TKB-Technical Briefing Note 14

Rapid Screeds and Cement Screeds with Screed Additives

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Prepared by Technical Commission on Construction Adhesives (Technische Kommission Bauklebstoffe (TKB)) of German Adhesives Association (Industrieverband Klebstoffe e.V.), Düsseldorf

In cooperation with:

- Bundesverband der Sachverständigen für Raum und Ausstattung e.V. (BSR)
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- Zentralverband Parkett und Fußbodentechnik (ZVPF)
- Zentralverband Raum und Ausstattung (ZVR)

Industrieverband Klebstoffe e.V.
www.klebstoffe.com

This briefing note is available from the Industrieverband Klebstoffe e.V., P.O. Box 26 01 25, 40094 Düsseldorf, Phone +49/211/6 79 31-14, Fax +49/211/6 79 31-33, Internet: www.klebstoffe.com

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1. Introduction

As a consequence of the growing trend to reduce construction schedules, the percentage of screeds with reduced setting and drying times increases.
For cement-based screeds there are mainly two approaches:

1. The use of rapid cements (SZ) as special binders, which set and dry quickly.
   The effectiveness of these rapid screeds has been well documented [1].
2. The use of screed additives (EZM) as binding agents in screed formulas based on common cement according to DIN EN 197. Screed additives allow for a reduction of the amount of mixing water or the water-cement ratio respectively. This can also result in a reduction of the time required for floors to reach readiness for installation.

There are a multitude of different statements regarding the screed properties to be achieved with screed additives, e.g. regarding strength development, shrinkage behaviour and in particular drying times. Partly, those statements do not hold up under examination. Consequently, this leads to great uncertainty among planners and installers as well.

The percentage of chemically bound water is almost identical for common cement screeds with or without screed additives. The percentage of water which must evaporate for screed to reach readiness for installation (physical drying) can be reduced by using screed additives.

This datasheet compares the differences between the characteristics of rapid cements on the one hand and common cements with screed additives on the other. It therefore provides assistance for planning and installation.

2. Definitions of Terms

2.1. Screed

Following DIN EN 13318 [2], screed is a layer or layers of screed material laid in situ, directly onto a base or onto an intermediate layer or insulating layer, to obtain one or more of the following purposes:

- to obtain a defined level
- to be used immediately or
- to carry the final flooring

2.2. Readiness for Installation

Readiness for installation: The condition of a screed when ready to permanently carry floor coverings without damage and defects.

The main time-sensitive criteria for readiness are:

- sufficient drying
- sufficient strength
- sufficient tension reduction

Specifications for these criteria may vary for different types of floor coverings.

This description extends previous definitions [1].

2.3. Cement Screed Mortar

Following DIN EN 13318 [2], a cement screed mortar consists of a binding agent (recommended common cement according to BEB information sheet 4.3. "Hinweise zur Auswahl von Zementen für die Estrichherstellung im Wohnungs- und Verwaltungsbau", 2002 [3] and "Hinweise zur Herstellung zementgebundener Estriche", Baugewerbe 19/2008 [4]) or rapid cement binding agents, suitable aggregate, water and screed additives if required. The properties of cement

screed mortars are regulated by DIN EN 13813 [5]. Drying behaviour and consequently readiness for installation of mineral screeds are not part of the standard product characteristics since these features are strongly influenced by conditions in situ.
The requirements of DIN EN 13813 [5] also apply for the properties of rapid cement screeds and screeds classified as "accelerated" on account of additives being used.

2.4. "Rapid Screeds" (cement-based)

In the construction sector, the collective term "rapid screeds" often includes:

- Rapid cement screeds
- Common cement screeds with additives said to have an "accelerating" effect (so-called "accelerated" screeds)

The collective term "rapid screeds" however is not correct and misleading on account of the different properties of these two types of screed.

This datasheet therefore generally differentiates between rapid cement screeds (SZE) and common cement screeds with additives, so-called "accelerated" screeds.

2.5. Rapid Cement Screeds (SZE)

Rapid cement screeds consist of a special binding agent, the rapid cement, the aggregate (on site mixture ratio is normally 1:4 to 1:6) as well as water as per manufacturer's instructions.

Rapid cement can be divided into two groups:

1. Rapid cements with fast setting and fast drying properties – ternary rapid cements (SZ-T, see 3.3.1):
   These cements are used when floors shall be ready to bear loads early and readiness for installation is to be achieved quickly.
   When rapid cement screeds are laid before floor covering or parquet is installed, mainly ternary rapid cements (SZ-T) are used.
2. Rapid cements with only fast setting properties – binary rapid cements (SZ-B, see 3.3.2):
   These cements are only used when loads shall be applied early. Drying behaviour und time until screed is ready for installation are only marginally affected compared to common cements.

In Germany, there are no separate standards for rapid cements and rapid cement screeds. The requirements of DIN 18560 apply for these types of cement accordingly [6, 7 and 8].

Specifications regarding readiness for installation are normally given by the individual manufacturers. In the absence of such specifications, the provisions of datasheets [9, 10] or interface coordination regarding readiness for installation [11,12] apply.

2.6. "Accelerated" Screeds

The terms "accelerated" screeds and/or "accelerators" are not standardised.
Mortars for "accelerated" screeds are prepared on site by adding additives to common cement screed mortars. The additive, the so-called "accelerator" corresponds to 0.5 – 3 % of the common cement content.

The properties of so-called "accelerated" screeds are regulated by DIN EN 13818 [5] (see 2.3.). This standard does not include provisions for readiness for installation.

2.7. Screed Additives (EZM)

Following DIN EN 13318 [2], additives are substances added in small quantities when mixing the screed mortar to change the properties of the screed mortar in either fresh and/or set condition.

The term "screed additives" covers a wide range of products for modification of screeds.

Screed additives can be divided into three groups based on their functional components:

a) Processing Aids (mainly air-entraining agents and tensides)
   These screed additives generate air voids in the screed mortar which results in better processability for installation, stripping and smoothing. The air voids remain in the set screed mortar.
   - these additives only have a limited effect on the drying time;
   - they may have a positive effect on tension behaviour
   - the strength of the screed may be reduced

b) Plasticizers and/or Flow Improvers, so-called "(drying) accelerators"
   These additives reduce the water required for the desired mortar consistency. In addition, they improve the compactability of the mortar. Water binding is not accelerated. Also, no additional water binding occurs on account of the use of common cement.
   - The "accelerating" effect, i.e. reduction of the time until moisture threshold for readiness for installation is reached [6, 9, 10, 11 and 12] is achieved by the reduced amount of mixing water.
   - Strength is increased which may lead to higher tension.

c) Setting Accelerators
These additives influence hydration of the common cement and result in faster setting of the screed mortar. Drying behaviour is only marginally influenced.

Note: Additives available on the market may contain one or several of above components.

2.8. Aggregate

Aggregate shall comply with DIN EN 12620 [13] "Aggregates for Concrete". According to this standard, the aggregate is a mineral substance with a suitable particle size for use in concrete or screeds, either occurring naturally or manufactured, recovered or recycled.

3. Drying Behaviour of Cement Screeds with Different Types of Binding Agents and Screed Additives

The point where a cement screed is dry and ready for installation depends on several factors, which can roughly be divided into chemical and physical factors. Depending on the composition of the mortar, in particular the type of binding agent, either chemical or physical factors prevail. Chemical factors include:

- Type and quantity of binding agent
- Amount of mixing water
- Ratio between binding agent and aggregate

Physical factors include:

- Ambient conditions (temperature, relative humidity and air exchange rate)
- Thickness of screed

Based on these factors, drying time to reach readiness for installation may vary.
When thickness and ratio between binding agent and aggregate are kept constant, this results in the binding agent-sensitive drying properties described in the following sections.

3.1. Cement Screed with Common cement

To improve processability of the screed mortar, the typical water-cement ratio lies between 0.5 and 0.7.
Such screed mortars dry on account of:

- hydration of the cement and
- parallel evaporation via the screed surface of the free (unbound) water contained in the screed .

Only part of the mixing water is chemically bound or transformed into crystalline form (hydration).

A considerable proportion of the water content needs to physically evaporate. Therefore, drying is significantly influenced by ambient conditions.

In unfavourable ambient conditions [low temperature, high relative humidity and/or low air exchange rate (table 1)] as well as with increasing screed thickness, time required for physical drying increases disproportionately [1].

Table 1

Fresh air humidity in % r.h.*	Outside temperature in °C										
	-10	-5	0	5	10	15	20	25	30	35	40
0	15	15	15	15	15	15	15	15	15	15	15
10	15	15	15	15	16	16	16	17	18	19	21
20	15	15	16	16	17	17	18	20	23	27	35
30	15	16	16	17	18	19	21	25	31	46	113
40	15	16	17	18	19	21	25	32	49	159	*
50	16	16	17	18	20	24	30	44	119	*	*
60	16	17	18	19	22	27	37	74	*	*	*
70	16	17	18	20	24	31	49	219	*	*	*
80	16	17	19	22	26	36	74	*	*	*	*
90	16	18	20	23	29	44	148	*	*	*	*
100	17	18	21	24	32	57	*	*	*	*	*

Number of days for drying of a screed at a typical air exchange rate of 0.5 per hour, depending on outside temperature (in °C) and a relative fresh air humidity (in % r. h.)
Indoor relative climate: 20 °C / 100 % r. h.
*** Relative humidity**

3.2. Cement Screed with Common cement and Additives

Such screed mortars dry in the same manner as common cement screeds without additives through hydration and parallel physical drying (evaporation) of the water contained in screed via the screed surface. On account of the additives, the water-cement ratio normally lies between 0.4 to 0.6.
Here as well, the mixing water is only partly chemically bound (hydration).
The rest must evaporate physically. Consequently, as with common cement without additives, drying is influenced by the ambient conditions.
In unfavourable ambient conditions [low temperature, high relative humidity and/or low air exchange rate (table 1)] as well as with increasing screed thickness, time required for physical drying increases disproportionately [1].

The proportion of water that needs to evaporate is reduced by lower water-cement ratio. Here as well, evaporation is mainly influenced by screed thickness and ambient conditions.

It is not possible to give a reliable statement regarding reduction of waiting period until readiness for installation.

3.3. Rapid Cements

Rapid cements are special binding agent mixtures, prepared according to manufacturer's specifications and used to produce rapid cement screeds.

In this instance, a general distinction is made between two binding agent systems, SZ-T (ternary) and SZ-B (binary), described in the following sections.

3.3.1. Rapid Cements – Fast Setting and Fast Drying Time (SZ-T, ternary systems)

Ternary binding agents are three-component mixtures consisting of Portland/common cement, high alumina cement, calcium sulphate and other additives. This results in a binding agent mixture through which a high proportion of the mixing water is chemically bound or transformed into crystalline form (hydration).
Typical water-cement ratios range between 0.4 and 0.45. On account of the high proportion of chemical or crystalline water binding and the relatively low water-cement ratio, only a small portion of the mixing water needs to evaporate.

Unfavourable ambient conditions and/or high screed thickness therefore hardly influence drying time until readiness for installation.

In contrast to common cements, common cements with additives and rapid cement with binary systems, here reliable statements can be made regarding reduction of waiting time until readiness for installation (moisture content, strength and shrinkage behaviour), see table 2. In this context, manufacturer's specifications are crucial.

3.3.2. Rapid Cements – Fast Setting and Normal Drying Time (SZ-B, binary systems)

Binary binding agents are two-component systems consisting of Portland/common cement and high alumina cement as well as other additives. Adding high alumina cement and other additives significantly accelerates the strength development so that mechanical loads can be applied to screed floors much earlier. Screed mortars with SZ-B rapid cements dry in the same manner as common cement screeds.

The water-cement ratios normally range between 0.40 and 0.50. The proportion of water that needs to evaporate is reduced by the lower water-cement ratio.
Only a small portion of the mixing water is chemically bound (hydration).
A considerable proportion of water needs to evaporate physically. Therefore, the drying process is influenced by ambient conditions.

In unfavourable ambient conditions [low temperature, high relative humidity and/or low air exchange rate] as well as with increasing screed thickness, time required for physical drying increases disproportionately (see table 2).

It is not possible to make a reliable statement regarding reduction of waiting period until readiness for installation.

Table 2

Cement screeds – summary comparison				
Type of screed	Common cement	Common cement + additives	SZ-T	SZ-B
Property				
Drying time (1)	long	reduced	short	n.a. (3)
Strength development (1)	normal	n/a. (2)	fast	fast
Shrinkage compensation (tension) (1)	no	n/a. (2)	yes	no
Drying – dep. on thickness	high	high	low	high
Drying – dep. on ambient climate	high	high	low	high

(1): crucial for readiness for installation
(2): no general statement possible on account of different effects of additives
(3): see section 3.3.2. in text

4. Assessment of Readiness for Installation

4.1. Determination of Moisture Content

The moisture content of the screed as one criterion for determination of readiness for installation shall be established via CM measurement. A complementary test shall preferably be performed with measurement of the corresponding relative humidity – KRL method.

Performance and moisture thresholds for cement screeds are documented in the interface coordinations [11,-12], in TKB datasheet no. 8 [9] or TKB report 2 [14], in BEB information sheet 8.1. [10] and in DIN 18560, part 1 [6].

Deductions from CM measurement results for common cement screeds with additives are not admissible, since mineralogical composition does not deviate from that of common cement screeds without additives [15, 16].

Other measuring methods (electrical resistance or dielectric loss) shall only be used as orientating tests to determine the areas with highest moisture content or moisture distribution [6].

In common cement screeds, additives may cause shifts in equilibrium moisture content and may thus influence readiness for installation [17]. In such instances, the KRL method can offer information regarding moisture level, independent of the material.

4.2. Additional Criteria for Determination of Readiness for Installation

Strength development and shrinkage behaviour as criteria for determination of readiness of a screed for installation can not be determined on site with conventional test methods of installers.

In these instances, solely the specifications given by the manufacturer apply which typically include information on waiting times and ambient conditions.

Furthermore, the inspection obligations of the individual tests shall be observed by the installers.

Note:
For common cement screeds without additives, the required strength and subsiding of shrinking is typically reached after 28 days.

5. Additional Information

5.1. CE Marking

According to the European Construction Products Regulation [18] screed mortars and floor screeds are regulated construction products. For this reason, all screed mortars are subject to CE marking according to DIN EN 13813 [5].
In situ screeds may be exempted from this requirement according to article 5 of Construction Products Regulation.

5.2. Emission characteristics

There are no construction law requirements regarding emission characteristics of cement-based screeds.
The Gemeinschaft Emissionskontrollierte Verlegewerkstoffe, Klebstoffe und Bauprodukte e.V (Association for the Control of Emissions in Products for Flooring Installation, Adhesives and Construction Products e.V) introduced the EMICODE [19], which also allows for classification of emission characteristics of screed binding agents and screed mortars. This helps to document compliance with the highest requirements regarding emission characteristics of screeds.

6. Summary

This report for the first time provides a description for rapid cement screeds. These are defined via their binding agent systems. They are differentiated from so-called "accelerated" common cement screeds with screed additives.

Screed additives are classified based on their function into the following product groups: processing aids, plasticizers and/or flow improvers and setting accelerators.

Readiness for installation is described in depth based on the screed characteristics required for installation of coverings such as moisture content, strength and shrinkage behaviour.

Cement screeds can be divided into four groups based on their composition and characteristics:

a) Rapid cement screeds based on ternary binding agent systems (SZ-T):
Fast setting, quick drying, low shrinkage
b) Rapid cement screeds based on binary binding agent systems (SZ-B):
Fast setting
c) Common cement screeds with additives (EZM):
Reduced water content, improved processability
d) Common cement screeds:
difficult to process, long drying times

An overview table clearly depicts these characteristics in relation to the individual screed binding agents.

7. Standards, datasheets and literature reference

The literature references listed below show the current status at time of print of this datasheet.

[1] W. Schnell, Das Trocknungsverhalten von Estrichen,
Aachener Bausachverständigentage, 1994

[2] DIN EN 13318 - Estrichmörtel, Estrichmassen und Estriche - Definitionen (01-2003)

[3] BEB Arbeits- und Hinweisblatt 4.5, Hinweise zur Auswahl von Zementen für die Estrichherstellung im Wohnungs- und Verwaltungsbau (09-2002)

[4] Hinweise zur Herstellung zementgebundener Estriche, Baugewerbe 19/2008

[5] DIN EN 13813 - Estrichmörtel und Estrichmassen - Anforderungen und Eigenschaften (01-2003)

[6] DIN 18560 – Teil 1, Estriche im Bauwesen - Begriffe, Allgemeine Anforderungen, Prüfung (09-2015)

[7] DIN 18560 – Teil 2, Estriche im Bauwesen – Estriche und Heizestriche auf Dämmschichten (schwimmende Estriche) (09-2009)

[8] DIN 18560 – Teil 4, Estriche im Bauwesen – Estriche auf Trennschicht (06-2012)

[9] Merkblatt TKB-8 - Beurteilen und Vorbereiten von Untergründen vor Bodenbelag- und Parkettarbeiten (02-2014)

[10] BEB Arbeits- und Hinweisblatt 8.1, Beurteilen und Vorbereiten von Untergründen, Verlegen von elastischen und textilen Bodenbelägen, Schichtstoffelementen (Laminat), Parkett und Holzpflaster, Beheizte und unbeheizte Fußbodenkonstruktionen (10-2008)
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[11] Schnittstellenkoordination bei Flächenheizungs- und Flächenkühlungssystemen im Neubau (05-2011)
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(01-2009)
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[13] DIN EN 12620, Gesteinskörnungen für Beton (07-2002)

[14] TKB-Bericht 2 - Belegreife und Feuchte – Die KRL-Methode zur Bestimmung der Feuchte in Estrichen (07-2013)

[15] J. Sieksmeier, Schnellestrich - Bindemittel ternärer Systeme contra Estriche mit Zusatzmitteln, in: 8. Internationales Kolloquium Industriefußböden, 25. - 27.3.2014, Esslingen, (Tagungsband Technische Akademie Esslingen)

[16] J. Sieksmeier, in TKB-Fachtagung, Köln, 18.3.2015 (Tagungsband, Industrieverband Klebstoffe e. V., Düsseldorf)

[17] TKB-Bericht 1 - Belegreife und Feuchte – Versuche zur Trocknung von Estrichen (03-2013)

[18] Verordnung (EU) Nr. 305/2011 des europäischen Parlaments und des Rats, 9.3.2011

[19] www.emicode.com