

TKB-Technical Briefing Note 1

Installation of Parquet

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 - Bundesverband der vereidigten Sachverständigen für Raum und Ausstattung
 - Zentralverband Parkett- und Fußbodentechnik

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1. Introduction

This information sheet provides information for parquet layers regarding selection of installation materials and the installation of parquet. It offers information on the different types of parquet, where possible classified according to European standards. Parquet adhesive types are described with reference to their composition, processing methods, setting properties, their requirements on sub floors and their effect on the parquet itself. They are additionally characterized with respect to industrial safety issues on the basis of the German Gefahrstoffverordnung.

This information sheet limits itself to general technical data. The data contained herein is based on state-of-the-art technology and level of knowledge at time of publication.

Bonded parquet offers the following benefits:

- Certain types of parquet must be bonded to a solid sub floor for stability reasons.
- On account of the higher dimensional stability resulting from bonding, the floor is more durable and can be renovated several times, consequently prolonging the service life of the floor.
- The formation of joints is minimized by bonding, dimensional changes of the parquet are minimized and the floor has a more even appearance.
- Bonding to a screed with subfloor heating system allows for better heat transfer.
- Impact sound is considerably reduced by bonding.

2. Parquet

2.1 Materials

The base materials for parquet are wood and wood-based materials. This includes chemically or physically treated wood, e.g. thermowood and parts of the lignified branches of certain types of bamboo.

2.1.1 Wood – A Material with extraordinary Characteristics

Wood is a natural material. Since each tree grows under different conditions, each piece of wood is unique with special characteristics. However, certain "averaged" characteristics can be determined for each individual wood species.

One important characteristic for the installation of parquet is that wood expands and contracts, i.e. it swells and shrinks as a result of absorbing and giving off water (or organic solvents). The degree

of swelling and shrinkage differs depending on orientation and type of wood.

Table 1 shows characteristic values for some typical wood species, table 2 the values for their equilibrium moisture content (EMC). It must be taken into account that different wood species have different swelling and shrinkage properties as well as different rates of changing moisture contents. The rate of moisture content change refers to the normal orientation of the parquet, i.e. wood absorbs moisture rectangularly to the fibre direction of the wood. With wood blocks on the other hand, which have a different orientation, moisture transfer takes place via the face side, i.e. parallel to fibre direction, approximately four times as fast.

2.1.2 Treated Wood and Thermowood

In order to change its physical (shrinkage and swelling, hardness, colour) and chemical properties (resistance to biological decomposition), wood can be treated either chemically or physically. In general, any such treatment might result in considerably changing not only one but several of its properties. For thermowood, significantly reduced moisture content is to be

expected, lower rate of moisture content change, lower shrinkage and swelling values and increased hardness and brittleness. Since the changes may vary depending on treatment, manufacturer must be contacted for specific values.

2.1.3 Bamboo

Lately, parquet made from bamboo, from the true grass family, has become more and more popular. Compared to regular wood, bamboo has lower shrinkage and swelling values in rectangular direction; however in grain direction the values are 2 to 5 times higher as with wood. On account of its extreme hardness, it can build up enormous stress. The "normal" sorption isotherm according to Keylwerth does not apply for bamboo. Other characteristics can be found in the tables contained in the next chapter 2.1.4.

2.1.4 Tables of Material Properties

Some important properties of materials for parquet are summarized in tables 1 and 2.

For admissible moisture content of parquet see chapter 2.2.2.

Table 1: Physical Data of some Materials for Parquet

citation: J. Sell, Eigenschaften und Kenngrößen von Holzarten, 3. Aufl., Baufachverlag AG Zürich 1989

Type of Wood	Density (air dry) in g/cm ³	Differential Degree of Shrinking in % per 1 % Change of Humidity Content		Stability of Dimension and Form	Rate of Adjustment of Wood Humidity
		radial	tangential		
Maple	0,61 ... 0,66	0,10 ... 0,20	0,22 ... 0,30	middle	middle to high
Birch	0,65 ... 0,73	0,18 ... 0,24	0,26 ... 0,31	middle	middle
Pear	0,68 ... 0,76	0,15 ... 0,16	0,30 ... 0,36	depending on drying	very low
Beech	0,70 ... 0,79	0,19 ... 0,22	0,38 ... 0,44	low	middle to high
Oak	0,65 ... 0,76	0,18 ... 0,22	0,28 ... 0,35	middle	low
Ash	0,68 ... 0,76	0,17 ... 0,21	0,27 ... 0,38	middle	low to middle
Cherry	0,56 ... 0,66	0,16 ... 0,18	0,26 ... 0,30	good	middle
Elm	0,60 ... 0,68	0,17 ... 0,20	0,27 ... 0,29	middle	low to middle
Afrormosia	0,70 ... 0,80	0,16 ... 0,18	0,30 ... 0,35	good	low to very low
Wenge	0,81 ... 0,89	0,20 ... 0,23	0,35 ... 0,43	middle	very low
Bamboo, light	0,60 ... 0,75	0,15		good	
Bamboo, dark	0,72 ... 0,80	0,15		good	

Table 2: Equilibrium Moisture Content

Wood (citation: R. Keylwerth and data of the U.S.Forest Products Laboratory, Madison 1951)							Bamboo (citation: E. Schwab, E. Kupstor, BWD 10/01)	
							light (nature)	dark
% relative air humidity	80	16,2	16,0	16,0	15,8	15,5		
	75	14,7	14,5	14,3	14,0	13,9	11,5	10,4
	70	13,2	13,1	13,0	12,8	12,4		
	65	12,0	12,0	11,8	11,5	11,2	10,6	9,5
	60	11,0	10,9	10,8	10,5	10,3		
	55	10,1	10,0	9,9	9,7	9,4		
	50	9,4	9,2	9,0	8,9	8,6	8,4	7,4
	45	8,6	8,4	8,3	8,1	7,9		
	40	7,8	7,7	7,5	7,3	7,0		
	35	7,0	6,9	6,7	6,4	6,2	6,4	5,8
	30	6,2	6,1	5,9	5,6	5,3		
	25	5,4	5,3	5,0	4,8	4,5		
		10	15	20	25	30	20	20
Temperature in °C								

Example: 60 % rel. air humidity, 15 °C => 10,9 % equilibrium wood moisture

Note: Thermowood may have an equilibrium wood moisture up to 50% lower than untreated wood. The values are significantly dependent on the kind of treatment. The manufacturer has to be asked for precise values.

2.2 Types of Parquet

There is a large number of different parquet types. Technically, they can be classified by the following parameters: type of wood, construction, dimension and surface treatment. This classification is found in the European parquet standards established in 2002. Popular types of parquet are mosaic parquet, lamparquet, strip parquet, engineered (multiple-layer) parquet etc., see table 3.

2.2.1 European Parquet Standards

Classification of parquet types follows the existing European standards (see table 3).

One specific feature of these standards is the fact that regarding wood moisture, they only specify "moisture content at first delivery". Compliance with these values allows manufacturer to trade and put into circulation parquet within the EU. The respective values are listed in table 3. Basically, "Moisture content at first delivery" is different from required installation moisture (see chapter 2.2.2).

Typical dimensions of the individual parquet types can be found in table 4.

Table 3: Standardized Types of Parquet and Wood Moisture Content at first Delivery

Standard	Title	with finished surface allowed wood humidity content [weight-%]		with raw surface allowed wood humidity content [weight-%]	
		from	to	from	to
DIN EN 13226:2002	wood flooring - solid parquet elements with grooves and/or tongues	7	11 chestnut and maritime pine: 13	7	11 chestnut and maritime pine: 13
DIN EN 13227:2002	wood flooring - solid lamparquet products	7	11 chestnut: 13	Standard is only valid for products without surface treatment According to DIN EN the products can be delivered also with surface treatment	
DIN EN 13228:2002	wood flooring - solid wood overlay flooring elements including blocks with an interlocking system	7	11 chestnut: 13	Standard is only valid for products without surface treatment	
DIN EN 13488:2002	wood flooring - mosaic parquet elements	7	11	6	10
DIN EN 13489:2002	wood flooring - multi-layer elements	5 upper layer	9 upper layer	5 upper layer	9 upper layer
DIN EN 13629:2002	wood flooring - solid pre-assembled hardwood board	6	12	6	12
DIN EN 13990:2004	wood flooring - solid softwood floor boards	for heated rooms: 9+/-2 for other application according to DIN EN: 17+/-2		for heated rooms: 9+/-2 for other application according to DIN EN: 17+/-2	
DIN EN 14761:2006	wood flooring - solid wood parquet - vertical finger, wide finger and module brick	7	11	Standard is only valid for products with raw surface	

Note: The wood humidity can be measured using the methods described in EN 13183-1 "moisture content of a piece of sawn timber - determination by oven dry method" and EN 13183-2 "moisture content of a piece of sawn timber - estimation by electrical resistance method". In case of doubt the oven dry method has to be chosen.

2.2.2 Installation Moisture Content of Parquet

Unlike the old standards of the DIN 280 series, which required a wood moisture value for each parquet type adjusted to climatic conditions in Germany, the new European standards specify a broader moisture range reflecting the climatic situation across Europe.

The expected room climate during use is the decisive factor that determines the proper wood moisture for installation. The expected room climate is mainly a combination of the following parameters: outside climate, passive ventilation, temperature control (heating and air-conditioning if necessary) as well as use of the room with active ventilation and water vapour intake. In this context, it must be noted that users normally adjust the last two parameters so that a room climate is achieved which is perceived as "cozy". Therefore, an average room temperature of 20 to 21 °C and an average relative air humidity of 50 % are to be

expected. Typical deviation from the average values is +/- 1 °C for temperature and +/- 20 % for relative air humidity.

According to "conventional" data, the appropriate wood moisture for these values would be 9 % with a deviation ranging from +/- 2 to 3 % during the course of the year. Depending on thickness of parquet, the rate of moisture change of individual wood species, layer thickness and type of surface treatment, a certain attenuation and phase shift in assimilation of wood moisture to room climate can be observed. In addition, the following characteristics must be noted:

- The "conventional data" was established for Sitka spruce and corresponds with the values for many, in particular European wood species. However, there are also distinctive deviations (Sipa, Missanda, Canadian maple ...).

- For multiple layer parquet and pre-finished parquet, a slightly lower installation moisture of 8 % on average has given best results.
- For parquet installed on underfloor heating systems, temperatures in the parquet can reach 25 to 28 °C during heating period, while room temperature stays at the average temperature of 21 °C mentioned above. Consequently, the relative air humidity in the parquet in relation to room air humidity decreases by approx. 10 %, resulting in a corresponding decrease of wood moisture by approx. 1 %. However, installation moisture of 9 % (solid parquet) or 8 % (multiple layer parquet) must be ensured, since these values represent the annual mean.
- For solid planks, compliance with the average installation moisture of 9 % is of particular importance, since based on their dimension, an increase in wood moisture may result in very high shear stress, a decrease of the wood moisture in the formation of large gaps. In the event of large wood moisture differences, a soft elastic bonding offers the advantage of reduced sub floor stress, however may also allow considerable dimensional changes of the planks.

In case parquet is installed when wood moisture greatly deviates from above values, damage is to be expected. If wood moisture is too high, this results in considerably larger joint width and – depending on adhesive type – increased stress values at the parquet edges, which may lead to debonding. If wood moisture is too low, considerable shear stress develops after moisture intake, which may even cause screed to crack. In case of buckling of more than 1 %, wood develops plastic deformation. This 1% buckling occurs when wood moisture is increased by more than approx. 3% with a simultaneous swelling obstruction, e.g. caused by shear-resistant bonding. With higher wood moisture differences, e.g. when parquet with reduced moisture content is installed, a disproportionate formation of gaps is to be expected in the future.

Even with the new European standards, for Germany installation of parquet with an average moisture content of 9 % (solid parquet without surface treatment) or 8 % (multiple layer parquet and parquet with surface treatment) is still required, always complying with the tolerance range of +/- 2 % for the individual elements.

When installing parquet in rooms where the ambient conditions regularly deviate from normal room climate conditions found in residential areas, e.g. in churches, a parquet must be selected the moisture content of which has been adjusted properly by the parquet manufacturer.

3. Parquet Adhesives

From a test methodology perspective, parquet adhesives can be classified into soft and hard adhesives according to EN 14293. The “hard” adhesives also comply with essential requirements of the old German standard DIN 281.

In addition, physical and chemical composition of an adhesive is used for classification, since it directly affects the hazard properties of the product.

3.1 Hard Adhesive Types

3.1.1 Dispersion Adhesives

All types of dispersion adhesives have in common that, in ready-to-use state, they contain as main binder a plastic dispersed in water. The setting and film formation properties of an adhesive depend on absorbency of the sub floor, the type of wood and the ambient climatic conditions (temperature and relative air humidity) on site. The water contained in dispersion adhesives makes parquet wood/elements swell. The extent of the swelling depends on parquet or wood type, wood moisture, water content and setting characteristics of the adhesive (see below, different dispersion adhesive types), absorbency of sub floor and ambient climatic conditions during and after installation.

Dispersion adhesives for parquet installation require a very level sub floor. Consequently, meticulous sub floor preparation is essential. Especially large-format elements sometimes need to be weighed down after installation. Also note a certain sensitivity of dispersion adhesives to mechanical disturbances during setting (also see chapter 4.4).

While ready-to-use dispersion adhesives normally are not subject to labelling requirements according to the German Gefahrstoffverordnung (GefStoffV) (Ordinance on Hazardous Substances) and do not require special protective measures, for some products containing cement these requirements must be followed all the same. Dispersion adhesives often comply with Eimcode EC1 or EC1R requirements (very low emission) and therefore also meet the strictest consumer protection requirements for healthy indoor air quality.

3.1.1.1 Ready-to-use Dispersion Adhesives

Ready-to-use dispersion adhesives (D) consist of organic binders dispersed in water, anorganic fillers and additives. Setting takes place physically by diffusion and evaporation of the water contained in the adhesive.

This type of adhesive typically requires an absorbent sub floor. In addition, it can only be used for parquet types which are resistant to swelling on account of their wood type, construction and dimension.

3.1.1.2 Two-Component Dispersion Adhesives

Two-component dispersion adhesives (D-2K) consist of a liquid component based on organic binders dispersed in water, gypsum and/or cement-based powder components as well as fillers and additives.

In addition to physical drying, a major part of the water contained in the adhesive is bound by a chemical reaction with the powder component. On account of this chemical binding of water, considerably less water is released to the environment (wood, sub floor) and setting is accelerated. This results in relatively reduced swelling of the wood and the adhesive can also be used on non- or poorly absorbent substrates.

The chemical reaction begins immediately after mixing. The products have a limited pot / processing life, normally between 30 and 60 minutes. On account of their limited pot life, reactive dispersion adhesives require good work preparation, e.g. pre-cutting of the parquet elements.

3.1.1.3 Dispersion Adhesives in Powder Form

Dispersion adhesives in powder form (D-P) consist of a water emulsifiable plastic powder (so-called redispersible powder), fillers, gypsum and/or cement and additives. This type of adhesive must be mixed with a specified amount of water. Overall, properties described in section 3.1.1.2 apply for these products as well.

3.1.2 Solvent-based Adhesives

Solvent-based adhesives (L) consist of dissolved organic binders, highly volatile solvents, anorganic fillers and additives.

For reasons of industrial safety, the German Gefahrstoffverordnung (GefStoffV) (Ordinance on Hazardous Substances) and the German TRGS 610 strongly restrict the use of adhesives with a high solvent content. The solvents used are highly volatile, flammable and harmful compounds. In the event that the existing threshold values for the individual solvents (Auslöseschwelle (trigger threshold), Arbeitsplatzgrenzwerte (AGW) (occupational exposure limits (OELs)) can not be complied with, measures must be taken as specified by the German Gefahrstoffverordnung (GefStoffV) (Ordinance on Hazardous Substances).

Solvent-based adhesives harden by diffusion and evaporation of the solvents (physical drying). This process is less dependent on room climate conditions than with dispersion adhesives, since the relative air humidity hardly affects the evaporation process.

The solvents contained in the adhesives make parquet wood swell, depending on type and ratio of the solvent and quantity of adhesive used, similar to water contained in dispersion adhesives. The extent of the swelling however is usually somewhat lower than with dispersion adhesives. This can be attributed to the lower specific swelling property of solvents and, compared to water, their higher volatility at normal room climate conditions.

3.1.3 Reaction Resin Adhesives

Reaction resin adhesives consist of chemically reactive organic binders, anorganic fillers and additives. They are normally water and solvent free and depending on their chemical basis are offered as either one or two component products.

Hardening characteristics of all reaction resin adhesives are strongly influenced by material temperature (adhesive, sub floor, parquet).

3.1.3.1 Polyurethane Adhesives

Polyurethane-based reaction resin adhesives are offered as two component systems (PUR-2K) and one component systems (PUR-1K).

2 c-polyurethane adhesives cure continuously by chemical reaction between their components and therefore only have a limited pot life or processing time, normally between 30 and 60 minutes.

For 2 c-polyurethane adhesives, installers must strictly adhere to the specified mixing ratio and thoroughly mix the components. Insufficient mixing or incorrect mixing ratios will inevitably lead to imperfect bonding. On account of their limited pot-life, they require a very careful work preparation, e.g. pre-cutting of the parquet elements.

1 c-polyurethane adhesives cure on account of the chemical reaction of the binder with ambient humidity (water). This process begins right after the container is opened and rapidly continues up to full curing. The setting properties therefore mainly depend on water or moisture content of sub floor and wood as well as on ambient climatic conditions on installation site.

Polyurethane adhesives normally do not contain components affecting the swelling properties of parquet wood, however at least one component contains hazardous substances which require adequate protective measures.

3.1.3.2 Epoxy Resin Adhesives

Reaction resin adhesives for parquet on an epoxy resin basis are only available as two-component systems.

Their technical characteristics are comparable to those of 2 c-polyurethane adhesives (PUR-2K). Consequently, the same information applies (see 3.1.3.1).

Like polyurethane adhesives, epoxy resin adhesives do not contain components making parquet wood swell, but it must be noted that in most cases both components contain hazardous materials requiring protective measures. As a result, it is recommended to preferably use the technically similar PUR-2K systems.

3.2 Soft Adhesive Types

Adhesives classified as “soft” according to EN 14293 are currently only available as reactive adhesives.

These soft reaction resin adhesives generally show elastic behaviour once hardened. As a consequence of the soft elastic mechanical properties higher dimensional changes of the parquet with changing wood humidity are allowed. On account of this mechanics a lower amount of stress is transferred from the wood to the subfloor. On the other hand the higher degree of allowed dimensional changes of the parquet elements in

combination with strongly sidebonding surface treatment products may result in a discontinuous pattern of gaps in the wooden flooring.

Soft elastic parquet adhesives are offered as ready-to-use (1 component) products and cure by chemical reaction of the binder with ambient moisture (water). This process starts right after the container is opened and continues after application until product has completely hardened. Setting properties therefore mainly depend on water content or moisture content of sub floor and wood as well as ambient climatic conditions on installation site.

In addition, the hardening speed of all soft reaction resin adhesives is substantially affected by material temperatures (adhesive, sub floor, parquet).

Soft reaction resin adhesives normally do not contain components attributing to swelling of parquet.

Many of these adhesives contain components (e.g. plasticizers) which can migrate to and soften adjoining materials. Organic thermoplastic materials such as asphalts, dispersion primers, and old adhesive residues are especially susceptible. Improper application can lead to softening of certain varnishes on direct contact with adhesive pushed up through joints. These effects can be avoided by selecting only well coordinated product systems.

Table 4: Technically Suitable Types of Parquet Adhesives for different Types of Parquet

Type of Parquet	Dimensions	Classification of the
		based on dimension and construction
solid / raw surface:		
mosaic parquet		low
8 mm - solid parquet - parallel pattern		high
vertical finger parquet		low
solid lamparquet 10 mm-solid parquet	$b \leq 50 \text{ mm}; l \leq 300 \text{ mm}$	high
big lamparquet elements	$b > 50 \text{ mm}; l > 300 \text{ mm}$	very high
parquet tapis		very high reduced by nailing
solid parquet elements with grooves and/or tongues	$t \leq 19 \text{ mm}, b \leq 75 \text{ mm}; l \leq 600 \text{ mm}$	middle
solid parquet elements with grooves and/or tongues	$t > 19 \text{ mm}, b \leq 75 \text{ mm}; l \leq 600 \text{ mm}$	low
solid parquet elements with grooves and/or tongues / short planks	$75 \text{ mm} < b \leq 100 \text{ mm}$ $600 \text{ mm} < l \leq 1200 \text{ mm}$	middle
solid floor boards / planks		very high
board / panel parquet		middle - high dimensional changes not allowed
solid / finished surface:		
dimensional changes must not occur because of the finished		
8 mm-solid parquet		high
solid parquet elements with grooves and/or tongues		middle - high
solid floor boards / planks		very high
multi layer / raw surface:		
double layer parquet sticks	$b \leq 70 \text{ mm}; l \leq 600 \text{ mm}$	low
double layer parquet sticks	$b > 70 \text{ mm}; l > 600 \text{ mm}$	middle
multi-layer board / panel parquet	tarsia parquet	middle dimensional changes not allowed
three layer boards / planks	$b \leq 70 \text{ mm}; l \leq 600 \text{ mm}$	low
three layer boards / planks	$b > 70 \text{ mm}; l > 600 \text{ mm}$	middle
multi-layer / finished surface:		
dimensional changes must not occur because of the finished		
double layer parquet sticks	$b \leq 70 \text{ mm}; l \leq 600 \text{ mm}$	low
double layer parquet sticks	$b > 70 \text{ mm}; l > 600 \text{ mm}$	middle
three layer boards / planks	$b \leq 70 \text{ mm}; l \leq 600 \text{ mm}$	low
three layer boards / planks	$b > 70 \text{ mm}; l > 600 \text{ mm}$	middle

Note:

1. With recommended parquet adhesives labelled with *, e.g. D*, special advice of the adhesive manufacturer has to be observed.
2. D, D-2K, D-P are not suitable for big elements because of the risk of hollow spots.
3. With the classification of the types of parquet based on the dimensions the thickness is regarded first, then the width, followed by the

swelling Potential of the Parquet		recommended notched Trowel				Parquet Standard
swelling potential of the type of wood based on differential degree of swelling and rate of wood humidity change		notched trowel of the group no. (see Tab. 5)				
low	high	1	2	3	4	
all		x				DIN EN 13488:2002
all	D*, D-2K, D-P, L, PU-2K, PU-1 K, WPU, WSi	x				
all			x	x		DIN EN 14761:2006
all	D*, D-2K, D-P, L, PU-2K, PU-1 K, WPU, WSi		x			DIN EN 13227:2002
PU-2K, PU-1K, WPU*, WSi*			x	x		
D, D-2K, D-P, L, PU-2K, PU-1K		x	x			
D*, D-2K, D-P, L, PU-2K, PU-1 K, WPU, WSi			x	x		EN 13226:2002
all				x		
L, PU-2K, PU-1K, WPU, WSi				x		
L, PU-2K, PU-1K, WPU*, WSi*	PU-2K, PU-1K, WPU*, WSi*		x	x		DIN EN 13226:2002 DIN EN 13629:2002 DIN EN 13990:2004
L, PU-2K, PU-1K, WPU*, WSi*	PU-2K, PU-1K, WPU*, WSi*		x	x		
surface!						
L, PU-2K, PU-1K, WPU*, WSi*	PU-2K, PU-1K, WPU*, WSi*	x				EN 13488:2002
PU-2K, PU-1K, WPU*, WSi*			x	x	x	DIN EN 13226:2002
PU-2K, PU-1K, WPU*, WSi*				x	x	DIN EN 13226:2002 DIN EN 13629:2002 DIN EN 13990:2004
all		x	x			DIN EN 13489:2002
D*, D-2K*, D-P*, L, PU-2K, PU-1K, WPU, WSi			x			
L, PU-2K, PU-1K, WPU*, WSi*	PU-2K, PU-1K, WPU*, WSi*		x	x		
all			x			DIN EN 13489:2002
D*, D-2K*, D-P*, L, PU-2K, PU-1K, WPU, WSi				x		
surface!						
all		x	x			DIN EN 13489:2002
D*, D-2K*, D-P*, L, PU-2K, PU-1K, WPU, WSi			x			
all			x			
D*, D-2K*, D-P*, L, PU-2K, PU-1K, WPU, WSi				x		
length						

3.2.1 Soft Polyurethane-based Reaction Resin Adhesives

Fundamentally, soft polyurethane-based reaction resin adhesives (WPUR) have the same composition as above 1-component PUR adhesives (chapter 3.1.3.1) and also have the same setting properties.

These products can be subject to labelling requirements according to the German Gefahrstoffverordnung (GefStoffV) (Ordinance on Hazardous Substances).

3.2.2 Silane-based Reaction Resin Adhesives

Soft reaction resin adhesives based on silane-terminated prepolymers (WSi) consist of an organic chemically reactive binder, anorganic fillers and additives.

These products are not subject to labeling requirements according to the German Gefahrstoffverordnung (GefStoffV) (Ordinance on Hazardous Substances).

3.3 Which Adhesive for which Type of Parquet?

When selecting the right parquet adhesive for a certain type of application, technical as well as legal aspects must be considered.

The technical suitability of a parquet adhesive is defined by parquet type (construction, dimension and surface treatment), the wood type (wood moisture change rate and differential swelling and shrinkage coefficient), type of subfloor and long-term room climate during use.

From a legal point of view, selection must consider compliance with the German Gefahrstoffverordnung (GefStoffV) (Ordinance on Hazardous Substances), version dated 23.12.2004, in particular compliance with §7. Employers are obligated to determine the hazard potential of each adhesive and must select a product which is technically suited for the intended purpose but has the lowest hazard potential.

Solvent-based synthetic resin adhesives (L), polyurethane-based adhesives (PUR-2K, PUR-1K and some WPUR) as well as some reactive powder dispersion adhesives are subject to the labelling requirements of the German Gefahrstoffverordnung (GefStoffV) (Ordinance on Hazardous Substances) and contain hazardous substances which must be substituted (§8 GefStoffV). Dispersion adhesives (D), some reactive dispersion adhesives (D-2K, D-P), some soft 1 c-PUR adhesives (WPUR) and silane-based adhesives (WSi) are not subject to the labelling requirements of the German Gefahrstoffverordnung (GefStoffV) (Ordinance on

Hazardous Substances) and shall therefore be the preferred choice.

From an adhesive bonding perspective, the following parquet type parameters are significant and have been considered for classification in table 4:

- Dimension of the parquet element, especially the thickness-width ratio, which influences deforming of the element when absorbing water or solvents as well as the dimensional stability of the element in case of wood moisture changes resulting from changes in ambient humidity.
- Construction of the parquet element, solid or multiple layer construction, also influences deformability and dimensional stability.
- The wood moisture change rate and the differential swelling and shrinkage coefficient significantly influence the speed and extent of dimensional changes of wood, especially with solid parquet.
- The type of surface treatment influences the degree up to which dimensional changes of the parquet element as a result of intake of water or solvent are acceptable. Parquet which is not surface-treated is normally sanded, in particular to correct small concave deformations. Surface-treated parquet shall not show noticeable dimensional changes after bonding; sealed parquet elements are optically more susceptible than oiled parquets or parquets with bevelled edges.

4. Installation

4.1 Sub floors

TKB Technical information sheet No. 8, "Assessment and Preparation of Sub Floors for Floor Covering and Parquet work" as well as BEB Information Sheet 'Beurteilen und Vorbereiten von Untergründen – Verlegen von elastischen und textilen Bodenbelägen, Schichtstoffelementen (Laminat), Parkett und Holzpflaster – Beheizte und unbeheizte Fußbodenkonstruktionen' (Assessment and Preparation of Sub Floors, installation of elastic and textile floor coverings, composite elements (laminated), parquet and wood blocks, heated and non-heated floor constructions) provide detailed instructions and descriptions of the required tests.

4.2 Parquet

Parquet shall never be stored on site. Conditioning of parquet wood moisture to site conditions is generally not required and also contradicts the rule that parquet shall be installed with the average humidity to be expected during use (see also

chapter 2.2.2). Parquet packaged in film shall only be unpacked shortly before installation.

Before installation, moisture content of parquet shall be checked by random sampling (also see chapter 2.2.1 und 2.2.2). If packaging is damaged, moisture content of this lot must necessarily be checked. Material which has developed deformations on account of moisture uptake, especially surface-treated material, shall not be installed.

Wood moisture measurements are performed with adequate electric wood moisture meters (DIN EN 13183-2), in case of doubt a drying test must be performed (DIN EN 13183-1). With exotic woods, divergent equilibrium moisture contents are to be expected (see also 2.2.2). Exotic woods may possess a specific wood moisture content that corresponds to the average room climate of 20 °C and 50 % relative air humidity that may be different from 9 %.

4.3 Climatic Preconditions for Bonding

The following ambient climatic conditions must prevail before and during installation:

- air temperature: minimum 18 °C
- sub floor temperature: minimum 15 °C
- sub floor temperature underfloor heating: 18 to 22 °C
- relative humidity: maximum 75 %, preferably maximum 65 %

Note: for the period of use of parquet, the ambient conditions specified in care instructions must prevail.

Temperature of all materials (primers, adhesives and parquet) must be conditioned to room temperature. Primers and levelling compounds must be sufficiently dry before the next product is applied. Always observe drying times specified by manufacturer.

4.4 Bonding

Manufacturer's instructions must be observed, when applying the adhesive.

Adhesives are applied using a notched trowel. For the different parquet types, notched trowels listed in table 5 are used, table 4 shows which trowel to use for which parquet type. The proper trowel is selected following manufacturer's instructions and trowel chart in TKB information sheet No. 6.

The area to which adhesive shall be applied must have a size which can be covered within "open time" of adhesive. It must be ensured that the underside of a parquet element is sufficiently wetted.

Parquet is installed with a wall clearance joint (joint to adjoining construction elements) of 1 to 2 cm. Over constructional expansion joints also in the wooden flooring joints have to be installed.

Parquet without tongue and groove joint (e.g. mosaic parquet, 10 mm solid and upright lamella parquet) is laid into adhesive bed and then tapped or pressed down.

For parquet with tongue and groove construction (e.g. strip, pre-finished and square parquet) it is recommended to first create a firm end stop (glueing down a first alignment row, mechanical fixing of a alignment plank).

For 8 and 10 mm solid parquet in parallel pattern and use of adhesives producing swelling of the wood (D, D-2K, L) it is recommended to start installation in the middle of the room and install elements alternately (approx. 2 m) in both halves of the area.

So-called „click“ parquet is generally directly locked into place with a tilting motion and in most cases does not need a fixed endstop. However, if the „click parquet“ must be interlocked with a horizontal sliding motion, like with tongue and groove parquet, a fixed endstop must first be created.

Wedges must be removed immediately after installation of the parquet, or else – especially when dispersion or solvent-based adhesives are used – bulges will form. During setting, dispersion adhesives are more susceptible to mechanical disturbances than solvent based or reaction resin adhesives. Freshly installed parquet shall therefore not be exposed to any mechanical stress, particularly shall not be walked on.

A number of parquet types, especially large-format panels, require a very careful preparation of the sub floor to achieve the necessary overall wetting of the undersides of the parquet elements, e.g. apply self-levelling compounds with required layer thickness.

In some cases, it might be required to weigh down the parquet after installation until adhesive has set, e.g. use sandbags. Special attention must be paid to:

- screed edges
- top ends of long multi-layer elements
- strip parquet areas and other solid parquet types with tongue and groove connection

Parquet bonded over the whole area shall not be glued lengthwise in tongue and groove, since this might result in a discontinuous pattern of gaps in the parquet floor.

Table 5: Notched Trowels

Group (compare recommendation of group of notched trowels in table 4)	TKB-Notched Trowel	Bridge Width a in mm	Notch Width b in mm	Notch Depth c in mm	γ (Notch Angle in °)
1	B3	3,30	3,70	3,25	55,0
	B6	4,90	4,10	3,60	55,0
	B7	4,40	3,60	3,90	45,0
	B8	3,90	4,10	3,60	55,0
2	B5	14,30	5,70	5,15	55,0
	B9	9,90	6,10	5,00	60,0
	B10	9,90	5,10	5,70	45,0
	B11	7,90	6,10	5,00	60,0
3	B12	4,90	5,10	5,10	50,0
	B13	11,40	7,10	6,50	55,0
4	B14	5,90	6,10	5,55	55,0
	B15	6,90	5,60	6,30	45,0
	B16	11,90	8,10	7,45	55,0

4.5 Setting and Waiting Times

Before installed parquet is further treated (sanding, sealing/oiling) or used, it must be ensured that the adhesive has sufficiently set/hardened and wood moisture has re-adjusted.

For parquet with untreated surface, the typical waiting times specified in table 6 apply, depending on type of adhesive and type of wood.

For parquet with treated surface, first use shall not take place earlier than 24 to 48 hours after installation, irrespective of adhesive type used.

The exact waiting times depend on sub floor, room climate, parquet and wood type. Always observe specifications of adhesive manufacturer.

Table 6: Curing Time and Waiting Time before Grinding and Surface Treatment respectively (in Days)

Subfloor	Type of Adhesive							
	D	D-2K	D-P	PU-1K	PU-2K	L	WSi	WPU
absorbent	5 - 10	3 - 5	3 - 5	2	1 - 2	3 - 5	2	2
non absorbent	not suitable	3 - 7	3 - 7	3	1 - 2	5 - 7	3	3

5. Relevant Standards and Technical Information Sheets

In the following, relevant standards and information sheets are listed with indication in which chapter of this information sheet the document is referenced.

5.1 Industrial Safety

Title: Gefahrstoffverordnung (vom 26.08.1986)
Verordnung zum Schutz vor gefährlichen Stoffen in der gültigen Fassung vom 23. Dezember 2004
Date of issue / Publisher: 12-2004
Bundesgesetzblatt

Title: GISCODE für Verlegewerkstoffe
Date of issue / Publisher:
aktuelle Fassung
Gefahrstoff Informationssystem der Berufs-
genossenschaften der Bauindustrie; Frankfurt

Title: EMICODE
Date of issue / Publisher: aktuelle Fassung
Gemeinschaft Emissionskontrollierte
Verlegewerkstoffe, Klebstoffe und Bauprodukte
e.V.; Düsseldorf

Title: TRGS 430
Isocyanate – Exposition und Überwachung
Date of issue / Publisher: 03-2002
Ausschuß für Gefahrstoffe (AGS)
Bekanntgegeben durch Bundesministerium für
Arbeit und Sozialordnung

Title: TRGS 440
Ermitteln und Beurteilen der Gefährdungen durch
Gefahrstoffe am Arbeitsplatz -
Ermitteln von Gefahrstoffen und Methoden zur
Ersatzstoffprüfung
Date of issue / Publisher: 03-2002
Ausschuß für Gefahrstoffe (AGS)
Bekanntgegeben durch Bundesministerium für
Arbeit und Sozialordnung

Title: TRGS 540
Sensibilisierende Stoffe
Date of issue / Publisher: 02-2000
Ausschuß für Gefahrstoffe (AGS)
Bekanntgegeben durch Bundesministerium für
Arbeit und Sozialordnung

Title: TRGS 610
Ersatzstoffe und Ersatzverfahren für stark
lösemittelhaltige Vorstriche und Klebstoffe für den
Bodenbereich
Date of issue / Publisher: 03-1998
Ausschuß für Gefahrstoffe (AGS)
Bekanntgegeben durch Bundesministerium für
Arbeit und Sozialordnung

Title: TRGS 613
Ersatzstoffe, Ersatzverfahren und
Verwendungsbeschränkungen für chromathaltige
Zemente, chromathaltige zementhaltige
Zubereitungen
Date of issue / Publisher: 10-2002
Ausschuß für Gefahrstoffe (AGS)
Bekanntgegeben durch Bundesministerium für
Arbeit und Sozialordnung

Title: TRGS 900
Grenzwerte in der Luft am Arbeitsplatz
Date of issue / Publisher: 01-2006
Ausschuß für Gefahrstoffe (AGS)
Bekanntgegeben durch Bundesministerium für
Arbeit und Sozialordnung

Title: TRGS 907
Verzeichnis sensibilisierender Stoffe
Date of issue / Publisher: 10-2002
Ausschuß für Gefahrstoffe (AGS)
Bekanntgegeben durch Bundesministerium für
Arbeit und Sozialordnung

5.2 Standards for Wood

Title: DIN 52180
Prüfung von Holz; Probennahme, Grundlagen
Date of issue / Publisher: 11-1977

Title: DIN 68100
Toleranzsystem für Holzbe- und –verarbeitung;
Begriffe, Toleranzreihen, Schwind- und Quellmaße
Date of issue / Publisher: 12-1984

Title: VG 81244- Teil 3
Bootsbauhölzer – Anwendung und Verarbeitung
Date of issue / Publisher: 9-1987

5.3 Standards for Parquet

Title: DIN EN 13226
Holzfußböden – Massivholz-Parkettstäbe mit Nut
und/oder Feder; Deutsche Fassung EN
13226:2002
(Wood flooring – Solid parquet elements with
grooves and/or tongues)
Date of issue / Publisher: 5-2003

Title: DIN EN 13227
Holzfußböden – Massivholz-Lamparkettprodukte;
Deutsche Fassung EN 13227:2002
(Wood flooring – Solid lamparquet products)
Date of issue / Publisher: 6-2003

Title: DIN EN 13228
Holzfußböden – Massiv-Overlay-Parkettstäbe
einschließlich Parkettblöcke mit einem
Verbindungssystem; Deutsche Fassung EN
13228:2002
(Wood flooring – Solid wood overlay flooring
elements including blocks with an interlocking
system)
Date of issue / Publisher: 6-2003

Title: DIN EN 13488
Holzfußböden – Mosaikparkettelemente; Deutsche
Fassung EN 13488:2002
(Wood flooring – Mosaic parquet elements)
Date of issue / Publisher: 5-2003

Title: DIN EN 13489
Holzfußböden – Mehrschichtparkettelemente;
Deutsche Fassung EN 13489:2002
(Wood flooring – Multi-layer parquet elements)
Date of issue / Publisher: 5-2003

Title: DIN EN 13629
 Holzfußböden – Massive Laubholzdielen;
 Deutsche Fassung EN 13629:2002
 (Wood flooring – Solid preassembled hardwood
 board)
 Date of issue / Publisher: 6-2003

Title: DIN EN 13990
 Holzfußböden – Massive
 Nadelholzfußbodendielen;
 Deutsche Fassung EN 13990:2004
 (Wood flooring – Solid softwood floor boards)
 Date of issue / Publisher: 04-2004

Title: DIN EN 14761
 Holzfußböden – Massivholzparkett –
 Hochkantlamelle, Breitlamelle und Modulklötz;
 Deutsche Fassung EN 14761:2006
 (Wood flooring – Solid wood parquet – Vertical
 finger, wide finger and module brick)
 Date of issue / Publisher: 05-2006

5.4 Standards for Parquet Adhesives

Title: DIN 281
 Parkettklebstoffe
 Date of issue / Publisher: 03-1994

Title: DIN EN 14293
 Klebstoffe – Klebstoffe für das Kleben von Parkett
 auf einen Untergrund; Deutsche Fassung EN
 14293:2006
 (Adhesives – Adhesives for bonding of parquet to
 subfloor)
 Date of issue / Publisher: 10-2006

5.5 Standards for Parquet Work

Title: DIN 18356
 Parkettarbeiten
 Date of issue / Publisher: 10-2006

Title: DIN 18367
 Holzpflesterarbeiten
 Date of issue / Publisher: 12-2002

Title: DIN 18202
 Toleranzen im Hochbau
 Date of issue / Publisher: 04-1997

Title: DIN EN 13183-Teil 1
 Feuchtegehalt eines Stückes Schnittholz
 - Bestimmung durch Darrverfahren; Deutsche
 Fassung EN 13183-1:2002
 (Moisture content of a piece of sawn timber –
 Determination by oven dry method)
 Date of issue / Publisher: 7-2002

Title: DIN EN 13183-Teil 2
 Feuchtegehalt eines Stückes Schnittholz
 - Schätzung durch elektrisches
 Widerstandsmeßverfahren; Deutsche Fassung EN
 13183-2:2002
 (Moisture content of a piece of sawn timber –
 Estimation by electrical resistance method)
 Date of issue / Publisher: 7-2002

5.6 Technical Information Sheets TKB

Title: Merkblatt TKB-8
 Beurteilen und Vorbereiten von Untergründen für
 Bodenbelag und Parkettarbeiten
 Date of issue / Publisher: 6-2004
 Technische Kommission Bauklebstoffe im
 Industrieverband Klebstoffe; Düsseldorf

5.7 Other Standards

Title: DIN 18299
 Allgemeine Regeln für Bauarbeiten jeder Art
 Date of issue / Publisher: 10-2006

Title: DIN 1960
 VOB Verdingungsordnung für Bauleistungen Teil
 A: Allgemeine Bestimmungen für die Vergabe von
 Bauleistungen
 Date of issue / Publisher: 10-2006

Title: DIN 1961
 VOB Verdingungsordnung für Bauleistungen, Teil
 B: Allgemeine Vertragsbedingungen für die
 Ausführung von Bauleistungen
 Date of issue / Publisher: 10-2006

5.8 Other technical Literature and Commentaries

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Karl Remmert, Josef Heller, Horst Spang, Klaus
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 Hamburg, SN-Verlag 2006

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 Zimmermann
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