

Dramix® steel fibres PRECAST elements

RNDr Jaroslav Boček

Abstract : Dramix® steel fibres not only for production industrial floor or shotcrete for tunneling and/or slope stabilization is used. Galvanized Dramix® steel fibres as a reinforcement of precast concrete provide a ductile concrete with high load-carrying capacity, efficient crack-control, durability of concrete of precast elements with complicated shapes and complex load patterns. Galvanized surface of fibres provide no staining of the concrete surface.

Keywords: Dramix® fibres, galvanized fibres, ductility, staining, precast elements

Introduction

The purpose of steel fibre reinforcement is to maintain the flexural strength of concrete as it cracks. Ordinary plain concrete is brittle, Dramix® concrete is ductile material that is homogeneously tough and ductile. Dramix® SFRC distribute loads more evenly and increase the load bearing capacity. That fact clearly offers major advantages for concrete products with complicated shapes and complex load patterns. The redistribution of tension forces and bending moments play an important role here.

Properties of Dramix® Steel Fibres Reinforced Concrete – Precast elements

Nevertheless, not only amount and dimensions of fibres gives an idea and data for sophisticated design. SFRC is characterised by Equivalent flexural strength $F_{ctm,eq}$ (N/mm²) and/or Ductility $Re_{1,5}$ (%). Test is done by Standards – beams those are tested on bending. In table are minimum $Re_{1,5}$ values for Dramix® fibres the most used at precast elements compared to „the most“ used steel fibre of dia 1 mm length 50 mm (RL 45/50 – BN).

Fibre type						B = bright C = galvanized
	15 kg/m ³	20 kg/m ³	25 kg/m ³	30 kg/*m ³	35 kg/m ³	
RL 45/50 - BN		38	43	48	52	
RC 65/35 - BN		58	64	69	75	
RC 65/40 - CN	39	48	55	61	69	
RC 80/60 - CN	52	62	72	82	88	

Tab.1. $Re_{1,5}$ (%) value for different fibre types



Some discussion re testing – Equivalent flexural strength – Ductility. Because of some spread of results during testing of beam, (tensile after first microcrack of beams) it is not accepted taking into account results of tests those were tested on one beam only.

Very often we can meet in practice the results when the highest data or data of one test only are taken as a „ efficiency - Re value „ of SFRC „ . Data for different fibres and different concrete tensile must be taken from large series of tests on appropriate testing device. Product data Sheet (/3/ of Dramix® steel fibres are results of such a large testing series.

2.1 Galvanized types RC - ** - CN Dramix® steel fibres

The steel wire fibres are evenly distributed through the concrete, right up to the surface and the edges of concrete product. That's where stining and corrosion may occur with ungalvanized – bright steel fibres. To prevent this problem, Bekaert has developed the CN – fibres with zinc coating of at least 30 g/m². This is more than adequate for most precast applications. The fibres are environmental friendly – type : **RC - **/** CN – Green.**

2.2 Pre - stressed T beams

Not only the load bearing capacity (bending) of steel fibres reinforced concrete can be taken into account, in some extent steel fibres can be used as a shear reinforcement replacing the stirrups. Design approach can be found in /1/. German construction company Bögl with cooperation with TU Braunschweig in 2003 tested and granted by approval for two different projects by the Germany authorities T beams. Span of beams is 25 m, maximum height of 2,20 m. Shear reinforcement was completely replaced by steel fibres. Apart from pre – stressing cables and Dramix® fibres , no other reinforcement is used. For production was used SCC quality C 60/75, Dramix® fibres RC 80/60 BP (length 60mm , dia 0,71 mm , tensile min 2000 Mpa) with dosage 40 kg/m² of concrete. More details can be found in /2/

2.3 Concrete lintels

In Czech Republik are steel fibres used for production concrete lintels. For production Czech company use Dramix® RC 65/35 BN (dia 0,55 mm , length 35 mm). Fibres completely replaced stirrups in products. Production is fully automatized, Dramix® fibres are delivered in 1100 kg Big Bags into Dosing Equipment, electronic connection with batching line automaticly dose requested dosage of fibres based on amount of concrete and type of products – lintels. Production was drastically simplified with positive economic results - products see Picture 1.

2.4 Precast pipes



Picture 1. Concrete lintels



Picture 2. Precast tubes



Dramix® steel fibres have the unique property of reinforcing in all directions. They can cope with complex loads. As the deformation transfers the main load to another zone, the ductile fibre matrix starts mobilizing other fibres in the most effective way. Tests were done and proved that first crack of SFRC provide cracks width of 0,1 mm against 0,2 mm for traditional reinforced concrete (mesh), for maximum load SFRC shows crack opening to 0,2 – 0,4 mm , traditional reinforced concrete 2 – 4 mm – 10 x more.

Company N.V. Bekaert developed design method that enable design of SFRC pipes against traditional reinforcement – instead of mesh/steel bars is used concrete with Dramix® fibres only. No mesh –SFRC only makes production of pipes much easy with remarkably economic result and with better quality of products. Fibres are simply added to mixer at production line.

Production and tests of rupture loads at state testing lab – TZÚS were done for pipes diameter of 300 mm (wall thickness 65mm), 400 mm (wall thickness 80 mm) and diameter 600 mm (wall thickness 100 mm).The tests were done for three pipes of each diameter. Instead of traditional reinforcement was used SFRC – with Dramix® galvanized fibres RC 65/40 CN – Green (dosage 25 kg/m³ for diameter 300 mm and dosage 28 kg/m³ for diameter 400mm) and fibres RC 80/60 CN – Green (dosage 35 kg/m³). Re1,5 value for each type of fibres and results see Table 1.

Dia (mm) pipes	Dramix	Re1,5 (%) value	Rupture Load kN/m	
			theory	test results
300	RC 65/40 CN - Green	62	105	139 - 152 - 137
400	RC 65/40 CN - Green	67	117	178 - 180 - 182
600	RC 65/40 CN - Green	88	133	168 - 172 - 174

Table .1. Tests results

As it is evident the received tests results are above the theory calculation and above minimum Rupture Loads for those size of pipes as well. No more is traditional reinforcement used for production.

Conclusion

This paper summarize the results from production and test of concrete reinforced with Dramix® steel fibres. A ductile concrete with high load carrying capacity and drastic simplification of the reinforcement bring the best choice for problem solving at precast industry. More regarding application of Dramix® fibres for precast industry - see /4/

References

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