THE MONITORING OF THE CEMENT PLATE'S SHRINKAGE

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Abstract: *You can hardly find an industry, in which you would not use textile fibres. From the mid-1940s, fibres or textiles found a wide range of use in material engineering in development of new material types, such as reinforcement of textile - building composite. They are used because of their relatively high strength and high mechanical elastic fibre modules. This serves for creation of composite materials (continuous matrix and reinforcement fibres or textile).*

Key words: *shrinkage, cement plate's, humidity.*

1. Introduction

The subject of the article is a set of results from series of tests carried out on nine mixture formulas. Asbestos-free plates bonded by hydro-silicate matrix and reinforced by organic fibres were produced from these mixture formulas. Within the scope of this article, the following activities were carried out: finding out the dimensional and weight characteristics of the plates and measurement of change of length in the direction along and across the fibres.

The following the aims of the tests were comparison of material length change values in predefined settings: Dried-up plate, Real condition after placing in laboratory and Air humidity 70%, temperature 20 °C.

2. Specimens and Preparation of the shrinkage test

Test specimens were left in laboratory in order to stabilize humidity and temperature of plates after delivering to our Institute. In the first step were measured dimensions and weight of plates.
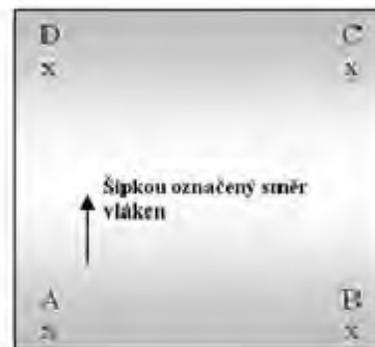

Fig. 1. *Identification of points from D to A and from C to B – direction along the fibres, from A to B and from C to D – in the fibres direction (in the direction perpendicular to the fibres)*

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In the second step were sticked on into each corner of plate gauging disc through use of two-pack paste Sikadur-31 CF Normal. These measuring points were marked A, B, C, D.

Due to positions of discs were possible measured length change both in direction and in vertically direction of stiffening organic fibres in plates.

3. Experimental

Deformater Huggenberger with dial gauge (accuracy 0,001 mm on measured length 220 mm) was used for deformations measuring developed in different ways specimens placing.

Fig. 2. *Distance measurement of points by the help of deformeters Huggenberger*

Measurement was carried out according to standards [2] and [3] in the same manner in all cases, especially was carried out stability placing of immovable deformeter part.

Points were marked A, B, C, D so that the distance change A-B, C-D was measured in vertically to the fibre direction and distance A-C, B-D in fibre direction. This procedure was carried out for 4 situations of specimens' humidity.

Situation 1: Dry condition – Test specimens were put into air drying plant with constant temperature 50°C for two days. After taking out plates were left in laboratory for 15 minutes in order to obtain surroundings temperature 20, 1°C. In the end disc distance changes were measured.

Situation 2: Nature humidity – After measuring of situation 1 test specimens were stabilised in laboratory setting humidity 50-60% for one week. In the end disc distance changes were measured.

Situation 3: Water placing – After measuring of situation 2 test specimens were put in water with constant temperature 20°C for two days. In second step test specimens were put out from water condition and left in laboratory for 15 minutes. In the end disc distance changes were measured.

Situation 4: 70% humidity – Test specimens were placed in climatic cabinet with fixity temperature 20°C, desired humidity were achieved with insertion of saturated solution NaCl. After one week test specimens were put out and left in laboratory for 15 minutes. In the end disc distance changes were measured.

Fig. 3. *Weight measurement*

4. Experimental results

Situation 3 – water placing was selected for test evaluation as referential. In situation 3 test specimens mostly changed their volumes. Distance change values were obtained from difference of measured values in other situations (in this case difference into water placing = shrinkage).

1 set – comparison of average volume weight of plates Table 1

Mixture formulas	Dry condition [kg.m⁻³]	Nature humidity [kg.m⁻³]	70% humidity [kg.m⁻³]	Water placing [kg.m⁻³]
4	1654,3	1782,9	1785,6	1945,6
5	1624,6	1703,5	1725,6	1986,3
6	1684,6	1754,3	1763,6	1925,6
Z	1645,6	1741,3	1746,3	1942,3

1 set – comparison of shrinkage average values (220mm) Table 2

Mixture formulas	The difference between water placing and 70% humidity [µm]		The difference between water placing and nature humidity [µm]		The difference between water placing and dry condition [µm]	
	the direction of measurement of fibres		the direction of measurement of fibres		the direction of measurement of fibres	
	along	across	along	across	along	across
4	-243	-221	-337	-297	-450	-421
5	-251	-252	-261	-312	-399	-397
6	-264	-250	-313	-336	-432	-409
Z	-182	-122	-310	-301	-483	-470

1 set – comparison of shrinkage average values (1000mm) Table 3

Mixture formulas	The difference between water placing and 70% humidity [µm]		The difference between water placing and nature humidity [µm]		The difference between water placing and dry condition [µm]	
	the direction of measurement of fibres		the direction of measurement of fibres		the direction of measurement of fibres	
	along	across	along	along	across	along
4	-1203	-1094	-1668	-1470	-2228	-2084
5	-1242	-1247	-1292	-1544	-1975	-1965
6	-1307	-1238	-1549	-1663	-2138	-2025
Z	-901	-0604	-1535	-1490	-2391	-2327

2 set – comparison of average volume weight of plates Table 4

Mixture formulas	Dry condition [kg.m⁻³]	Nature humidity [kg.m⁻³]	70% humidity [kg.m⁻³]	Water placing [kg.m⁻³]
7	1689,3	1745,6	1756,9	1965,3
8	1685,2	1785,3	1799,5	1912,3

9	1645,6	1788,6	1793,6	1983,2
10A	1623,5	1745,2	1739,6	1914,5
10B	1636,9	1723,3	1785,6	1912,3

2 set – comparison of shrinkage average values (220mm)　　　　　Table 5

Mixture formulas	The difference between water placing and 70% humidity [µm]		The difference between water placing and nature humidity [µm]		The difference between water placing and dry condition [µm]	
	the direction of measurement of fibres		the direction of measurement of fibres		the direction of measurement of fibres	
	along	across	along		along	across
7	-205	-198	-387	-339	-517	-516
8	-134	-175	-275	-380	-436	-531
9	-205	-163	-273	-266	-477	-451
10A	-43	-34	-322	-325	-535	-532
10B	-101	-116	-319	-328	-509	-516

2 set – comparison of shrinkage average values (1000mm)　　　　　Table 6

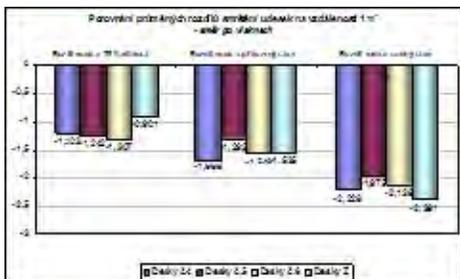| Mixture formulas	The difference between water placing and 70% humidity [µm]		The difference between water placing and nature humidity [µm]		The difference between water placing and dry condition [µm]	
	the direction of measurement of fibres		the direction of measurement of fibres		the direction of measurement of fibres	
	along	across	along		along	across
7	-1015	-980	-1916	-1678	-2559	-2554
8	-663	-866	-1361	-1881	-2158	-2628
9	-1015	-807	-1351	-1317	-2361	-2232
10A	-213	-168	-1594	-1609	-2589	-2633
10B	-500	-574	-1579	-1624	-2520	-2554

Fig. 4. *Shrinkage of samples direction along the fibers, set A*

Fig. 5. *Shrinkage of samples direction across the fibers, set A*

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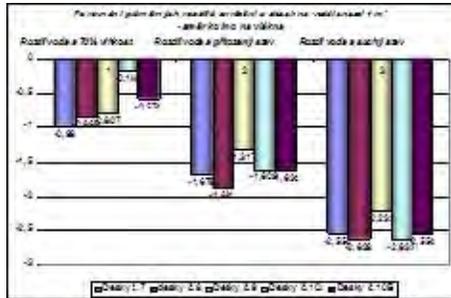Brasov, ROMANIA, 2012, May 30-June 2

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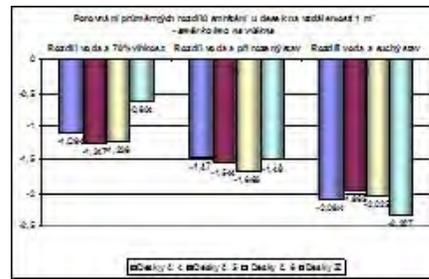
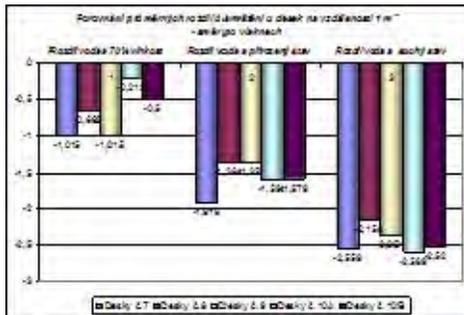Fig. 6. *Shrinkage of samples direction along the fibers, set B*

Fig. 7. *Shrinkage of samples direction across the fibers, set B*

In the *Fig. 1*. is identification of four points. In the *Fig. 2* is distance measurement of points by the help of deformeters Huggenberger from Switzerland Company. *Fig. 3* show weight measurement - within the scope of this article, the following activities were carried out: finding out the dimensional and weight characteristics of the plates.

In the *Table 1 and Table 4* is comparison of average volume weight of plates – this is average of 3 measurements. Table 1 is for Set A and Table 2 is for set B. The *Table 2* and *Table 5* show comparison of shrinkage average values on the measured distance 220mm. Table 2 is for Set A and Table 5 is for set B. Again in the tables are average values from three measurements. Last two *Tables 3* and *6* show the comparison of shrinkage average

values on the rate distance 1000mm. Table 3 is for Set A and Table 6 is for set B. Again in the tables are average values from three measurements.

With the following graphs – from Fig.4. to Fig. 7. are values processed to the graphs.

5. Conclusion

The article presents measurement of shrinkage thin fiber-cement plates, which are reinforced by short orientated dispersed PVA fibers.

The aim of the experimental programme was to check volume (length) change of plates depending on different humidity impact on testing specimens' material, and to verify the influence of fibre direction on the resulting change of length. Volume changes (expanding and shrinkage) have a negative influence on the possibility of spontaneous crack formation during the production of long-format plates from forced transformation.

Two sets of plates of nine different recipes were measured. The measurement was carried out according to the procedures in ČSN 12468 [3] standard. The specimens were placed in four different settings defined in chapter 3. After each placement in specific setting, the actual measurement of length and weight changes was carried out. Water placing was selected for test evaluation as referential, because in this situation test specimens changed their volumes most.

From the results in the above stated tables we can see:

Humidity state of materials greatly influences the change of length of tested fibre-cement plates. The ratio of change of length between dried plates and the plates saturated by humidity is the biggest and very significant. It ranges between 0 and 0, 25 %.

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It was expected that the orientation of fibres would influence the change of length; however, this was not confirmed. The change of length, in this case, is not dependent on orientation of fibre in the matrix. In both directions, the change of length was the same due to varied humidity impact. It is obvious that the elimination of free shrinkage is predominantly given by matrix, and the influence of fibres is not significant.

We should note that the values stated in the tables above do not include only the change of length due to humidity state (drying out), but also the possible bending of tested plates. Bending of such thin specimens cannot be ruled out. With respect to the same thickness and the same treatment of plates the results are comparable. At the same time, we can see that this type of tests does not cover the influence of fibres on tension transmission by fixed shrinkage, which appears in large-scale plates.

Acknowledgements

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