An excellent example is built in Singapore (fig. 2.).

Fig. 2. A winter garden in Singapore

Tempered glass use is not desirable at a glassing of roofs. Let it also will not wound, but, it is unpleasant, when on a head pours a glass medley. In addition, a few years later tempered glass with age cracks and crumbles on its own, without any external influence, according to professionals; this is a maximum of ten years.

That's how you build a conservatory its mast [1, 2].

REFERENCES

1. Information site [http://www.pusk.by/bse/141152].
2. Information site [http://www.pro-landshaft.ru/articles/detail/2206].

UDC 624.012.45

STRENGTH OF REINFORCED CONCRETE BEAMS, STRENGTHENED WITH ADDITIONAL PRESTRESSED TRANSVERSE REINFORCEMENT

YAHOR LAZOUSKI
Polotsk State University, Belarus

In this article the author gives the results of the experimental and theoretical studies of the strength of the reinforced concrete beams, strengthened with additional pre-stressed transverse reinforcement.

For obtaining new experimental data about the behavior of reinforced concrete beams, strengthened in shear zone, under load, experimental studies were conducted. The studies included testing of experimental beams that were strengthened in shear zone with the additional pre-stressed transverse reinforcement. The strengthening was at the initial stress-strain state and under the load action also.

Test Procedure [3]. The experimental studies were conducted on the test beams with the rectangular cross-section (175 mm (*b*) x 400 mm (*h*). The length of the test beams was 3m. As varied factors in the experiment, shear span (ranged from 1,5*d* to 2,5*d*) and the value of load under which strengthening occurred (from the initial load level (the dead weight and the weight of the test equipment) to the load value, corresponding to 71% of failure load).

During the experimental studies, three series of test beams were tested. Each series consisted of three beams. First test beams in each series were tested with different shear spans without strengthening as reference. The second and the third test beams were tested after their strengthening at the initial stress-strain state and under the load action respectively.

Test beams of the I series were tested with the shear span 1,5*d*, II – 2*d*, III – 2,5*d* respectively.

The actual cross-sectional dimensions of the test beams, transverse reinforcement characteristics before and after the strengthening, shear spans, the value of load, acting at the strengthening of the test beams are shown in Table 1.

Table 1 – The Characteristics of test beams

Series	Beam identifier	The size of the cross-section, mm	Transverse reinforcement before the strengthening, step, mm	Additional transverse reinforcement, step, mm	Prestress of the add. transverse reinforcement, MPa	Load level at the strengthening	Shear span
I	Б-1-1	175x401	2Ø6,5 S240 s=150	-	-	-	1.5*d*
	Б-1-2	176x400		1Ø12 S240s_{ad}=150	97,2	V=0	
	Б-1-3	176x400		1Ø12 S240s_{ad}=150	114,3	V=0.71V_R	
II	Б-II-1	176x399		-	-	-	2*d*
	Б-II-2	176x400		1Ø12 S240s_{ad}=150	98,1	V=0	
	Б-II-3	175x399		1Ø12 S240s_{ad}=150	98,5	V=0.57V_R	
III	Б-III-1	176x402		-	-	-	2.5*d*
	Б-III-2	176x400		1Ø12 S240s_{ad}=150	96,5	V=0	
	Б-III-3	174x401		1Ø12 S240s_{ad}=150	108,4	V=0.49V_R	

The experimental studies of the test beams were conducted in the laboratory of the EE "PSU". Only checked equipment was used. The load was applied to the sample by means of the press PR-1000. To control the magnitude of the applied external load press dynamometer was used.

During the test, to obtain the data about the stress-strain state of the test beams shear zones, the measurements of the basic and additional transverse reinforcement strains, as well as shear zone concrete strains were conducted.

The strengthening scheme of the test beams is shown on Fig. 1.

The experiment showed that all test beams, strengthened in shear zone by installation of an additional pre-stressed transverse reinforcement, collapsed in the shear zone by the critical inclined crack with the attainment of the basic and additional transverse reinforcement strains values, corresponding to the yield strength.

The ultimate strength calculations were performed using the real physical and mechanical characteristics of steel and concrete, which were obtained from the experiments. The calculation results, that were obtained using the limit equilibrium method [1], strut and tie method [4], limit equilibrium method for bending structures, strengthened in shear zone [5] and proposed method, based on the Modified compression field theory and general deformational model [2], as well as the relationship of experimental data to the calculated values are shown in the Table 2.

1. It was experimentally confirmed the efficiency of the strengthening of the reinforced concrete beams by installing the additional pre-stressed transverse reinforcement in shear zone in the initial stress-strain state and under load action also.

2. The results of the experimental and theoretical studies have shown the satisfactory convergence between the experimental data and data, calculated using proposed method, based on the modified compression field theory and general deformational model [2].

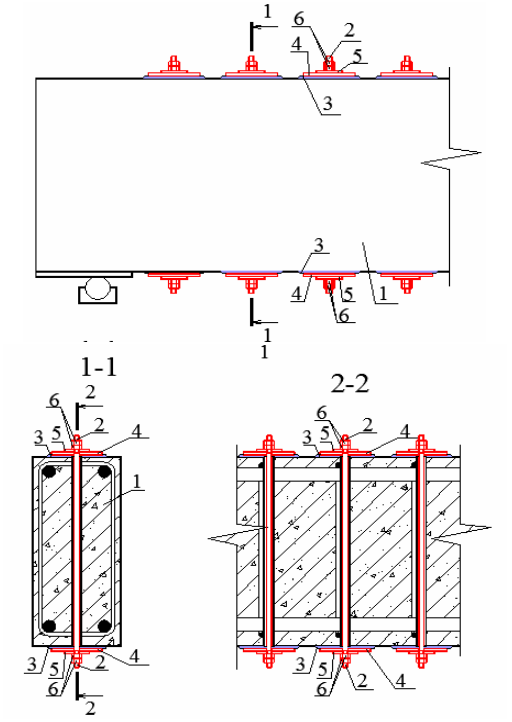

Fig. 1. The strengthening scheme of the test beams:
1 – strengthened beam; 2 – additional ransverse reinforcement ∅12 mm; 3 – gupsum slurry layer;
4 – steel distributor plate 100x100x5 mm; 5 – steel plate washer 50x50x5 mm; 6 – nut and lock nut M12

Table 2. – The tested beams shear capacity

Beam identifier	V_{exp}, кН	V_{th} , кН [1]	$\frac{V_{exp}}{V_{th}}$ [1]	V_{th} , кН [4]	$\frac{V_{exp}}{V_{th}}$ [4]	V_{th} , кН [5]	$\frac{V_{exp}}{V_{th}}$ [5]	V_{th} , кН [2]	$\frac{V_{exp}}{V_{th}}$ [2]
Б-I-1	283.3	281.05	1.01	50.34	5.63	-	-	267.3	1.06
Б-I-2	482.8	398.01	1.21	143.44	3.37	-	-	465.5	1.04
Б-I-3	460.8	398.01	1.16	143.44	3.21	384	1.20	445.3	1.03
Б-II-1	244.5	252.5	0.97	50.34	4.86	-	-	236.3	1.03
Б-II-2	351.4	351.74	1.00	143.44	2.45	-	-	363.2	0.97
Б-II-3	335.6	351.74	0.95	143.44	2.34	344.7	0.97	348.5	0.96
Б-III-1	184.8	224.5	0.82	50.34	3.67	-	-	176.3	1.05
Б-III-2	315.6	323.7	0.97	143.44	2.20	-	-	290.9	1.08
Б-III-3	295.4	323.7	0.91	143.44	2.06	316.7	0.93	276.4	1.07

REFERENCES

1. Бетонные и железобетонные конструкции: СНБ 5.03.01-02. – Введ. 01.07.2003. – Минск: Минстройархитектуры Респ. Беларусь, 2003. – 140 с.
3. Лазовский, Е.Д. Предпосылки, методика и программа для расчета напряженно-деформированного состояния усиленных в зоне среза изгибаемых железобетонных элементов / Е.Д. Лазовский, Д.О. Глухов // Вестн. Полоц. гос. ун-та. Сер. F. Строительство. Прикладные науки. – 2013. – № 16. – С. 40 – 45.
4. Лазовский, Е.Д. Экспериментально-теоретические исследования прочности изгибаемых железобетонных элементов, усиленных в зоне среза установкой дополнительной предварительно напряженной поперечной арматуры / Е.Д. Лазовский // Вестн. Полоц. гос. ун-та. Сер. F. Строительство. Прикладные науки. – 2013. – № 16. – С. 40 – 45.
5. Проектирование железобетонных конструкций: ТКП EN 1992-1-1-2009 (02250). Еврокод 2. – Минск: Минстройархитектуры Респ. Беларусь, 2010. – 191 с.
6. Усиление железобетонных конструкций: пособие П1-98 к СНиП 2.03.01-84*. – Введ. 01.05.1998. – Минск: Минстройархитектуры Респ. Беларусь, 1998. – 189 с.