MATEC Web of Conferences **385**, 01012 (2023) https://doi.org/10.1051/matecconf/202338501012
Young Scientist 2023

Cohesion and adhesion of a sealant joint subjected to compressive stress

Adam Bohacek[1*], *Michal* Brandtner[1] and *Jiri* Slanhof[1]

[1] Brno University of Technology, Faculty of Civil Engineering, Veveri 331/95, 60200 Brno, Czech Republic

Abstract. This article is devoted to the evaluation of the suitability of the use of sealants when applied to a cement-based material and its subsequent exposure to compressive stress. Aquapanel cement board is chosen as the underlying material. In general, cementitious materials are characterized by a high concentration of dust particles on the surface, which prevent the correct adhesion of the sealant to the substrate, and therefore their sealing is often problematic. The sealants presented in this research are selected based on the manufacturer's recommendations for suitability for sealing cement-based materials. Base plates are made from cement board, which are subsequently sealed according to the procedures established by the ČSN EN ISO 11432 standard. The samples produced in this way are then cycled and their resistance to pressure stress is subsequently tested. The results of the test performed in this way are evaluated by measuring and visually evaluating the adhesion and cohesion of the cemented joint. Based on the results, it is possible to recommend all of the tested sealants for sealing cementitious base materials that are exposed to compressive stress.

1 Introduction

The issue of cementing individual materials is still a current topic in the field of construction today. The main functions of the cemented joint are to allow a certain range of movement of the substrates, preventing the entry of water, air and other substances into the structure. Furthermore, it provides thermal and sound insulation, possibly also resistance to fire [1] [2]. Sealed joints are exposed to a large number of external influences. Therefore, it is necessary to choose a sealant based on the effects against which it should be resistant. This information is provided by the sealant manufacturer as a recommendation for sealant use. However, this recommendation does not always correspond to reality, and the cemented joint is able to retain its properties and not degrade even after exposure to these influences [3].

In this article, the author specifically deals with the sealing of a problematic cement-based material, the adhesion and cohesion of a cemented joint after its exposure to compressive stress.

2 Material

For the purposes of the research published in this contribution, the materials for its implementation are selected. First, the base material is selected. Aquapanel cement board is chosen as the underlying material. In addition, sealants are selected, which are intended by the manufacturer for sealing the selected base material.

* Corresponding author: bohacek.a@fce.vutbr.cz

The Aquapanel cement board is chosen because it is problematic when sealing. This sealing problem is caused by the presence of fine dust particles on the surface of the board, which disrupt the cemented joint formed by the base material and the applied sealant.

Sealants are selected based on several criteria. One of them is the manufacturer's recommendation on the suitability of use on the selected base material. Another criterion is availability for ordinary consumers and, last but not least, the price of the selected sealant. According to the manufacturer's recommendations, there is no need to use a primer for selected sealants.

3 Methods

The methods used in this contribution are based on the valid European technical standard with the designation ČSN EN ISO 11432 Building constructions – Sealants – Sealants – Determination of resistance to compression. This European technical standard defines the test sample and the exact test procedure.

The test sample defined by the standard consists of two base plates with plan dimensions of 30x50 mm and a thickness of 12.5 mm. These base plates are made of aquapanel cement board. It is also made up of wooden spacers with plan dimensions of 9x12 mm and a height of 50 mm. Two base plates and two wooden spacers delimit the space for the sealant with floor plan dimensions of 12x12 mm and a height of 50 mm. Five test samples are made for each sealant. During production, the regulations and recommendations of the manufacturer of the selected sealant are taken into account. Furthermore, the following measures defined by the technical standard are observed: exclude the formation of air bubbles, press the sealing sealant to the contact surfaces of the underlying bodies and smooth the surface of the sealant to the plane of the auxiliary bodies and spacers.

After the production of the test samples, the test samples are stored for 28 days at a temperature of (23±2) °C and a relative humidity of (50±5) % in order to allow the sealant to mature properly. Before starting the testing of the test samples, it is necessary to submit the test samples according to the procedure prescribed by the technical standard. This prescribed cycle of preloading test specimens is repeated three times. The preset is as follows:

1. 3 days in the oven at room temperature (70±2) °C
2. 1 day in distilled water at room temperature (23±2) °C
3. 2 days in the oven at room temperature (70±2) °C
4. 1 day in distilled water at room temperature (23±2) °C

For the research published in this contribution, a pressure test is used, the exact procedure of which is described in the already mentioned European technical standard. The test takes place at a temperature of (23±2) °C and a relative humidity of (50±5) %. First, the wooden spacers are removed and the test specimens are placed in the testing machine and compressed at a rate of (5.5±0.7) mm/minute to 75 % or 80 % of the initial length, or any other % value agreed upon by the parties involved. For this research, a value of 75 % of the initial length is chosen.

The result of this test is the recorded maximum force required to compress the test sample to a value of 75 % of the original length. Furthermore, it is the calculated secant modulus of elasticity, which is calculated from the relation:

$$\sigma = \frac{F}{S}$$

σ secant modulus [N/mm2]

F force at selected compression [N]
S initial cross-sectional area of the test specimen [mm2]

Table 1. Relation of compression value to initial length.

Compression length relative to initial length [%]	Compression [%]	Length after compression [mm]
75	25	9.0
80	20	9.6

4 Results

Five test samples are produced and subsequently tested for both selected sealants. The test results are shown below in table 2. For each test sample tested, the measured value of the maximum force required to compress to 75 % of the original length in Newtons is shown in the results table. The table also shows the average value of the maximum forces required for compression to 75 % of the original length for both selected sealants. The table of results also shows the calculated secant modulus of elasticity for the individual tested test samples and the calculated average value of the secant modulus of elasticity for the individual tested sealants.

Table 2. Test according to ČSN EN ISO 11432.

Sealant	Test sample nr.	Max. force to compress to 75 % of original length [N]	Diameter of max. force for compression to 75 % of original length [N]	Secant modulus of elasticity [N/mm^2]	The diameter of the secant modulus of elasticity [N/mm^2]
Sealant I	1	220.04	306.87	0.37	0.51
	2	343.67		0.57	
	3	267.21		0.45	
	4	306.47		0.51	
	5	396.98		0.66	
Sealant II	1	134.98	148.74	0.22	0.25
	2	155.10		0.26	
	3	147.28		0.25	
	4	159.46		0.27	
	5	146.88		0.24	

5 Analysis of results

It is clear from the results of the tests that for sealant I, a force greater than 300 N is needed to compress it to 75 % of the original length, which indicates a high resistance of the sealant against compression. For sealant II, it is necessary to develop a force of almost 150 N, i.e. half less than for sealant I. Therefore, we can say that sealant I is more resistant to compression than sealant II.

As for the failure of the test samples, there was no disruption of the cemented joint during testing for both tested sealants, which indicates their solid structure resistant to the pressure stress to which the test samples were subjected during testing.

The results of the maximum force for compression to 75 % of the original length of the individual tested samples are shown in Figure 1.

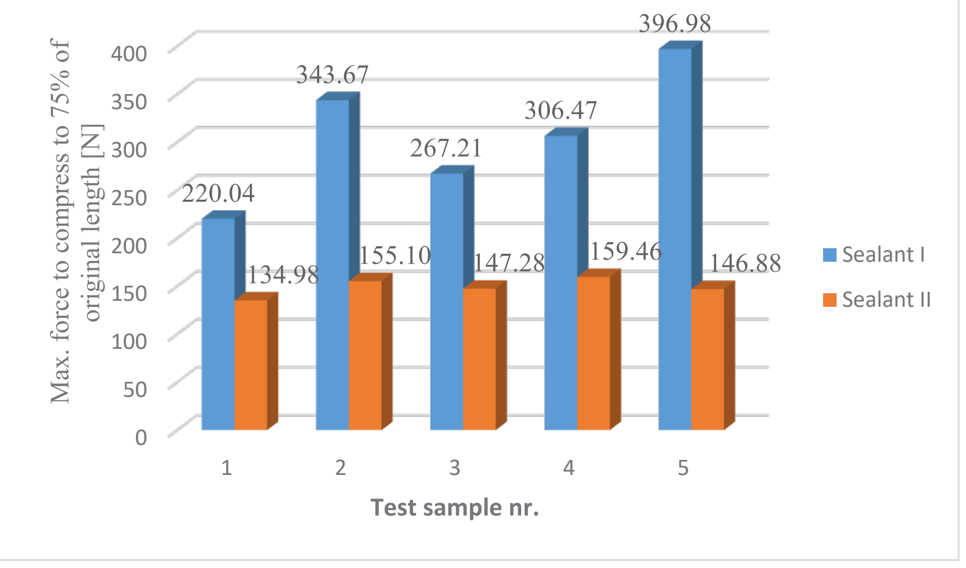

Fig. 1. Comparison of the results of the maximum force for compression to 75 % of the original length of both tested sealants.

6 Conclusion

Based on the results of the pressure test, it can be declared that both of the selected sealants met the conditions of the test, during which there was no violation of cohesion and adhesion of the tested test samples. Based on the pressure test, both selected sealants can therefore be recommended for sealing the selected cement base material.

The contribution was made with the support of junior specific research of the Faculty of Civil Engineering of the Brno University of Technology conducted under the designation FAST-J-22-7872.

References

1. E. M. Petrie, *Handbook of adhesives and sealants*, New York (2009)
2. J. Klosowski, A. T. Wolf, *Sealants in construction*, United Kingdom (2016)
3. K. Lal Mittal, A. Pizzi, *Handbook of sealant technology*, United Kingdom (2009)

4. A.T. Wolf, *Movement capability of sealants*, Construction and Building Materials, USA (1991)
5. M. Z. L. Chew, X. Zhou, S. T. Tan, *On-site weathering of sealants under tropical conditions*, Construction and Building Materials (2004)
6. H. Stögbauer, A. T. Wolf, *The influence of heat ageing on one-part construction silicone sealants*, Construction and Buildings Materials (1991)
7. ČSN EN ISO 11432 *Building construction - Jointing products - Sealants - determination of compressive strength* Prague: Czech Standards Institute (2006)
8. J. Šlanhof. M. Šimácková, P. Liška, B. Nečasová, *Sealing possibilities of glass fibre reinforced concrete elements and fibre - Cement facade cladding panels*, Proceedings of an International Scientific Conference in Bratislava (2014)
9. P. Liška, B. Nečasová, J. Šlanhof, M. Šimáčková, *Determination of Tensile Properties of Selected Building Sealants in Combination with High-pressure Compact Laminate (HPL),* In: Procedia Engineering (2015)
10. J. Šlanhof, P. Liška, B. Nečasová, *Evaluation of test methods for testing of sealants, Advances and Trends in Engineering Sciences and Technologies II*, Proceedings of the 2nd International Conference on Engineering Sciences and Technologies (2016)