**UDC 624.012.45**

# RESEARCH INVESTIGATION OF DEFORMABILITY OF ROAD SLABS MADE OF REINFORCED CONCRETE AND STEEL FIBER CONCRETE USING INDICATORS

**Bershadska A.,** *student of the group ICE-466*
*Scientific supervisor –* ***Korneieva I.,*** *PhD, associate professor*
*(Department of Materials resistance, Odesa State Academy of Civil Engineering and Architecture)*

**Abstract.** The subject of the study is two road slabs of the 1P30-18-30 brand, one plate is made of reinforced concrete, and the second is the same with the addition of steel fiber. Both plates were manufactured at the plant in accordance with the State Standards of Ukraine [6-8] (SSU) and State Building Codes (SBC).

The test was carried out according to the cantilever loading scheme on a specially designed stand. As a result of laboratory tests of reinforced concrete and steel-fiber-reinforced concrete road slabs, data on the process of deformation of structures under the influence of load were obtained. To investigate deformations, load cells were pre-glued up and indicators were arranged.

In the cantilever loading scheme on both plates, the longitudinal relative deformations inside the span and on the cantilever support differ by 22 times.

The average values of the final maximum deformations are 14% higher for a reinforced concrete slab. It has been experimentally proven that the use of steel fiber in the manufacture of concrete mix avoids the brittle nature of destruction.

**Topicality.** Improving transit routes is currently one of the most important tasks, as thousands of vehicles pass through our country and ports every day. Therefore, it is necessary to make sure that roads, as one of the ways to export or import products, are strong and do not need to be repaired for a long time. Determination of the properties of road surfaces and their improvement is the purpose of the study and is considered in the article.

In [1], the results of an experimental study of the endurance of models of concrete road surfaces on various bases under the action of repeated dynamic loads are presented. Repeated loads cause fatigue phenomena in the materials of road structures. To increase the endurance of concrete road surfaces, that is its ability to provide long-term resistance to repeated loads, it is necessary to structurally reduce the amount of cyclic stresses in the surfaces. One of the options for increasing the endurance of concrete coatings is the device of bases made of materials reinforced with cement, but there are no wishes to improve the materials of the slabs themselves.

Transport concretes are destroyed by tensile stresses. Therefore, it is relevant to study the factors that make such destruction impossible. The authors [2] considered the effect of steel fiber in testing road concretes.

Steel fiber concrete can increase the efficiency of reinforced concrete products by increasing the strength of the product [3]. Based on the optimal composition of the fiber-reinforced concrete mixture already chosen by the authors earlier, the load-bearing capacity of steel-reinforced concrete was studied. So, the study of deformability of road slabs and determination of the optimal composition of concrete is relevant.

For the production of road slabs of the 1P30-18-30 brand weighing 2200 kg/piece, concrete (class B30), rebar Ø12 AI KR5 , KR11, dimensions of slabs were used 3000x1750x170 mm.

One plate is made of reinforced concrete, and the second is the same with the addition of steel fiber. Both plates were manufactured at the factory in accordance with SSU [6-8] and SBC. The test was carried out according to the cantilever loading scheme on a specially designed stand.

The load was applied in two strips, steps and recorded using dynamometers. First, calculations were made for internal destructive loads and the size of the load stages during testing. To investigate deformations, load cells were pre-glued up and indicators were arranged.

Watch-type indicators were used in the test. They are used to check parts according to a reference sample to check quality within the framework of standards and tolerances at various enterprises.

The purpose of this work is to experimentally study the deformability of road slabs made of reinforced concrete and steel fiber concrete using indicators by conducting full-scale static tests in laboratory conditions.

Fig. 1 shows: load diagram, detailed location of indicators (1i, 7i, 8i, 14i are located on the end planes of the plate, 2i-6i, 8i-13i are located on the upper plane), as well as supports and two strips along which the load acts. The dimensions of the plate are shown in the figure, as well as the distances between characteristic places.

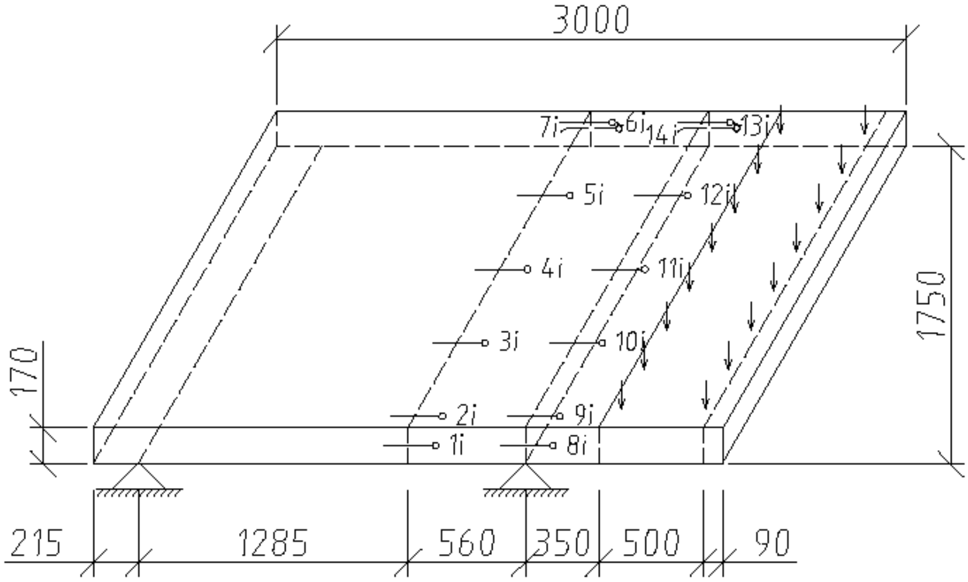


Fig. 1. Road plate loading diagram and indicator location

At the preparatory stage, according to [3], standardized samples of fiber-reinforced concrete made of a material identical to the construction material were tested. The structure itself is manufactured and tested in accordance with current regulations [5, 6, 7, 8].

As a result of laboratory tests of reinforced concrete and steel-fiber-reinforced concrete road slabs, data on the process of deformation of structures under the influence of load were obtained. Graphs of the dependence of relative longitudinal deformations on the load are done.

We investigate the deformability based on the readings of clock-type indicators. The base of each indicator is 24 cm, so the passage of a crack through the base does not affect the operation of the indicator, but this phenomenon is visible on the chart or in the table. Only if a crack has passed through the mounting of the indicator base, the device will not display correct data. To check the correctness of measurements, load cells were pasted under some indicators inside the database.the data obtained from the two types of measuring devices almost coincide, so we can talk about the correctness of the research.

Let's consider the process of plate deformation using the example of several indicators, for example, indicators 2 and 3 inside the span and 9 and 10 located above the support. Indicator 2 and 9 are on the same line along the plate, as are 3 and 10.the data is shown in Tables 1 and 2.

Deformations inside the span grow slowly and increase significantly only after the beginning of crack formation for the reinforced concrete slab, which cannot be said about the steel fiber concrete slab, because with the appearance of the first crack, deformations will not grow so quickly, because fiber fibers restrain the development of trishins.

If we analyze the process of deformation of the upper layer of plates on the support near the console, then relative to the data inside the span, the deformation is 22 times greater, because it is there that the first and widest trishines appear. With the formation of the first crack, the average values of relative deformations are 0.82 · $10^{-4}$ for reinforced concrete slab and 0.55 · $10^{-4}$ for steel fiber concrete, the difference is 33%.

Table 1

Values of relative deformations based on indicator readings for reinforced concrete road slab, $\varepsilon \cdot 10^4$

| Load, кN | 2i | 3i | 9i | 10i |
|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 38.4 | 0.0 | 0.0 | 0.0 | 0.1 |
| 48.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| 57.6 | 0.1 | 0.1 | 0.1 | 0.1 |
| 67.2 | 0.1 | 0.1 | 0.1 | 0.2 |
| 76.8 | 0.1 | 0.1 | 0.2 | 0.2 |
| 86.4 | 0.1 | 0.1 | 0.2 | 0.2 |
| 96.0 | 0.2 | 0.1 | 0.8 | 0.6 |
| 105.6 | 0.2 | 0.2 | 1.2 | 1.3 |
| 115.2 | 0.2 | 0.2 | 2.0 | 2.1 |
| 124.8 | 0.2 | 0.2 | 2.8 | 2.6 |
| 134.4 | 0.2 | 0.2 | 3.2 | 3.0 |
| 144.0 | 0.3 | 0.2 | 3.6 | 3.4 |
| 153.6 | 0.3 | 0.3 | 4.0 | 3.7 |
| 163.2 | 0.3 | 0.3 | 7.6 | 6.7 |

And also, the average values of deformations on the cantilever support at the end of tests almost do not differ for slabs, the values are 14% higher for reinforced concrete slabs.

The tables show the data of indicators of half of the plate relative to the longitudinal axis, since a load scheme that is symmetrical in length should also give symmetric values of deformations, which happened during tests.

The final average values of relative deformations for both plates are almost identical, in the span 0,28 · $10^{-4}$ for reinforced concrete slabs and 0,25 · $10^{-4}$ for steel fiber-reinforced concrete, on the cantilever, respectively, the value of relative longitudinal deformations is equal to 6,40 · $10^{-4}$ and 5,52 · $10^{-4}$.

Table 2

Values of relative deformations based on indicator readings for a steel-reinforced concrete road plate, $\varepsilon \cdot 10^4$

| Load, кN | 2i | 3i | 9i | 10i |
|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 38.4 | 0.0 | 0.0 | 0.1 | 0.1 |
| 48.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| 57.6 | 0.0 | 0.0 | 0.2 | 0.1 |
| 67.2 | 0.0 | 0.1 | 0.2 | 0.2 |

| | | | | |
|---|---|---|---|---|
| 76.8 | 0.0 | 0.1 | 0.3 | 0.2 |
| 86.4 | 0.0 | 0.1 | 0.3 | 0.4 |
| 96.0 | 0.0 | 0.1 | 0.7 | 0.6 |
| 105.6 | 0.0 | 0.1 | 1.0 | 0.9 |
| 115.2 | 0.1 | 0.1 | 1.2 | 1.2 |
| 124.8 | 0.1 | 0.1 | 1.4 | 1.4 |
| 134.4 | 0.1 | 0.1 | 1.6 | 1.7 |
| 144.0 | 0.1 | 0.1 | 2.0 | 2.0 |
| 153.6 | 0.1 | 0.1 | 2.5 | 2.5 |
| 163.2 | 0.1 | 0.1 | 2.7 | 2.8 |
| 172.8 | 0.1 | 0.1 | 2.9 | 3.3 |
| 182.4 | 0.1 | 0.2 | 3.0 | 3.7 |
| 192.0 | 0.1 | 0.2 | 3.3 | 4.3 |
| 201.6 | 0.1 | 0.2 | 4.2 | 5.1 |
| 211.2 | 0.2 | 0.3 | 7.4 | 5.5 |

**Conclusions and results.** In the cantilever loading scheme on both plates, the longitudinal relative deformations inside the span and on the cantilever support differ by 22 times.

The average values of the final maximum deformations are 14% higher for reinforced concrete slabs.

It has been experimentally proved that the use of steel fiber in the manufacture of concrete mix avoids the brittle nature of destruction.

**References:**


1. Витривалість бетонних дорожніх покриттів на основах різної жорсткості / І. Ю. Думич, Н. О. Балаян // Вісн. Нац. ун-ту "Львів. політехніка". - 2007. - № 602. - С. 53-56.
2. Анализ факторов, влияющих на прочность при изгибе бетонов транспортного назначения / Д. С. Захаров // Вестн. ХНАДУ. - 2017. - Вып. 79. - С. 151-157.
3. Неутов С.П., Корнеєва І.Б. Влияние стальной фибры на прочностные и деформативные свойства фибробетона / С.П. Неутов., І.Б. Корнеєва // Вісник ОДАБА. – Одеса, 2019. – №76 – С. 63-70.
4. Дорожко Є. В. Удосконалення методу розрахунку тонких асфальтобетонних шарів на жорсткій основі. ХНАДУ.2016. С. 1-22
5. Бетони. Методи визначення міцності за контрольними зразками. ДСТУ Б.В.2.7-214:2009. – [чинний від 2009-12-22]. – К.: Мінрегіонбуд України, 2010. – 43 с. (Національний стандарт України).
6. ДСТУ-Н Б В.2.6-218:2016 Настанова з проектування та виготовлення конструкцій з дисперсноармованого бетону. [Чинний від 2017-04-01]. Вид. офіц. Київ, УкрНДНЦ, 2017. 32 с.
7. ДСТУ Б В.2.6–120:2010 (ГОСТ 21924.0–84, MOD). Конструкції будинків і споруд. Плити залізобетонні для покриття міських доріг. Технічні умови. [ Чинний від 2011–07–01]. ТОВ НТК "Будстандарт", 2011. 37 с.
8. ДСТУ Б В.2.6-122:2010 (ГОСТ 21924.2-84, MOD). Конструкції будинків і споруд. Плити залізобетонні з ненапруженою арматурою для покриття міських доріг. Конструкція і розміри.