Long-term maintenance of value of resilient floor coverings

Use of resilient floor coverings in hygiene-relevant areas – Wheels and castor systems

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Inhalt:

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1 Introduction:

Resilient floorings fulfil the use and hygiene requirements in hospitals, care facilities and doctors' practices in many respects as, among other things, they are "smooth, wipable, have tight joints and can be disinfected".

In recent years, the requirements for flooring constructions have increased significantly. Static and dynamic loads and stresses due to castor systems (e.g. beds, service trolleys) play a decisive role.

Statistical surveys show a significant increase in weight and size of the population. This leads to changing requirements and technical developments, through which the weight of the castor systems changes accordingly.

However, the specific features of the facilities also set specific requirements for the flooring construction.

Resilient floorings, including the whole construction, are expected to withstand these requirements for the expected use period.

Increased requirements and trends, such as floor-to-ceiling window façades, high-gloss surfaces and discreet designs, can lead to conspicuous surface appearances.

This Technical Information summarises the effects of static loads caused by castor systems on flooring constructions with resilient floorings in hygiene-relevant areas.

It is directed at investors, architects and operators of facilities, manufacturers of floorings and laying materials, bed, service trolley and castor manufacturers, as well as the installers and other groups involved.

The Technical Information provides information on influencing factors and recommendations for minimising conspicuous surface appearances.

2 Definitions and Explanations:

2.1 Laying materials

Primers, filling and levelling compounds must firmly and permanently bond with the substrate, produce a keying surface for the adhesive and have qualities that help to enable the floor construction to withstand the loads. They must not have any negative effects on the substrate, underlay, adhesive and flooring. Filling and levelling compounds for specific areas of use must be suitable for the respective use, e.g. chair castors, underfloor heating.

Adhesives must have properties that enable them to achieve firm and permanent bonding. They must be suitable for the planned use and approved for it by the manufacturer.

The adhesives are divided into:

- Dispersion adhesives
- Solvent-based adhesives
- Powder adhesives
- Reactive (cold-setting) adhesives
- Dry adhesives

The coverings are generally bonded with very low emission dispersion adhesives (Emicode EC1/EC1 plus).

Mineral systems are mainly used as filling compounds for levelling the substrate.

2.2 Resilient floorings

Resilient floorings increase underfoot comfort and convenience of use, they are gentle on the human musculoskeletal system and even standing for long periods is made easier due to their elasticity. The covering can compensate for the forces of falling objects, mostly without damage to the covering or the object. When it is laid, a resilient flooring adapts to its surroundings and enables stress-free laying.

Resilient floorings are produced from different synthetic or natural raw materials. Used in different recipes, these give the floorings their necessary elastic and technical properties, which the flooring must have for the respective intended use. They therefore meet the standards necessary for a construction project or a particular ambience. In addition, resilient floorings can be produced in all kinds of different colours and designs.

The following floorings are mainly used in the areas relevant here:

- Floorings made of polyvinyl chloride (PVC)
- Linoleum floorings
- Elastomer/rubber floorings
- Floorings made of polyurethane
- Floorings made of synthetic thermoplastics

The essential requirements for resilient floorings for CE marking are defined in the harmonised EN 14041 standard.

The areas of use for resilient floorings are diverse and range from moderate to light use in domestic areas to the intensely used commercial and industrial sector. The classification of the areas of use is described in EN ISO 10874.

2.3 Wheels and castor systems

Hospital beds and transport equipment on the market, as well as castors, wheels and wheel materials in hygiene facilities.

Castor types in accordance with EN 12530, EN 12531, EN 12532.

Hospital bed castors:

Single or twin-wheel swivel castors with wheel diameter from 100 to 200 mm are mainly used here.

Apparatus castors:

Use on care beds, furniture, bedside tables and other furnishings.

Single and twin-wheel swivel castors, with and without locking device, with wheel size from Ø 50 to Ø 150 mm are mainly used here.

Transport equipment castors:

Use, among other things, on food serving trolleys

Single swivel or fixed castors, with and without locking device, with wheel size from Ø 100 to Ø 200 mm are mainly used here.

Wheel tread materials:

The materials most frequently used for the wheels and their treads are:

- Polypropylene
- Polyamide
- Polyurethane
- Rubber (NR; SBR)

The castors can be electrically conductive.

2.4 Cleaning, care and disinfection of the floorings and castor systems

Proper cleaning and care of floorings and castor systems are a decisive factor for the appearance, hygiene, life and maintaining the value of the coverings.

"Patient care areas or in areas in which people work with biological materials must be smooth, wipable, have tight joints and be able to be disinfected using disinfectants and disinfection methods with the concentrations and exposure times given in the list of the Robert Koch Institute." (RKI Guidelines)

3 Test Results of the FEB Project Group:

The following tests were performed under laboratory conditions to consider the indentation behaviour on resilient floorings in the overall system of the flooring construction. Working with the Steinbeis Applied Movement Technology Consulting Centre (Steinbeis-Beratungszentrum Angewandte BewegungsTechnologie - ABT) and the Centre of Excellence for Movement Processes (Kompetenzzentrum für Bewegungsvorgänge KfB) at Bielefeld University of Applied Sciences, we were able to draw upon many years of know-how.

The results of these extensive tests and the experience of the workgroup led to the recommendations given in this code of practice.

Initially, measurements of the residual indentation behaviour were taken according to EN ISO 24343-1 on flooring samples on a steel substrate in order to evaluate the material properties of the flooring (see Fig. 1).

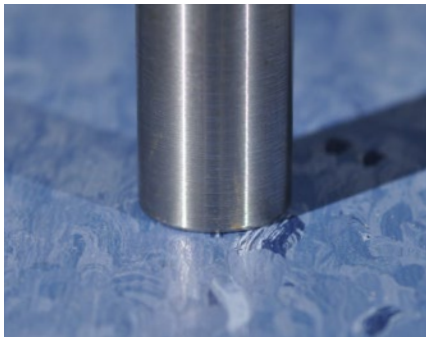

Fig. 1: Standard indenter, EN ISO 24343 on PVC covering, contact area 100 mm² [3]

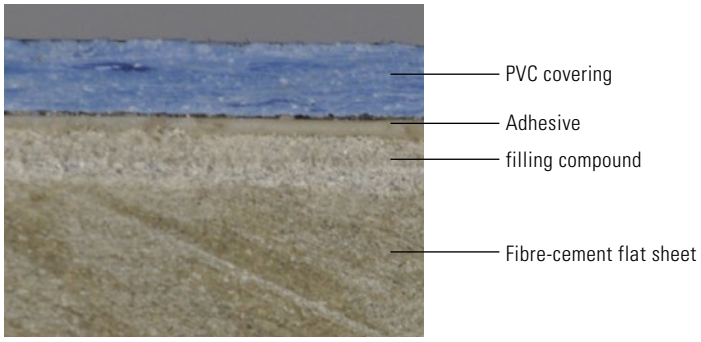

Fig. 2: Cross-section of a sample [3]

Further measurements were taken with flooring samples bonded onto fibre-cement flat sheets (see Fig. 2).

The results showed that the indentation behaviour of bonded floorings was significantly higher than the material-specific residual indentation behaviour of the flooring.

Extensive tests were therefore performed to determine the influence of the different flooring construction systems and wheels on the indentation behaviour:

The influences of different flooring rest times after bonding (24, 72, 120 h) and loads (100 kg and 150 kg) were examined. The flooring constructions defined in the following and the test wheel were identical in these tests:

- Fibre-cement flat sheets to EN 12467
- Dispersion primer for absorbent substrates - Giscode D1 solvent-free
- Self-levelling smooth cement smoothing compound to DIN 13813 C35-F7 (coat thickness ≥ 2 mm)
- Fibre-reinforced wet adhesive, adhesive spreader TKB A2
- Homogeneous PVC flooring to EN ISO 10581
- Reference wheel made of steel with geometry Ø 150 x 32 mm and tread convexity of R70

This resulted in:

The largest indentations were found under loading 24 h after bonding. The differences between 72 and 120 hrest time after bonding were only marginal. Further tests were performed with loads after 24 h and 72 h had passed.

Due to the ever-larger loads applied in practice, all further indentation tests were performed with 150 kg.

Fig. 3: Test wheel made of steel (reference wheel) [2]

Fig. 7: Wheels and castors of the test series [2]

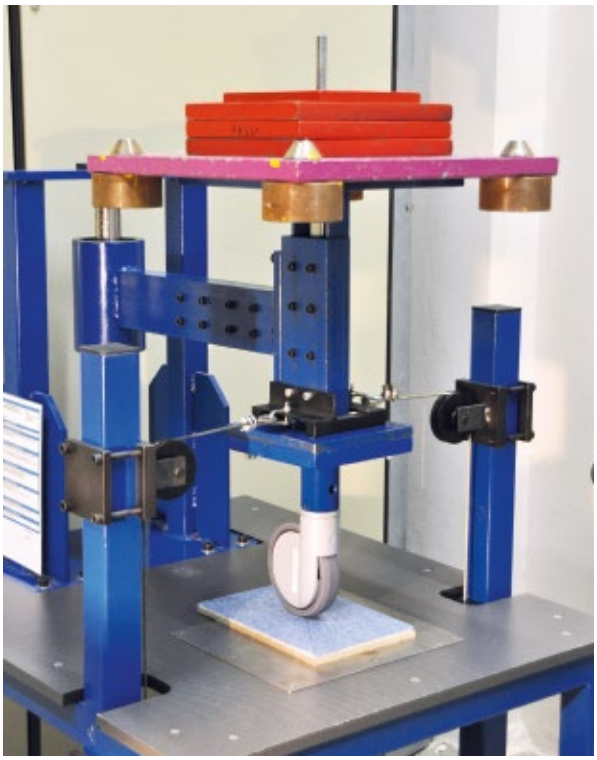

Fig. 4: Test bench of the test series [2]

Fig. 5: Visibility of the indentations after loading depending on the level of gloss [1]

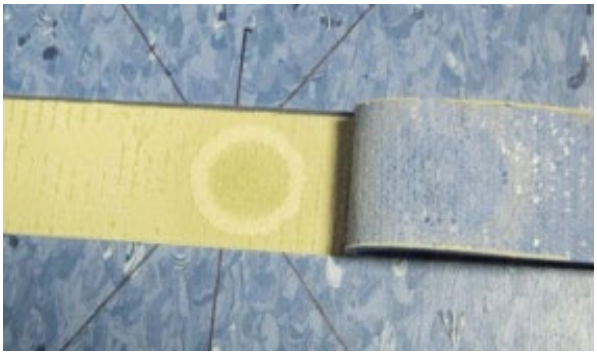

Fig. 6: Adhesive compression after loading [1]

In the next step, the influence of different adhesives (universal adhesive for resilient floorings as well as a fibre-reinforced, dispersion-based wet adhesives) with otherwise the same parameters was examined.

Due to the small and thus negligible differences between the above-named adhesives, the further tests were performed with one of the dispersion adhesives.

As different wheels and rollers with varying geometries and hardnesses are used in practice, their influence on the indentation behaviour was examined next. To this end, customary single wheel and twin-wheel castors (Ø 150 mm, Ø 50 mm) were selected as typical representatives. It was found that the smaller twin-wheel castor left the deepest indentations in all cases. The large twin-wheel castor left the smallest indentations.

The same tests were performed multiple times to determine the dispersion and as confirmation. The dynamic behaviour was not tested, but can be important for certain use cases.

3 Test Results of the FEB Project Group:

The diagram in Fig. 8 shows the indentation behaviour depending on the drying times after bonding (24 h/72 h drying time) as well as the recovery behaviour (resilience) after the load was removed.

The indentation depth was measured directly after removing the load (0 min.), 150 min after removing the load as a comparison to the standard test of "residual indentation of floorings". To consider the long-term behaviour, the indentation depth was measured three weeks after removing the load.

Castor 1: Single-wheel castor Ø 150 mm Castor 2: Twin-wheel castor Ø 150 mm

Castor 3: Twin-wheel castor Ø 50 mm

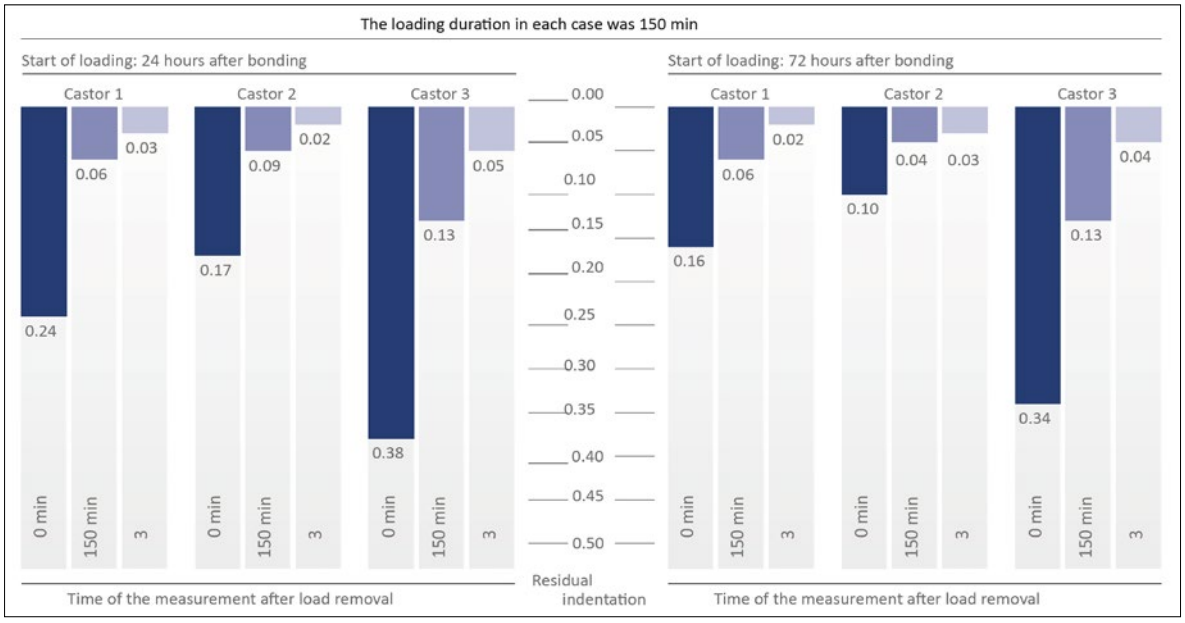

Fig. 8: Comparison of indentation behaviour under loading after 24 h and 72 h drying time after bonding [1]

The diagram in Fig. 9 shows the indentation behaviour for two different loading periods (24 h/72 h) and the recovery behaviour (resilience) after removing the load. The measurement of the indentation depth for evaluating the recovery behaviour was taken directly after removing the load (0 min) and 150 min after removing the load. To consider the long-term behaviour, the indentation depth was measured three weeks after removing the load.

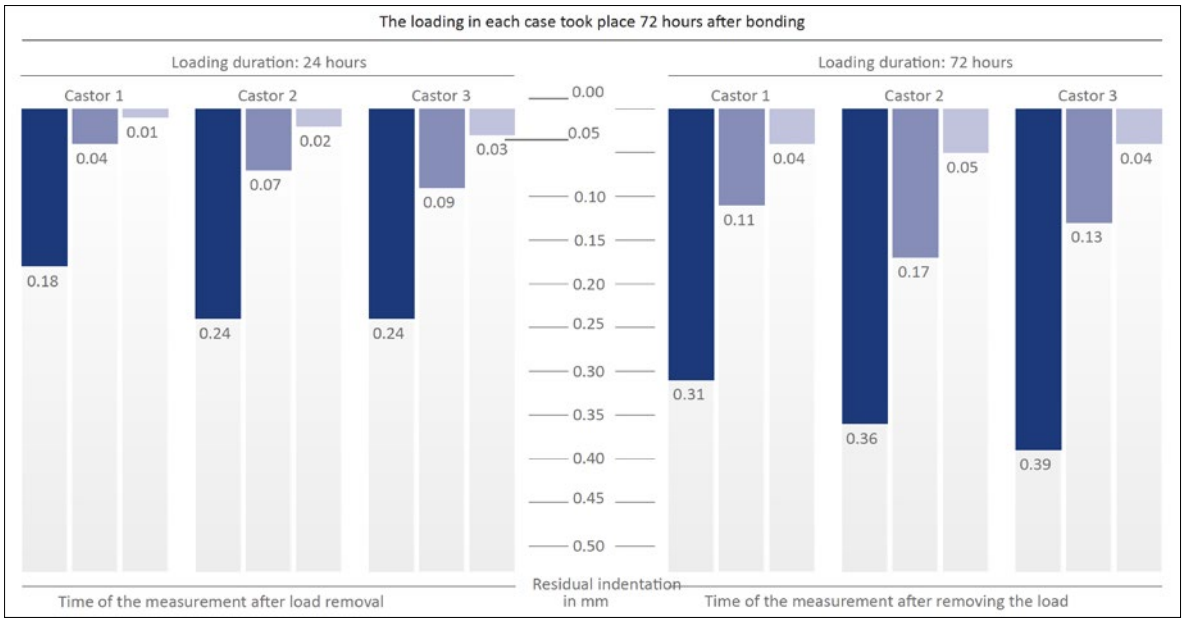

Fig. 9: Comparison of the indentation behaviour after 24 h and 72 h loading duration [1]

4 Recommendation for the Minimisation of Indentations:

4.1 General design requirements

The floor construction (insulation layer, load distribution layer, waterproofing if necessary) must be designed by the building designer/consultant with regard to the building physics, moisture protection and load-bearing capacity aspects. The relevant standards must be complied with, which also includes a detailed joints plan. With regard to the required

strength and thickness of the load distribution layer, in particular it is necessary to comply with the information in DIN 18560-2 and DIN 18560-4.

Mastic asphalt screeds should not be used in these areas of use due to their material-specific properties.

The floorings must be selected by the building designer/consultant in consultation with the client/ building developer. Recommendations of the covering manufacturers must also be taken into consideration. Apart from hygiene, visual influences (e.g. light incidence of floor-to-ceiling window elements, gloss level) must also be included. When selecting the floorings and the laying materials required, the type of traffic loading to be expected is also of decisive importance (e.g. castors of hospital beds or castor systems). The flooring, laying materials and expected traffic load must be matched with each other.

The materials necessary for laying the floorings (primers, smoothing compounds, adhesives) must be specified by the building designer/consultant. When specifying the materials to be used, the application recommendations of the product manufacturers must be taken into consideration.

In particular, in case of high point loads (e.g. castor systems and furnishings), material-specific indentations are not avoidable with certainty, even if a suitable system construction is selected and it is laid properly. This circumstance should be pointed out to the client/developer during the design phase.

4.2 Selection of resilient floorings

When selecting resilient floorings, it is necessary to ensure that the selected floorings offered by the flooring manufacturers for the planned use are offered with wear class ≥ 33 to

EN ISO 10874 (Resilient, textile and laminate floor coverings. Classification).

In case of special project requirements, e.g. dissipative capacity/antistatic properties, acoustic properties, slip-resistance, heavy-duty areas, etc., these must be clarified with the flooring manufacturers as part of the floor selection procedure and verified with certificates if necessary.

4 Recommendation for the Minimisation of Indentations:

Die Farbgestaltung und Musterung kann die optische Wahrnehmung von Eindrücken hervorheben oder minimieren. Bei hellen oder sehr dunklen unifarbenen Bodenbelägen können Eindrücke optisch stärker erscheinen.

Die Verwendung von Unterlagen/Unterlagensystemen führt unter anderem zu erhöhten Eindrücken bei elastischen Bodenbelagssystemen.

Die Verarbeitungsanleitungen der Bodenbelagshersteller sind unbedingt zu beachten!

4.3 Selection of laying materials and methods

All laying materials (primers, smoothing compounds, adhesives, etc.) must be matched with each other, the substrate, the covering and the intended use.

Mineral systems are used as smoothing compounds. Use of smoothing compounds with a strength class

≥ C 30-F6 (in acc. with EN 13813)

is recommended for this area of use.

An absorbent substrate required for bonding with dispersion adhesives, with the required evenness, without trowel marks, is achieved with a uniform

smoothing compound coat thickness of > 2.0 mm. The smoothing compound should be applied with a flexible blade.

The coverings are bonded with products with national technical approval. Hard-curing wet adhesives should be given preference over pressure-sensitive adhesives.

The indentation behaviour of a covering is decisively determined by the quantity of adhesive applied.

This is defined by the adhesive spreader (adhesive application). The laying material/flooring manufacturer recommends the adhesive spreader for the relevant floorings and their intended use.

Pressure-sensitive bonding may not be used in case of expected high static and dynamic loads. Here the flooring should be bonded using the wet/semi-wet method or the double-drop method. After laying the flooring in the adhesive it must be rubbed down and rolled according to the laying instructions of the flooring manufacturers. The drying, curing and hardening times of the adhesive must always be complied with.

The information on achieving the final strength of the adhesive used must be taken into consideration. Loading the floor too early must always be avoided, as otherwise irreversible indentations can result. In general, bonded floorings should not be loaded for 5 – 7 days. The manufacturer's instructions must be followed.

This must always be taken into account in the construction progress scheduling.

4.4 Notes on castor systems

Notwithstanding all the requirements set for castor systems and resilient floorings, the needs and standards of the operating personnel and patients/clients must not be overlooked. Here rollability and operability functions must be weighed against resilience and rolling convenience.

On the one hand the requirements can be met with hard treads on a hard substrate and relatively small contact surfaces. In general, it is true to say that good rollability is achieved by:

- hard treads on hard substrate
- optimum tread geometry

On resilient floorings, these cause a high surface pressure with disadvantageous indentation behaviour of the flooring construction. On the other hand, there are the comfort and convenience for walking and rolling processes. In general, it is true to say that good comfort and convenience is achieved by:

- resilient treads
- damping properties

A lower surface pressure is achieved by soft treads and partially by larger contact surfaces.

A compromise must always be reached, taking into consideration the project-specific requirement.

To minimise local point indentations, the maximum loads that will occur due to the castor systems must be considered in the design phase when selecting the flooring system.

In case of particularly dynamic loads and stresses (e.g. starting up, swivelling, motor drives), in addition to this Technical Information, it is recommended that additional tests be considered in order to make a decision. These should include the requirements for dynamic processes, functionalities and use period.

4.5 Cleaning and care

Proper cleaning and care is a decisive factor for the appearance, hygiene, life and maintaining the useful value of the floorings. Therefore, according to the VOB, ATV DIN 18365, the contractor is obliged to hand over to the client the written cleaning and care instructions for their flooring as early as possible (e.g. with the order confirmation).

The care instructions describe the cleaning and care measures required as well as preventive measures, e.g. entrance mats.

It is the responsibility of the building operator/user to maintain the flooring (or have it maintained) so that it meets the intended purpose with regard to appearance and wear in every respect.

Castor systems must be cleaned regularly to remove adhering dirt.

High-gloss covering surfaces make imperfections significantly more visible, even if they lie within the material-specific tolerances (Fig. 5). This is particularly true for indentations in the flooring system which are caused, for example, by castor systems. Therefore, preference should be given to mat flooring surfaces.

5 Summary:

Influence of the rollability of the castor systems and the indentations in the flooring:

Influencing factors		Single-wheel swivel castor		Twin-wheel swivel castor	
		Rollability	Indentations	Rollability	Indentations
Influencing factors	ø 50–100 mm	Use possible	Use conditionally possible	Use possible	Use conditionally possible
	ø 125–200 mm	Use recommended	Use recommended	Use recommended	Use recommended
Wheel treads	Hard wheel tread (Shore hardness > 90 Shore A)	Use recommended	Use conditionally possible	Use recommended	Use conditionally possible
	Soft wheel tread (Shore hardness < 90 Shore A)		Use recommended		Use recommended
Geometry	Large contact surface		Use recommended		Use recommended
	Small contact surface	Use recommended	Use conditionally possible	Use recommended	Use possible

Use recommended · Use possible · Use conditionally possible

With increasing total load (bed and patient) the rollability decreases and the indentations increase.

Summary of the influencing factors for indentations and visual awareness:

Influencing factors for the awareness of indentations	direct	indirect (visual/tactile awareness)
Designated residual indentation	High influence	
Wear class*	Low influence	
Colour selection		High influence
Design/pattern		Moderate influence
Gloss level	High influence	Moderate influence
Incidental light		High influence
Use of underlays/acoustic floorings	High influence	
Floor construction		Moderate influence
Laying/workmanship	High influence	
Smoothing technology		Low influence
Adhesive selection	Moderate influence	
Adhesive quantity applied	High influence	
Bonding method	High influence	
Curing/hardening and drying times	High influence	
Loading time/putting into service	High influence	
Cleaning/care/disinfection		High influence

High influence · Moderate influence · Low influence

* When classifying the floorings in wear classes, wear class 33 should be planned as a minimum. Deviations must be specified by the designer.

Refer to the other parameters and influencing factors in section 4.

Material-specific residual indentations in the floorings, as offered in the technical specifications of the manufacturers, must also be taken into consideration in the design.

6 Conclusion:

This Technical Information shows the relationships between the influences of floor constructions and castor systems and their effects and gives recommendations.

By taking these recommendations into account, influences can be identified in the design phase and risks can be minimised.

The preconditions therefore exist for an optimised design and execution phase.

7 List of Sources:

Standards and codes of practice:

ATV DIN 18365	Bodenbelagarbeiten [Flooring works] (2019-09)
DIN 18560-2	Estriche im Bauwesen -Teil 2: Estriche und Heizestriche auf Dämmschichten (schwimmende Estriche) [Floor screeds in building construction - Part 2: Floor screeds and heating floor screeds on insulation layers (floating screeds)] (2009-09, Correction 1: 2012-05)
DIN 18560-4	Estriche im Bauwesen -Teil 4: Estriche auf Trennschicht [Floor screeds - Part 4: Screeds laid on separated layer] (2012-06)
EN ISO 10581	Resilient floor coverings — Homogeneous poly(vinyl chloride) floor covering — Specifications (2019-11)
EN ISO 10874	Resilient, textile and laminate floor coverings — Classification (2009-11)
EN 12467	Fibre-cement flat sheets. Product specification and test methods (2018-07)
EN 13813	Screed material and floor screeds. Screed material. Properties and requirements (2002-11 and draft 2017-03)
EN 14041	Resilient, textile, laminate and modular multilayer floor coverings. Essential characteristics (2018-02, the 2008-05 issue is to be used for the CE marking)
EN ISO 24343-1	Resilient and laminate floor coverings. Determination of indentation and residual indentation. Part 1: Residual indentation (04.2012)
EN 12526	Castors and wheels. Vocabulary, symbols and multilingual terminology, Published 05.1999
EN 12527	Castors and wheels -Test methods and apparatus, Published 03.1999
EN 12528	Castors and wheels – Castors for furniture - Requirements, Published 03.1999
EN 12529	Castors and wheels. Castors for furniture. Castors for swivel chairs. Requirements, Published 03.1999
EN 12530	Castors and Wheels - Castors and Wheels for Manually Propelled Institutional Applications, Published 03.1999
EN 12531	Castors and Wheels - Hospital Bed Castors, Published 03.1999
EN 12532	Castors and Wheels - Castors and Wheels for Applications up to 1.1 m/s (4 km/h), Published 03.1999
EN 12533	Castors and wheels. Castors and wheels for applications over 1.1 m/s (4 km/h) and up to 4.4 m/s (16 km/h), Published 03.1999
TKB Code of Practice 6	Adhesive spreaders for flooring, parquet and tiling work (2019-03)
RKI Guidelines	Hygiene requirements for the cleaning and disinfection of surfaces 2004 - 47 : 51-61

Figures and photos:

Title	FEB Assembly, bed: Joh. Stiegelmeyer GmbH & Co. KG, Flooring: Wineo, PURline eco Levante "Sinai Sand"
[1]	Photos / FEB-AK-Technik project group
[2]	Documents/Archive of the "Kompetenzzentrum für Bewegungsvorgänge KfB" (Centre of excellence for dynamic processes) at Bielefeld University of Applied Sciences
[3]	Project documents/Archive of the Steinbeis Beratungszentrum „Angewandte BewegungsTechnologie ABT" (Applied movement technology consulting centre), Spenge

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- BEB - Bundesverband Estrich und Belag e. V. (Federal Screed and Flooring Association), Troisdorf
- BSR - Bundesverband der vereidigten Sachverständigen für Raum und Ausstattung e. V. (Federal Association of Sworn Experts for Interiors and Finishes), Bonn
- IBF - Institut für Baustoffprüfung und Fussbodenforschung (Institute for construction material testing and floor research), Troisdorf
- TFI - Institut für Bodensysteme an der RWTH Aachen e.V. (Institute for floor systems at RWTH Aachen University)
- KFB - Kompetenzzentrum für Bewegungsvorgänge (Centre of excellence for dynamic processes), Bielefeld University of Applied Sciences
- TKB - Technische Kommission Bauklebstoffe im Industrieverband Klebstoffe e. V. (Technical Building Adhesives Commission in the Adhesives Industrial Association), Düsseldorf
- BVPF - Bundesverband Parkett- und Fußbodentechnik (Federal Parquet and Flooring Association), Berlin
- ZVR - Zentralverband für Raum & Ausstattung (Central Association for Interiors and Finishes)
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