A. S. Morgun, Dc. Sc. (Eng.), Prof.; I. M. Met

ACCOUNT OF STRESSES REDISTRIBUTION IN THE PROCESS OF INVESTIGATION OF STRESSED-STRAINED STATE OF JOINT-FUNCTIONING OF THE SYSTEM "BASEMENT-FOUNDATION-CONSTRUCTION"

Influence of joint impact of "basement-foundation-construction" system on redistribution of internal strains in overground part is analyzed.

Key words: *stressed-strained state, numerical modeling, redistribution of strains, setting of bearings.*

Introduction

Traditional computation of stresses in statically defined constructions is based on the assumption that constructive elements are ideally elastic and their rigidities do not depend on the magnitude and duration of force impact, as well as on the assumption that minor deformations allow to consider geometric values, being the components of equilibrium.

In reinforced concrete constructions besides elastic strains we observe non-elastic strains: flow ability, creep, shrinkage, temperature deformations, displacement of supports and others.

Due to these factors, stressed-strained state of buildings both in condition of exploitation and on the limit of carrying capacity differ greatly from the state, determined by the calculation of the same system as elastic. In case of load increase, proportionally one parameter, stressed-strained state of the system grows, in greater part of cases, non-proportionally to this parameter. Non-elastic strains lead to redistribution of forces, such redistribution often has considerable impact on carrying capacity of constructions, rigidity and crack proof.

Redistribution of efforts leads to the increase of carrying capacity of the system, that is why consideration of this redistribution can help to save materials. On the other hand, non-elastic strains of overground and subsurface part of constructions, formation of cracks, sleep of soil particles, as a rule, reduce rigidity. Delay of strength growth, caused by this phenomenon, in some elements, at the expense of accelerated strength growth in other elements, can lead both to formation and prevention of formation of cracks or their opening. Thus, taking into consideration redistribution of forces provides more accurate evaluation of exploitation qualities of the system and can prove the expedience of measures, which improve the properties of system elements in order to increase the rigidity and crackproof analytical solution of the problem dealing with mutual influence of system components is rather difficult to obtain, since many factors must be taken into account: rigidity characteristics of the construction, characteristics of strength and strain of active zone soil, soils reology, history of soil lead and active soils of foundations of constructions located near.

Problem set-up, determining factors.

For solution of the problem, we will involve the mechanics of continuous media and numerical method of the finite elements (MFE). Computations of curves M,Q,N, six variants of plane reinforced frame of the construction (fig. 1) were performed according to classic method of displacements and compared with the results of their computations by PC “lira” on the subject of all proper weight, simultaneous impact of proper weight and forced displacement of supports. Rigidity of reinforced concrete columns of square section (30 cm× 30 cm) EI = 2025 t·m^2, rigidity of cross-bar ofrectangular section (30 cm × 37,8 cm) EI = 4050 t·m^2.

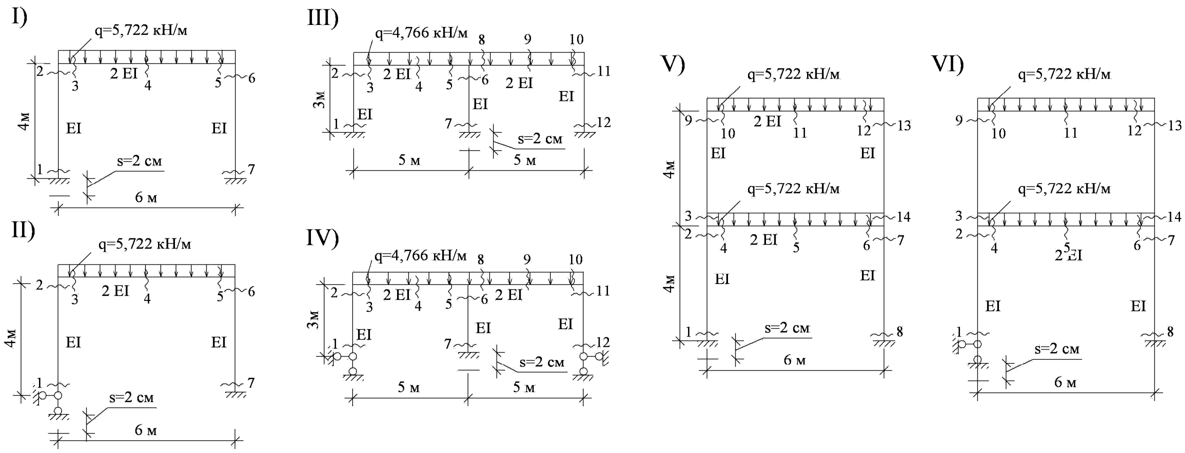

Fig.1. Variants of considered calculation schemes of frames and characteristic sections

In Fig.1, in schemes I and II the behavior of one-storeyed, single-span frame in different conditions of left support fixing (rigid, articulated) in case of its forced displacement was considered. In schemes III and IV one-storeyed two-span frames with different types of fixing of extreme supports in case of forced displacement of middle support were studied. In schemes V and VI redistribution of forces in case of forced displacement of left support at the distance of 2-8 cm with the step of 2 cm.

Results of calculations of bending moment diagrams M (кN·m), shear diagrams Q (кN), axial force diagrams N (кN) are presented in the Table analogous to Table 1 of the given calculation for the first scheme (Fig. 1, I). The Table contains in the numerator the value of diagrams M, Q, N taking into account forced displacement of supports, in denominator-values of diagrams M, Q, N, without forced displacement of supports. Hence, the result of such relation characterized the picture of corresponding effort change (M, Q, N) for each characteristic section, restoring the picture of efforts redistribution in greater or smaller side. Such relation serves a derivative (gradient) of the part of function of diagram M, Q or N change relatively calculation of frame without the account of the work of underground part of the construction. This gradient (relation) gives general characteristic of studied function (changes of M, Q, N) behavior near certain characteristic section. In direction shows the direction of the most rapid growth or decrease of the function (M, Q, N). Results of study of internal efforts change for the schemes are shown in Fig. 2, 3, 4.

Table 1

Data of M, Q, N calculation for the first scheme

N of characteristic sectioon	M with account of displasement	M without account of displasement	Q with account of displasement	Q without account of displasement	N with account of displasement	N without account of displasement
1	19,9	5,29 = 3,88	-3,893	-3,854 = 1,01	-12,464	-17,161 = 0,73
2	4,403	-10,287 = -0,43	-3,893	-3,854 = 1,01	-12,464	-17,161 = 0,73
3	4,403	-10,287 = -0,43	12,459	17,161 = 0,73	-3,924	-3,854 = 1,02
4	8	15,465 =0,52	-4,707	0 = 0	-3,924	-3,854 = 1,02
5	-25,134	-10,287 = 2,44	-21,873	17,161 = 1,27	-3,924	-3,854 = 1,02
6	-25,134	-10,287 = 2,44	3,891	3,854 = 1,01	-21,868	-17,161 = 1,28
7	-9,951	5,129 = -1,87	3,891	3,854 = 1,01	-21,868	-17,161 = 1,28

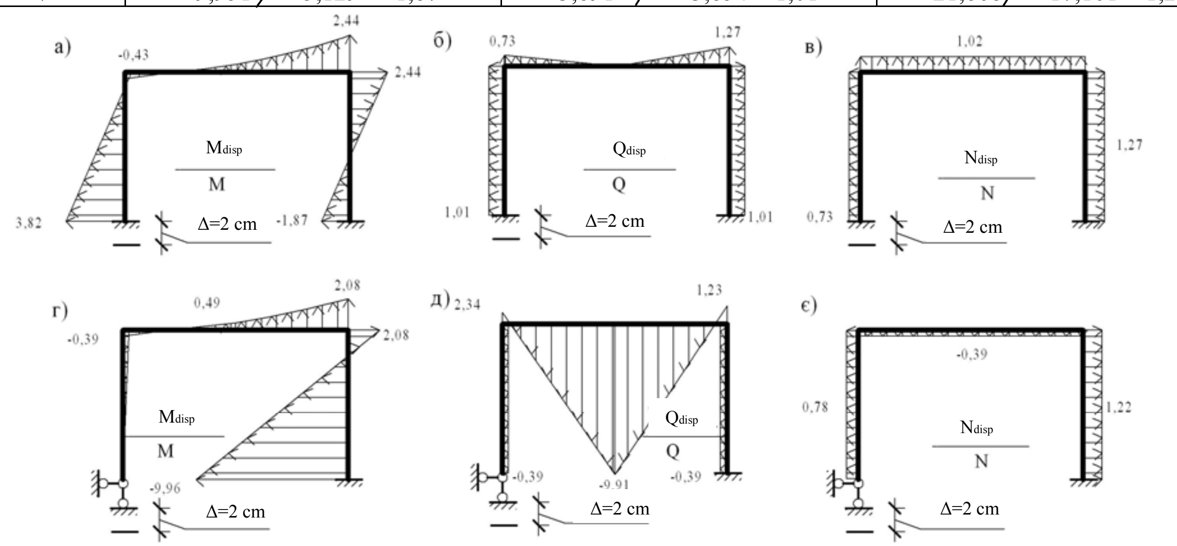

Fig.2. Change gradient of internal efforts (M, Q, N): a, b, c – for variant of scheme I; d,e,f – for variant of scheme II

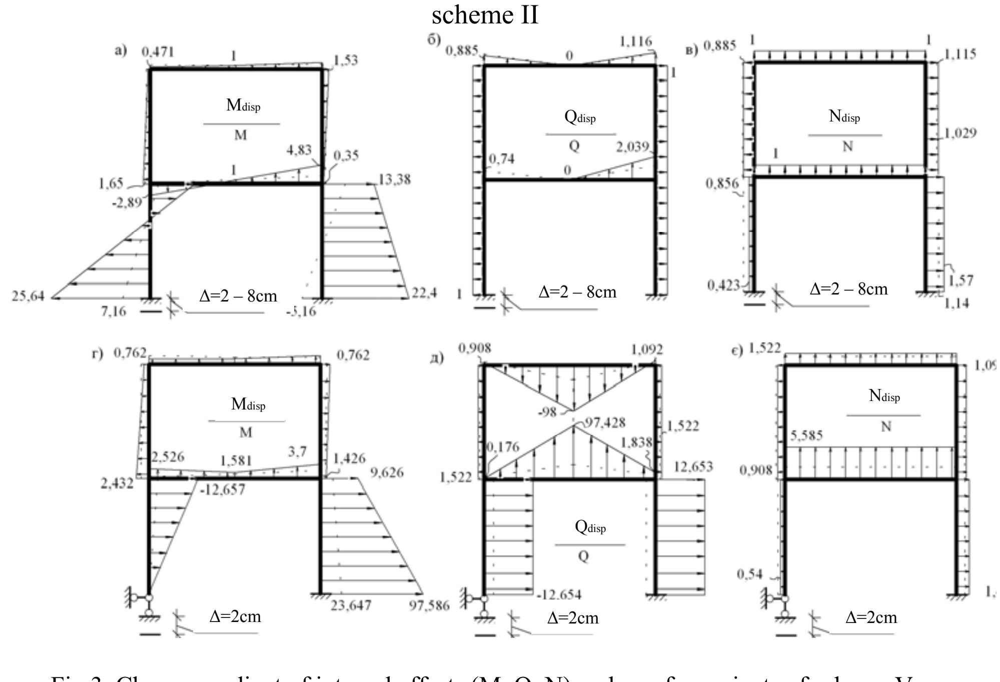

Fig.3. Change gradient of internal efforts (M, Q, N): a, b,c – for variants of scheme V; d,e,fr, д, e – for variant of scheme VI

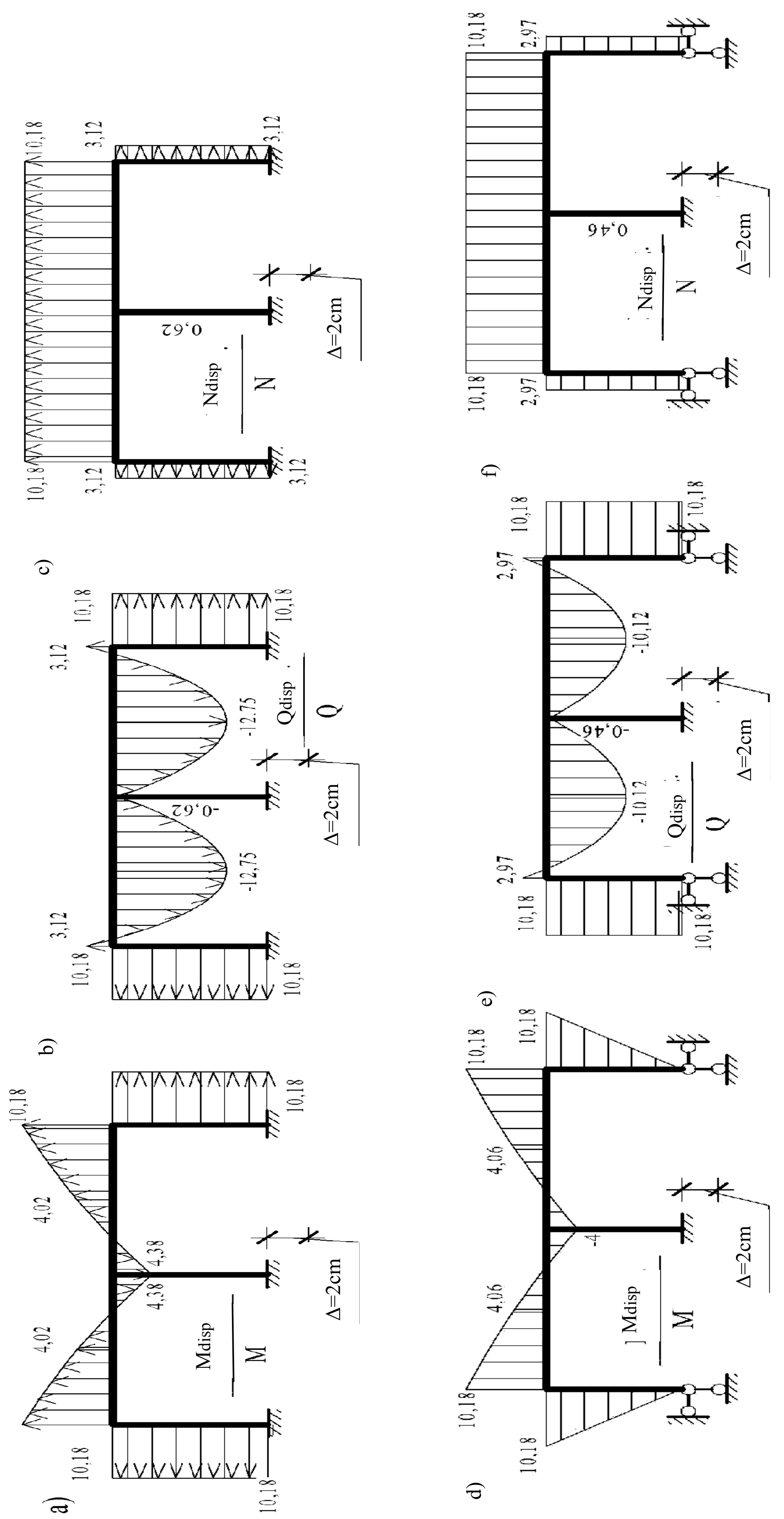

Fig.4. Change gradient of internal efforts (M, Q, N): a, b,c, – for variant of scheme III, d,e,f – for variant of scheme IV.

Bending moment in rigidly fixed settled column (I scheme) increases 3.82 times, in extreme column and cross-bar – 1.27 times, redistribution N falls to 0/73 as compared with initial value in settled column and, correspondingly, by 27% N increases in angular column.

Displacement of articulated fixed column (scheme II, Fig.2, d,e,f) increases bending moment 9.96 times, Q in cross-bar – 9.91 times. Picture of redistribution N is practically identical to the scheme 1 – decrease of N in settled left column by 22%, and the same increase of N in extreme opposite column.

Displacements of middle column by 1 cm (schemes III, IV,Fig.4) lead to sharp increase 10,1times, of M in extreme columns both in case of their rigid and articulated fixing. Increase of Q,10.18 times, is observed in extreme columns and, 12.75-10.12 times growth of Q in cross-bars in both types of fixing is observed. N increases in extreme columns 3 times, and in cross-bar – 10.18 times.

Fig.3 a,b,c (scheme V) shows dynamics of efforts redistribution while left support settling from s=2 cm to s=8 cm, sharp increase of bending moments in supports of the first floor if s=2 cm is observed, 5-7 times, if s=8 cm the increase is 26-23 times. Value of left support displacement from 2 cm to 8 cm on bending moments of the second floor is of minor influence (approximately 1.53 times). Displacement of left support increases transverse force in cross-bars (approximately 2 times) and decreases longitudinal force N in left support, which is displaced up to 0.43 from initial value (if s=2 cm), up to 0.86 (if s=8 cm), N in opposite column increases from 1.14, if s=2 cm, to 1.57, if s=8 cm.

In scheme 6, results of numerical calculation show sharp increase of bending moment of M in non-settled, rigidly fixed column and transverse force Q in cross-bar both of the first and second floors, longitudinal force N in settled columns, both of the first and second floors decreases by 46% and increases by the same value in non-settled column.

Conclusions

1. Redistribution of efforts of longitudinal force N practically does not depend on the type of columns fixing (rigid or articulated) and provides decrease of N in settled columns, transferring effort N on extreme non-settled columns, by the value they are decreased in settled columns.

2. Greatest redistribution of bending moment N in two-storeyed frame, appears in columns and cross-bar of the first floor, slightly influencing the elements of the second floor.

3. Design of constructions, taking into account redistribution of efforts is actual nowadays, since it enables to use more efficiently materials, as their price constantly grows.

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Morgun Alla – Doctor of Sc.(Eng.), Professor, Head of the Department of civil and industrial engineering.

Met Ivan – Post-graduate, Department of civil and industrial engineering.
Vinnytsia National Technical University.