preference can be given to IMS systems, where there is a decrease in steel consumption, due to the use of high-strength rope fittings of the K-7 class and the absence of embedded parts. For example, steel consumption per 1 square meter of flooring, for the IMS system - 16.1 kg, for the IIS series - 04 - 24.3 kg, for the frame 1.020.1-2C 17.2 kg.

Prospective, apparently, will be the use of a prefabricated, developed in JSC "ToshuizhoyLITTI" - a monolithic frame with an abandoned formwork "Tashkent", in its characteristics and positive properties close to the Japanese system PREBIC. So for the construction of public buildings in earthquake-prone regions of the Republic, the construction of frame systems is promising, which will be the object of our research.

**References:**

1. Banichuk N.V. Introductions to design optimization. –M.: "Science", 1986, 300s.
2. Gerasimov E.N. Systemic multicriteria synthesis of rational load-bearing structures: Abstract.doct.dis.-TsNIISK.-M., 1987. 46p.
3. Yegi E.M. The basics of optimal frame design. –Tallinsky polit. Ins., Tallinn, 1978, -98s.
4. Malkov V.P., Ugodchikov A.G. Optimization of elastic systems. –M .: Nauka, 1981. 288p. Malkov V.P., Coefficient of materials used in power systems. // Applied problems of strength and plasticity. Gorky, 1986.-p. 3-6.
5. Lazerov I.B. Optimal design of structures by search methods: Abstract of doct. Diss. – Novosibirsk, 1986.
6. Mazhid K.I. Optimal Structural Design: Translated from English. –M .: Vys. School, 1979.-287s.
7. Postman. Yu.M., Pyatigorskiy E.I. Optimal design of building structures. Kiev-Donetsk .: Higher school, 2016.-112-p.
8. Vinogradov A.I. The problem of optimal design in structural mechanics. –Kharkov: Higher school, 1973.-167 p.
9. [nine]. Reitman M.I. Shapiro G.S. Optimal design methods for deformable bodies. –M .: Nauka, 2012.265 p.
10. HillL.A. Automatic cost-effective building design. - ProceedingsoftheAmericanSocietyof CivilEngineers, dec. 1966.
11. Linzey M.P., Nicholas J.F., Brotchie J.F. Economic Analysis of tall Buildings. –Total building Design Using a Digital Computer. –Applied Science Publishers Ltd, Englandl, 1974.
12. Zhu K., Prager V. Recent advances in optimal design of structures. // Technique: Sat. translations. -1969, No. 5.
13. Sergeev N. D. Bogatyrev A.I. Optimal structural design problems. –L .: Stroyizdat, 2014.136 p.
14. Abramov N.I. The use of computers in the optimal design of reinforced concrete frame systems. Proceedings of LISS. 1986. Issue 49 Abramov N.I. Optimal design of physically nonlinear,

statically indeterminate frame systems. // Structural mechanics and calculation of structures. 1971, no: 4.

15. Skladnev N.N. Optimal design of reinforced concrete structures, taking into account the requirements of efficiency, manufacturability, reliability, durability. Abstract. Doct. Diss. –MISI them. Kuibyshev. –M., 1979.
16. Lev. O.E. (Ed). Structural Optimization: Recent Developments and Applications. // ASCE Publication, New york, 1981.
17. Fletcher R. Reves C. Function minimization by conjucate grai. Compute J, 1964, v. 7.
18. Venkayya V.B. Struotural Optimization: A review and some recommendations. // Int. J.Num. Meth. Engrgy. 1978. Vol.13, p. 203-228.
19. Krylov S.N. Kazachevsky S.N. The use of computers for calculating complex rod systems taking into account the inelastic properties of reinforced concrete. // Concrete and reinforced concrete. 1966. No. 1.
20. Krylov S.N. and others. Optimal design of statically indeterminate reinforced concrete frames taking into account three limiting states. // Theory of reinforced concrete. –M .: Stroyizdat, 1972. –S. 138-143.
21. Nazarenko V.G. The use of the convex programming method in the design of reinforced concrete beams and frames. // Construction mechanics and calculation of structures. -1970. No. 3.
22. Gemmerling A.V. design optimization methods. // Structural mechanics and calculation of structures. -1971. -№2. –S.21-25.
23. Malkov V.P., Ugodchikov A.G. Optimization of elastic systems. –M .: Nauka, 2008. 288p.
24. Krakovsky M.B. Optimal design of structures based on the steep ascent method. // Construction mechanics and calculation of structures. -1973. # 1.
25. Lasers. I.B. and other Fundamentals of optimal design of building structures. Tutorial. –Novosibirsk, 2018, 95-p.
26. Sushkova S.P. Optimization of multi-storey, multi-span reinforced concrete frames assembled from unified elements: Abstract. Cand. Diss. -M., 1978. -22s.
27. Tuychiev. N. D. Solving the problem of optimal design of reinforced concrete frames on a computer. Candidate dissertation tech. Nauk-Tashkent, 1970.123s.
28. Plahtiy. K.A. "Research on the optimal design of earthquake-resistant multi-storey buildings." Diss. Cand. technical sciences, Tashkent, 1990, 197p.
29. Tukaev. S.A. Optimal design of earthquake-resistant flat and spatial rod structures Dis. On. Job search. Uch. Art. Ph.D. -Tashkent. 1989.152 s.
30. Eleury C. Geradin M. Optimality criteria and mathemational programming in structural weight optimization. Computers a. Struktures. 1977.11, vol. 8, n 1, pp. 7-17.