International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

IJIEMR Transactions, online available on 21st Oct 2020. Link :http://www.ijiemr.org/downloads.php?vol=Volume-09&issue=ISSUE-10

Title: **THE STRESS-DEFORMED ANALYSIS OF MULTI-STOREY BUILDING FRAME ELEMENTS ADJUSTED ITS CONSTRUCTION AND LOADING STAGE**

Volume 09, Issue 10, Pages: 189-193

Paper Authors

Khamrakulov U.D

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

ISSN: 624.046

THE STRESS-DEFORMED ANALYSIS OF MULTI-STOREY BUILDING FRAME ELEMENTS ADJUSTED ITS CONSTRUCTION AND LOADING STAGE

Khamrakulov U.D., doctoral student (PhD), SamSACI.

Samarkand. midimin@mail.ru, tel: +99891-552-96-64

Abstract

The article presents the reinforced concrete frame calculation of a five-story building according to the traditional method and taking into account its construction stages.

The calculations results are analyzed and the construction staging influence and frame loading on the elements stress-strain state it's established.

The necessity of taking into account the staged construction of buildings in their calculation has been substantiated.

To determine construction stages influence degree and multi-storey frame buildings loading on the stress-strain state of their elements, a numerical analysis was performed.

Key words: reinforced concrete, frame, column, girder, traditional method, staging, loading, multi-storey.

A frame made of monolithic reinforced concrete was used as a numerical experiment. The five-story frame has a traditional span used in civil buildings design. The frame spans in the axles are taken 6+3+6 m. Frame pitch 6,0 m. The floors height is 3,0 м (fig. 1). Construction area is Samarkand. Wind load - 0.38 kPA; snow load - 0.5 kPA; the construction seismicity site is 8 points with 500 years repeatability. Region index is IV. The seismic property category is III.

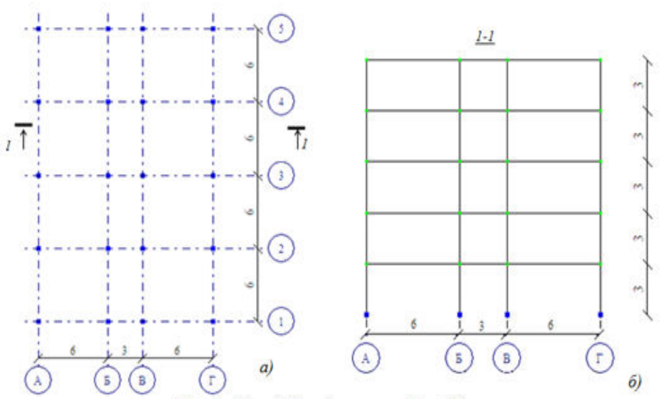


Fig. 1. Plan (*a*) and cross section (*b*)

Reinforced concrete square columns section with rib 400 mm dimensions; cross-

section of cross-sections is square with 400x400 mm dimensions.

The frame elements are made monolithic reinforced concrete. Naturally hardened concrete of compressive strength class *B15* (R_b=8,5 MPa; E_b=36×103 MPa).

Class steel *A400* was used as longitudinal working reinforcement. (R_s=365 MPa; $E_s=2\times10^5$ MPa).

Typical prefabricated reinforced concrete hollow-core slabs with a reduced 120 mm thickness are used in floors and roofs.

The temporary payload on the floor is assumed to be 4,0 kPA.

Loads acting on 1 r/m girder are given in table. 1.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

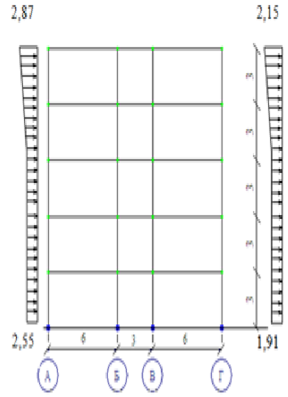


Fig. 2. Loading the frame with wind load

Wind load acting along the frame height:

active pressure -

$V_1 = 0{,}38x1x0{,}8x6x1{,}4=2{,}55$ кPa;

$V_2= 0{,}38x1{,}125x0{,}8x6x1{,}4=2{,}87$ кPa;

passive pressure -

$V_1 =0{,}38x1x0{,}6x6x1{,}4=1{,}91$ кPa;

$V_2= 0{,}38x1{,}125x0{,}6x6x1{,}4=2{,}15$ кPa;

Seismic load is defined as concentrated from static loads in accordance with [1].

The loadings list by the traditional method and taking into account the frame construction staging is given in Tables 2 and 3.

Table 2

Load List by Traditional Method			
№	Loadname	Form	Type
1	Permanent	Permanent (0)	
2	Temporary long	Temporary duration(1)	
3	Short-term	Short-term (2)	
4	Wind	Short-term (2)	
5	Seismic	Seismic (5)	SEISMIC

Table 3.

List of load cases taking into account the staging of the frame construction			
№	Loadname	Form	Type
1	Self-weight column basement	Permanent (0)	systems Installation
2	Net weight of basement girder	Permanent (0)	systems Installation
3	Self-weight column of the 1st floor	Permanent (0)	systems Installation
4	Net weight of the 1st floor girder	Permanent (0)	systems Installation
5	Self-weight column of the 2nd floor	Permanent (0)	systems Installation
6	Net weight of 2nd floor transom	Permanent (0)	systems Installation
7	Self-weight column of the 3rd floor	Permanent (0)	systems Installation
8	Dead weight of 3rd floor transom	Permanent (0)	systems Installation
9	Self-weight column of the 4th floor	Permanent (0)	systems Installation
10	Net weight of the 4th floor girder	Permanent (0)	systems Installation
11	Temporary long	Temporary duration (1)	
12	Short-term	Short (2)	
13	Wind	Short (2)	
14	Seismic	Seismic (5)	SEISMIC

The frame element numbers are shown in Fig. 3.

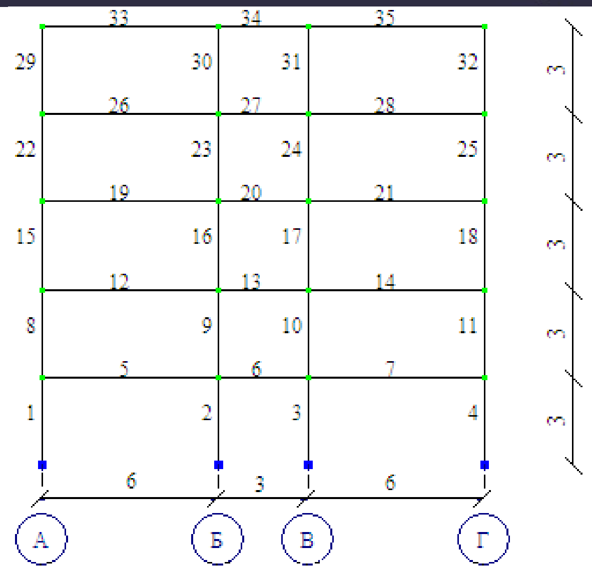


Figure: 3. Elements numbering

The calculated efforts values N, M and Q according to the traditional calculation method and taking into account the frame staged construction are given in Tables 4 and 5.

Table 4.

Efforts calculated combinations according to the traditional method

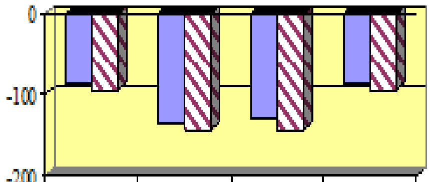
№ ELEMENT		N	M	Q
1	1	-87,12	-17,92	9,91
	2	-87,12	11,39	9,62
2	1	-132,26	18,34	-11,02
	2	-132,26	-14,71	-11,02
3	1	-129,01	-20,04	11,97
	2	-129,01	15,87	11,97
4	1	-85,27	16,44	-9,10
	2	-85,27	-10,88	-9,10

Table 5.

Efforts calculated combinations taking into account staging

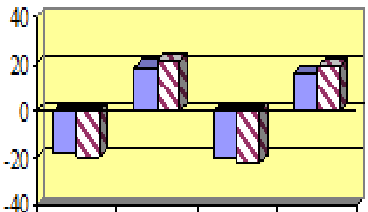
№ ELEMENT		N	M	Q
1	1	-94,30	-19,65	10,37
	2	-92,98	11,47	10,37
2	1	-141,65	20,95	-12,49
	2	-140,33	-16,54	-12,49
3	1	-141,65	-22,43	13,16
	2	-140,33	17,07	13,16
4	1	-94,30	18,72	-10,23
	2	-92,98	-12,01	-10,23

The calculation comparison results using the traditional method and taking into account the frame staged construction are shown in Fig. 4 ... 6.



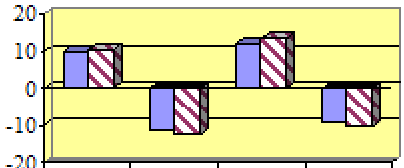
	1 элем.	2 элем.	3 элем.	4 элем.
According to the traditional method	-87,1	-132,3	-129	-85,3
Taking into account the staging	-94,3	-141,7	-141,7	-94,3

Figure: 4. Longitudinal forces N (t) in the frame elements



	1 элем.	2 элем.	3 элем.	4 элем.
According to the traditional method	-17,9	18,3	-20	16,4
Taking into account the staging	-19,7	21	-22,4	18,7

Figure: 5. Bending moments M (t * m)



	1 элем.	2 элем.	3 элем.	4 элем.
According to the traditional method	9,9	-11	12	-9,1
Taking into account the staging	10,4	-12,5	13,2	-10,2

Figure: 6. Transverse forces Q (t)

The longitudinal reinforcement number in the columns sections, calculated according to the traditional method and taking into account construction stages, is given in table 6 and 7. The reinforcement area, calculated according to the traditional method, is taken as 100%.

Table 6.

Floor	KK1 (A_s,см²)		Differences in%	Floor	KK2 (A_s,см²)		Differences in%
	According to the traditional method	Taking into account the staging			According to the traditional method	Taking into account the staging	
1	6,72	8,00	119	1	8,00	8,96	112
2	4,32	7,84	181	2	7,84	10,88	138,8
3	5,12	5,44	106	3	6,56	7,52	114,6
4	5,60	5,92	105,7	4	5,44	6,08	111,7
5	7,04	7,20	102	5	4,96	5,28	106

Table 7

Floor	KK3 (A_s,cm²)		Differences in%	Floor	KK4 (A_s,cm²)		Differences in%
	According to the traditional method	Taking into account the staging			According to the traditional method	Taking into account the staging	
1	9,60	10,56	110	1	6,08	6,72	110
2	9,28	12,4	133,6	2	4,00	7,84	196
3	7,36	8,64	117,4	3	4,80	5,44	113
4	5,92	6,40	108	4	5,44	5,92	108,8
5	5,12	5,28	103	5	7,04	7,20	102

The girders longitudinal reinforcement number, calculated according to the traditional method and taking into account construction stages, is given in table 8. The reinforcement area, calculated according to the traditional method, is taken as 100%.

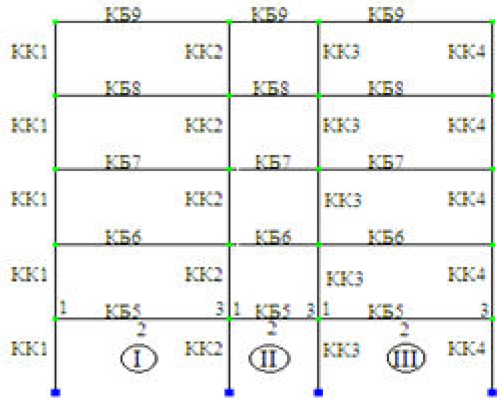


Figure: 7. The structural element name

Conclusions:

1. The construction staging significantly affects the stress-strain the building frame elements state [3];

2. The staged construction significantly increases the design forces and, accordingly, the reinforcement area (see Tables 6 and 7) for the outermost second floor columns, respectively, by 81% (KK1) and 96% (KK4) [6].;

3. The staged construction significantly increases the design forces and, accordingly, the reinforcement area (see Table 8) in the outermost crossbars spans of the second floor by 50% (CB6) [2];

4. The staged construction significantly increases the design forces and, accordingly, the reinforcement area (see Table 8) on the supporting sections the cross-sections in the middle span of the second floor by 25% (CB6).

Based on a numerical experiment with a five-story frame building made monolithic reinforced concrete, it was found that when designing a multi-story frame building, taking into account the staging their construction significantly affects the stress-strain state the frame elements and leads to an increase in the design efforts:

Similar results were obtained in the work. [1].

References

1. Strukov S.Yu., Efryushin S.V. Computational analysis of the stress-strain state of a monolithic frame of a multi-storey building, taking into account the stages of construction. Construction mechanics and structures. Scientific and technical journal. Issue №. 2 (11), 2015, p. 79-89.

2. Khamrokulov U.D., Usmanov V.F. Design of crossbars of critical buildings taking into account the gradual loading. «Problems of architecture and construction», Issue № 1, 2019, p. 44-48.

3. Khamrokulov U.D., Ibragimov Kh.M., Usmanov V.F. Taking into account the influence of filling on the work of reinforced concrete frames. "Problems of architecture and construction", Issue No. 4, 2019, p. 112-115.

4. Almazov V.O. Klimov A.N. Experimental study of the stress-strain state of high-rise building structures. Publisher: Federal State Budgetary Educational Institution of Higher Education "National Research Moscow State University of Civil Engineering", 2013.

5. Xamrokulov U.D. Calculation methods of multi-storey buildings. "Innovative technologies in construction". Materials of the republican scientific and practical conference, Issue No. 15, 2020, p. 272-274.

6. Ferraioli, M. Dynamic Increase Factor for Nonlinear Static Analysis of RC Frame Buildings Against Progressive Collapse. Int J Civ Eng 17, 281–303 (2019).

7. Vamvatsikos D, Allin Cornell C (2002) Incremental dynamic analysis. Earthq Eng Struct Dyn 31(3):491–514.

Table 8.

	Points №	I-span (A_s,cm²)			II-span (A_s,cm²)			III-span (A_s,cm²)		
		According to the traditional method	Taking into account the staging	Differences in%	According to the traditional method	Taking into account the staging	Differences in%	According to the traditional method	Taking into account the staging	Differences in%
1st floor CB5	(1)	19,84	18,24	92	15,04	15,36	102	19,36	18,40	95
	(2)	9,12	9,28	102	7,52	8,48	113	9,12	9,28	102
	(3)	18,40	18,40	100	13,44	15,04	112	18,08	17,92	99
2nd floor CB 6	(1)	19,36	21,12	109	13,6	16,96	125	19,52	22,72	116
	(2)	8,16	12,48	153	7,04	5,44	77	8,32	12,48	150
	(3)	17,76	22,72	128	12,8	16,16	126	18,24	21,12	116
3rd floor CB 7	(1)	17,28	15,20	88	11,04	11,20	101	16,80	15,52	92
	(2)	8,80	8,26	94	4,32	4,16	96	8,32	8,16	98
	(3)	16,16	15,52	96	10,24	11,04	108	16,64	15,20	91
4th floor CB8	(1)	15,36	13,12	85	7,84	8,00	102	15,20	13,76	91
	(2)	8,80	9,12	104	1,44	1,12	78	8,80	9,12	104
	(3)	14,72	13,76	93	7,52	8,00	106	14,72	13,12	89
5th floor CB9	(1)	8,00	8,32	104	4,64	5,44	117	8,64	9,76	113
	(2)	6,24	7,20	115	-	-	-	6,24	7,20	115
	(3)	8,64	9,76	113	4,64	5,44	117	7,84	8,32	106