Service life of wood in outdoor above ground applications - engineering design guideline

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Engineering design guideline

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Preface

This is the first technical guideline in Europe for design of wooden constructions with respect to durability and service life. The guideline is focusing on constructions above ground, in particular on decking and cladding – two commodities where wood is abundantly used.

The philosophy behind this guideline is similar to that of structural design and it shall be seen as the first attempt to develop a quantitative tool for use in practice.

We believe that it will be continuously improved as it will be tested in practice by architects, specifiers and researchers, and that it will serve as a discussion document in the process of introducing performance-based engineering design for wood-based building components with respect to durability.

The guideline has been developed within the European research project WoodExter (Service life and performance of exterior wood above ground).

The project was initiated by the European Confederation of Woodworking Industries, CEI Bois, and their initiative Building with Wood, following a feasibility study on wood durability and service life in 2007.

The financial support of WoodWisdom-Net (www.woodwisdom.net) and wood industry partnership Building with Wood is gratefully acknowledged as well as the support from local industrial partners. The WoodExter research partners are thanked for their cooperation and collaboration in this project.

Reinhold Steinmaurer
Chairman of WoodExter Steering Committee

Jöran Jermer
WoodExter coordinator

WoodExter organization and support

This guideline has been developed within the European project WoodExter (Service life and performance of exterior wood above ground) during 2008-2011.

WoodExter has had the following R&D partners:

SP Technical Research Institute of Sweden (co-ordinator)
LTH - Lund University, Sweden
BRE - Building Research Establishment, United Kingdom
VTT, Finland
FCBA, France
HFA - Holzforschung Austria
TUW – Technische Universität Wien, Austria
NFLI – Norwegian Forest and Landscape Institute
UGOE – Universität Göttingen, Germany
UG – Universiteit Gent, Belgium

Industrial partners were:

CEI-Bois (major industrial partner)
Swedish Wood Preservation Institute
Södra Timber AB, Sweden
Bergs Timber Bitus AB, Sweden
Kebony ASA, Norway
Fachverband der Holzindustrie Österreichs, Austria
Synthesa GmbH, Austria
Adler-Werk Lackfabrik, Austria

Author team

The guideline has been written by the WoodExter partners and the following persons have directly contributed:

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Contents

Summary

This engineering design guideline is intended for wood in outdoor above ground applications, i.e. use class 3 according to EN 335. It is based on a prescribed limit state for onset of decay during a reference service life of 30 years. Onset of decay is defined as a state of fungal attack according to rating 1 in EN 252. The approach is to determine the *climate exposure* as a function of geographical location, local exposure conditions, sheltering, distance to ground and design of details. The exposure is then compared with the *material resistance* defined in five classes and the design output is either OK or NOT OK. The present version of the guideline covers applications for decking and cladding. The data included in the guideline have partly been derived with the help of a dose-response model for decay, which was used to derive relative measures of decay risk between different locations and between different detail solutions. Other elements in the guideline have been estimated in a semi-subjective manner based on expert opinions as well as experience from field testing. The guideline has been verified by a number of reality checks of real buildings, which show that the output from the tool agrees well with documented experience. The guideline has also been presented in a computerized Excel format, which makes practical use more convenient. It is believed that many building professionals will appreciate a tool within the area of wood durability which has an approach similar to other design tasks in building projects. An advantage is that in applying the method the designer will go through a check list where he/she becomes aware of the importance of appropriate design and detailing solutions. In addition the user will have to consider the target service life as well as the consequences of non-performance in the design of a construction.

1. Introduction

This prototype guideline deals with wood in outdoor above ground applications, i.e. use class 3 according to EN 335 [1], focusing on cladding and decking, see Figure 1. The degradation mechanism considered is the risk for fungal decay. Two examples dealing with decking and cladding applications are presented in the Annex to this guideline. Background documentation for the guideline is presented in a separate publication [2].

Service life design is based on a clearly defined *limit state*, here corresponding to *onset of decay*, during a reference service life assumed to be 30 years. Onset of decay is defined as a state of fungal attack according to rating 1 in EN 252 [3]. Other types of limit states may be considered in the future, such as a certain extent of decay or other reference service lives.

The design condition on the engineering level is formulated in the following way

$$I_{Sd} = I_{Sk}\gamma_d \leq I_{Rd} \tag{1}$$

where I_{Sk} is a characteristic exposure index, I_{Rd} is a design resistance index and γ_d depends on consequence class. The consequence class refers to the expected consequences if the limit state is reached before the reference service life. If the condition in Eq. (1) is fulfilled, then the design is accepted, otherwise it is not accepted.

The definitions of I_{Sk} and I_{Rd} are based on the following reference situations

- Exposure situation: The exposure to outdoor temperature, relative humidity and rain of a horizontal member with no moisture traps, is used to define a basic exposure index depending on geographical location.
- Material: Norway spruce (*Picea abies*) sapwood, uncoated, corresponds to I_{Rd} = 1,0
- Consequence class 3 (most severe) corresponds to γ_d = 1,0

Since the reference exposure is a favourable design condition for avoiding decay, the expsoure normally gets worse when accounting for moisture traps and various design details. This is considered by various exposure factors described in Section 3 below.

Figure 1. Design involving cladding and decking.

The design of a certain detail is made in the following steps:

1. Choose consequence class to determine γ_d
2. Determine a base value I_{S0} for the exposure index depending on the geographical location of interest
3. Find a correction factor for the exposure index to account for the local climate conditions (meso-/micro climate). Factors of importance are orientation, overall geometry of the structure, nature of the surroundings
4. Find appropriate correction factors for

    a) Sheltering conditions
    b) Distance from ground
    c) Detailed design of the wood component considered

Steps 2-4 give a characteristic value I_{Sk} for the exposure index

5. Choose material to determine a design value I_{Rd} for the resistance index
6. Check performance by the condition

$$I_{Sd} = \gamma_d \cdot I_{Sk} \leq I_{Rd}$$

7. If non-performance, change inputs in some or all of steps 2, 3, 4 and 5.

Factors influencing exposure and resistance are described in the following sections.

2. Consequence class

The consequence class depends on the severity of consequences in case of non-performance and is described by the factor γ_d as shown in Table 1.

Table 1. Safety factor γ_d as a function of consequence class

Consequence class	γ_d
1 Small (e.g. cases where it may be acceptable to replace a limited number of elements in a structure if decay occurs)	0,8
2 Medium (e.g. cases where the expected consequences are of significant economic and practical nature)	0,9
3 High (e.g. wood elements in load-bearing structures where failure may imply risk for humans)	1

3. Exposure index I_{Sk}

3.1 General

The exposure index I_{sk} shall be conceived as a “characteristic (safe) value” accounting for uncertainties. The exposure index is assumed to depend on

- Geographical location determining global climate
- Local climate conditions
- The degree of sheltering
- Distance from the ground
- Detailed design of the wood component
- Use and maintenance of coatings

The exposure index is determined by

$$I_{Sk} = k_{s1} \cdot k_{s2} \cdot k_{s3} \cdot k_{s4} \cdot I_{S0} \cdot c_a \tag{2}$$

where

I_{S0} = basic exposure index depending on geographical location/global climate
k_{s1} = factor describing the effect of local climate conditions (meso-climate)
k_{s2} = factor describing the effect of sheltering
k_{s3} = factor describing the effect of distance from ground
k_{s4} = factor describing the effect of detailed design
c_a = calibration factor to be determined by reality checks and expert input

The exposure index intends to describe the severity in terms of combined moisture and temperature conditions favourable for development of decay fungi.

3.2 Basic exposure index I_{S0}

The basic climate exposure index I_{S0} is a function of geographical location and describes the relative climate effect on a horizontal board of spruce sapwood (exposed to rain but without moisture traps). The exposure valid at one specific site, Helsinki, is chosen as reference, and I_{S0} = 1,0 at this site.

For other sites the (relative) base value of the exposure has been estimated with the help of the performance model described in [2]. The performance model (in the form of dose-response relationship) describes the combined effect of moisture content, temperature and the variation in time of these parameters on the potential for decay fungi to germinate and grow. Values for a number of European sites are shown in Figure 2. Table 2 gives these estimates on the European level evaluated with performance models, taking into account the combined effect of moisture content and temperature and where the moisture content includes the effect of rain. The macroclimate at different sites is based on the software Meteonorm [4,5]. The underlying dose-response model is partly based on Brischke *et al* [6]. The results have been partly verified against another model [7].

Table 2. Basic exposure index for different climate zones at altitudes lower than 500 m above sea level. For altitudes above 500 m, reduce factor by 0,3.

Climate Zones	I_{S0}	**Description**
Continental Europe	1,4	All Europe except Nordic, Atlantic and Mediterranean zones
Nordic climate zone	1,0	Northern Europe
Atlantic climate zones: • South of latitude 50° • Latitude 50-55° • North of latitude 55°	 2,0 1,7 1,4	Coastal regions, higher values in southern parts, lower in northern parts
Mediterranean climate zone	1,5	Mediterranean regions south of the Alps

Figure 2. Relative climate exposure for sites in Europe. The results are based on reference [2].

The climate characterization for the whole Europe shown in Table 2 is basic and approximate. A more detailed mapping on a national level should be made with the same methodology, which is presented in the background document [2]. A more precise characterization for a given location can also be made by using climate data from Meteonorm as input evaluating the dose according to the method described in [2].

3.3 Local conditions

This part describes the effect of meso-climate conditions and is a function of land topography, adjacent buildings and distance from the sea. The local conditions are described in terms of four classes as presented in Table 3. The factor k_{s1} is valid for wood facing the dominating wind direction, since this case gives the most severe exposure. Adjustments for less exposed directions are not made, because the design of e.g. cladding typically does not vary between different walls for the same building.

Table 3. Definition of local conditions

Rating	**Description**	k_{s1}
Light	Local conditions have little impact on performance as the three features all offer sheltering (i) land topography (ii) local buildings (iii) >5 km from the sea (so no maritime effect).*	0,8
Medium	Local conditions have some impact on performance as one of the three features does not offer sheltering (i) land topography (ii) local buildings (iii) >5 km from the sea (so no maritime effect).	1,0
Heavy	Local conditions have an impact on performance as two of the three features do not offer sheltering (i) land topography (ii) local buildings (iii) >5 km from the sea (so no maritime effect).	1,2
Severe	Local conditions have a significant impact on performance as the three features do not offer sheltering (i) land topography (ii) local buildings (iii) >5 km from the sea (so no maritime effect).**	1,4

* e.g. building is sheltered by hills and neighbouring buildings and is inland.

** e.g. building is on a flat plain, with no nearby buildings and less than 1 km from the sea.

3.4 Degree of sheltering and distance from ground

The sheltering from eaves is described by a factor k_{s2}, which is a function of the ratio of eave overhang *e* relative to the position *d* of the detail under consideration, see Figure 3. The sheltering effect can be used for both decking and cladding. Similarly, the effect of distance from ground is described by a factor k_{s3}, see Figure 3. Values for coefficients k_{s2} and k_{s3} are given in Tables 4 and 5.

Table 4. Effect of sheltering from eave overhang.

Sheltering: eave to detail position ratio e/d (see Figure 3)	k_{s2}
e>0,5d	0,7
e= 0,15d-0,5d	0,85
e<0,15 d (directly exposed to rain)	1,0

Table 5. Effect of distance from the ground.

Distance from ground	k_{s3}
> 300 mm	1,0
100 – 300 mm	1,5
< 100 mm	2,0

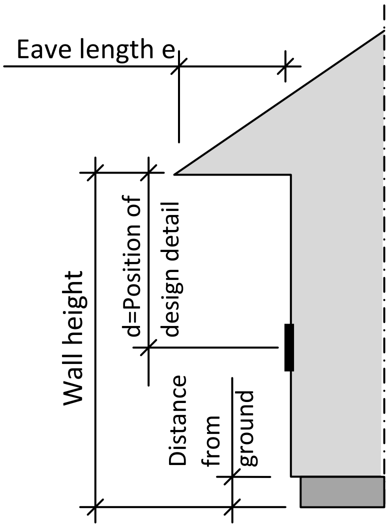


Figure 3. Illustration of effect of eave overhang and definition of distance from ground.

3.5 Detail design

3.5.1 General

This part considers the microclimate conditions as influenced by the detailed design. Different details are assumed to be allocated to 5 different ratings according to Table 6. This table describes the rating in generic terms, and is illustrated below with separate interpretations for decking and cladding.

Table 6. Rating of design details.

Rating	Description
1. Excellent	Excellent design with features to maximize water shedding and ability to dry when wet
2. Good	Good design with features to provide water shedding and ability to dry when wet (corresponds to the reference of a horizontal board without possibility of moisture trapping)
3. Medium	Design with a limited probability of water trapping and with some ability to dry when wet
4. Fair	Design with medium probability of water trapping and limited ability to dry when wet
5. Poor	Design with high risk of water trapping and very limited ability to dry when wet

3.5.2 Rating of details for decking

As an aid to determine the design rating, common details related to decking are given in Table 7. Illustration of the different types of details given in Table 7 can be found in Figure A1 in the Annex.

Conventional coating systems used for decking (e.g. oil systems) do not affect risk of decay significantly. Therefore, coating has not been considered relevant to the detail design of decking.

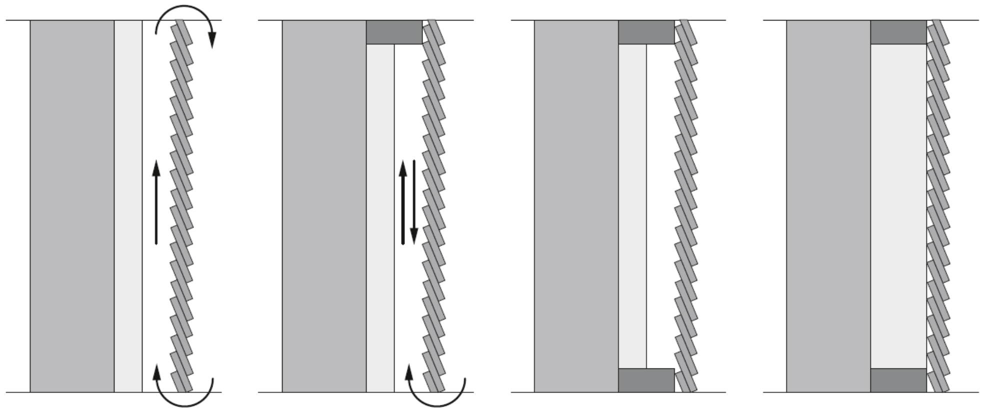
Table 7. Rating of details for decking.

Rating	Details	k_{s4}
1. Excellent	Vertical wood element free to dry on all sides	0,9
2. Good	Horizontal board free to dry on all sides (e.g. with sufficient gaps between boards in the deck)*	1,0
3. Medium	Contact area side grain to side grain with sufficient gap if kept clean from dirt*	1,2
4. Fair	Horizontal and vertical contact area side grain to side grain without designed gap or with too narrow a gap * Horizontal boards near end grain	1,4
5. Poor	Horizontal and vertical contact area end grain to side grain as well as contact end grain to end grain	1,6

* The effect of gap is related to the ability to dry out when wet as well as providing space for moisture induced swelling/shrinkage of the wood perpendicular to grain. There is no clear agreement between existing guidelines in different countries how large the gap should be to be "sufficient". Advice is normally given as absolute numbers in mm and also in % of panel width. A 'sufficient' size is typically 5-8 mm.

3.5.3 Rating of details for cladding

The rating of details for cladding is given in Table 8. This classification is based either on ventilation of the back of the cladding or the degree of protection of wood end grain. The worst classification depending on either of these two features is decisive for choosing the detail design factor.



fully ventilated limited ventilation not ventilated with air space not ventilated without air space

Figure 4. Categories of ventilation of the back of the cladding [8].

Ventilation of the back of the cladding depends on design of the exterior wall layers, and the four categories included in Table 8 are shown and explained in Figure 4. Full ventilation is valid when ventilation gaps are present at the bottom and the top of the cladding whereas the absence of ventilation gaps reduces the ventilation of the back side. For non-ventilated cladding the presence of an air space between the cladding and the outermost wall material (e.g. heat insulation) is decisive to distinguish the two categories.

For the quality of end grain protection it is decisive if the end grain is protected by construction elements or if it is open, whether or not a gap (> 1 cm) is constructed at the end grain of panels and whether or not the end grain is sealed with low water permeability sealant.

Ventilation at the back of the cladding and end grain protection are the two major factors. Further recommendations of best practice guidance documents should be respected but they usually have less dominant impact on the risk of decay.

Coatings can have a positive effect to reduce the exposure of the wood provided that

- The coating system is checked and maintained regularly
- The coating system used is of the type that the risk for additional moisture trapping is limited, i.e. it is sufficiently permeable for water vapour (s_d-value ≤ 1 m)
- Suitable board profiles with rounded edges (radius min 2,5 mm) are used for coated wood parts
- Coating application is carried out according to manufacturers' specifications, early after machining the wood surface and shortly after installation of the cladding.

Table 8. Ratings of details for cladding (vertical wood members) depending on ventilation (a) or end grain protection (b). The worst rating of (a) and (b) determines the overall rating.

Rating	**a) Ventilation**	**b) End grain protection**	**Uncoated**	**Coated**
			k_{s4}	k_{s4}
1. Excellent	fully ventilated	with gap and sealed or end grain covered	0,8	0,5
2. Good	limited ventilation	with gap unsealed	0,9	0,6
3. Medium	not ventilated with air space		1,1	0,9
4. Fair		without gap but sealed	1,3	1,1
5. Poor	not ventilated without air space	without gap and unsealed	1,5	1,5

4. Design value I_{Rd} for resistance factor of the material

The design resistance index I_{Rd} for selected wood materials is determined on the basis of resistance class according to Table 9. This is a simplified first step for a material resistance classification based on a balanced *expert judgment of moisture dynamics and durability class*. The resistance class term is based on a combination of durability class data according to EN 350-2 [9], test data, practical experience of treatability and permeability for wood species as well as experience from use in practice. Biological durability is the key factor determining performance for wood in different use classes. The robust laboratory and field test methods that exist make it possible to assign a durability rating to timber linked to the intended use class according to EN 335 [1], assuming a worst case scenario. Other factors, see Section 3 above, determine the likelihood of the worst case scenario occurring in practice.

The natural durability of wood is classified into durability classes as described in EN 350-1 [9] and presented as durability classes for heartwood of timber species in EN 350-2 [9]. Durability class is a classification on five levels from non-durable to very durable. This is based on decades of data from ground contact field trials for use class 4. The natural durability for a wood species can vary widely.

Table 9. Resistance rating of selected wood materials and corresponding design resistance index I_{Rd}.

Material resistance class	**Examples of wood materials***	I_{Rd}
A	Heartwood of very durable hardwoods, e.g. afzelia, robinia (durability class 1) Preservative-treated sapwood, industrially processed to meet requirements of use class 3	10,0
B	Heartwood of durable wood species e.g. sweet chestnut and western red cedar (durability class 2)	5,0
C	Heartwood of moderately and slightly durable wood species e.g. douglas fir, larch and Scots pine (durability classes 3 and 4)	2,0
D	Slightly durable wood species having low water permeability (e.g. Norway spruce)	1,0
E	Sapwood of all wood species (and where sapwood content in the untreated product is high)	0,7

* For the majority of wood materials there is variability in material resistance. The material resistance classification should defer to local knowledge based on experience of performance of cladding and decking and where this is not available field test data and then laboratory test data. It is possible that a classification with different design resistance indices may need to be adopted for specific regions or countries, based on practical experience e.g. from the use of a material in that region.

For out of ground contact (e.g. exterior wood cladding) the challenge is to translate durability class from use class 4 to use class 3. In EN 350-1 [9] the term “markedly different” is used to describe the additional benefits of low permeability on the performance of wood out of ground contact. Expert advice is recommended for assigning the material resistance class for wood materials such as:

Preservative treated wood is often a combination of mixed treated heartwood and sapwood. The treated sapwood should be thoroughly treated and enhanced to durability class 1. The heartwood is more resistant to treatment and the enhancement of the heartwood can be considered to be slightly higher than the natural durability class of the heartwood for the species (EN 350-2). Therefore, for preservative treated decking it may be more sensible to take a mid-point between the resistance class of the treated sapwood and the treated heartwood. E.g. for pine heartwood treated (resistance class

C) and pine sapwood treated (resistance class A) the overall batch of preservative treated wood should then be classified as resistance class B.

For ***untreated wood*** if there is a mixture of heartwood and sapwood present in the wood species then the material resistance can either be classified as the mid-point between the class of the heartwood (resistance class A to D) and the sapwood (resistance class E). If this risk is not acceptable then the material resistance class should be taken as the worse case (E), the least resistant component of the overall material.

The durability of ***modified wood***, e.g. acetylated, furfurylated and thermally modified, is specific to the technologies employed and may vary between specifications for the different materials. Expert advice is also recommended for assigning the material resistance class for modified wood.

5. Calibration factor

All elements in the design system are expressed in relative terms. The calibration factor has been determined to c_a =1,0, which means that the system will give reasonable results in accordance with generally accepted experience. This is documented in [2] by verifications of the guideline against a number of reality checks with good results. There are however always uncertainties in this kind of design given the high variability for both exposure and resistance. The user may increase the safety of the design by choosing a higher value for the calibration factor.

6. Summary and conclusions

Examples illustrating the application of the guideline are given in the Annex. A software tool, based on Excel, is available to facilitate application of the guideline [10].

Background documentation is presented in [2] on how the values have been determined from experimental data and physical models. Where necessary, input based on experience and expert opinions has been used for some of the elements in the design guideline. The guideline can be seen as a first attempt to formulate a quantitative type of tool in this field, and it could be continuously improved in the future when new research results and data become available.

It is not possible to quantify all the factors in this design method on a scientific basis. But the characteristic exposure index for the reference situation has been estimated by using time series of climate data at different geographical locations together with performance models for onset of decay. Attempts have been made to make a relevant assessment of variability to achieve appropriate safety margins.

The system gives the designer a method to consider climate conditions at the actual geographical site and also to some extent local exposure conditions. A very simplified way to account for the effect of coatings on exposure has also been introduced.

One advantage with the system is that the user is encouraged to think about the consequences of violation of the limit state. Another advantage is that in applying the method the designers will go through a check list where they will become aware of the importance of appropriate detailing solutions. Even if the factors describing the effects of detailing, contact zones, coating systems and maintenance are difficult to quantify in a reliable way the use of the method will generally lead to better solutions.

Many users have limited understanding of the concept of durability by design. Direct descriptions of so called best practice solutions are quite difficult to use because the designer does not understand what happens if the solution is modified, which is most often necessary.

The resistance class describing effect of wood material selection is estimated by relative comparison between the decay resistance of different materials, supported by subjective expert opinions. An important background are the test results presented by Brischke [6].

The design system as a whole has also been tested with good results in a number of "reality checks" from real buildings, to see if the output from the design method agrees with known experience and results from practice investigated in a separate part of project WoodExter. These reality checks are reported in reference [2].

7. References

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[10] Excel tool, see www.kstr.lth.se.

Annex: Application examples

Example 1: Design of decking

Based on the design guideline the decking shown in Figure A1 will be checked. Details A-E are identified and evaluated.

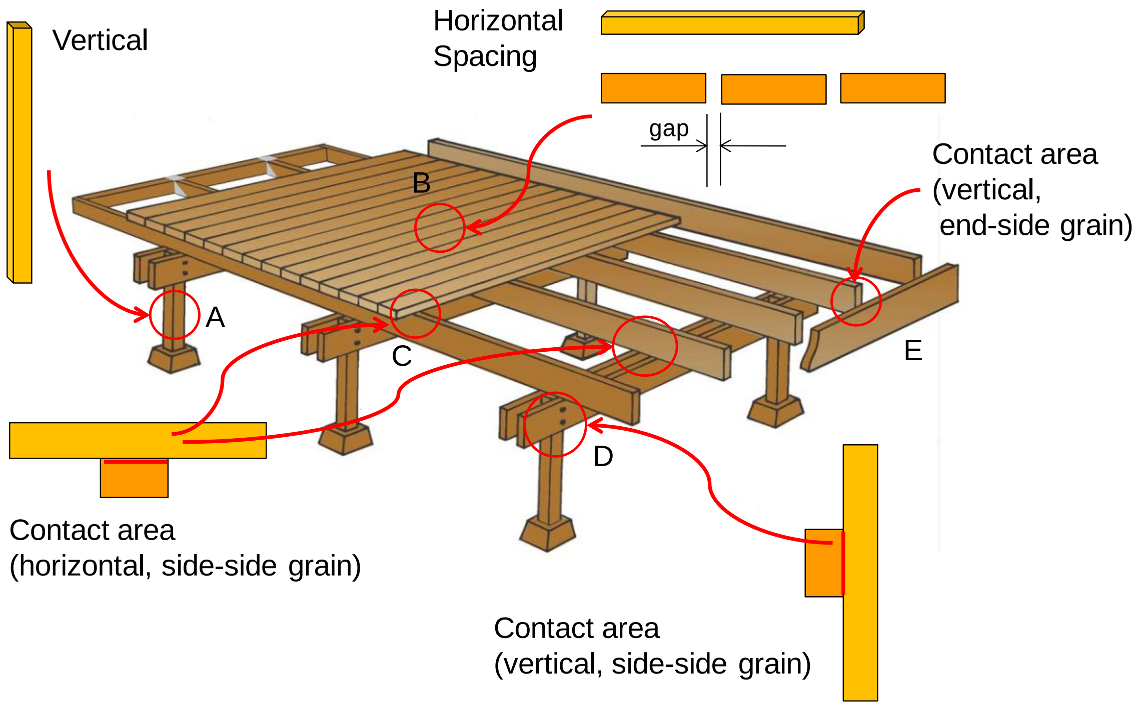

Figure A1. Decking with design details. Courtesy: Timber Decking Association, UK.

Consequence class 2 is assumed for details A, C, D and E. γ_d=0,9

Consequence class 1 is assumed for decking boards (can be easily replaced) γ_d=0,8

Exposure index

Location Berlin I_{So}=1,26 (Figure. 2)

Local conditions, rating medium k_{s1} = 1,0 (Table 3)

Sheltering: Exposed to rain k_{s2} = 1,0 (Table 4)

Coating: No coating

The different details are described in Table A1.

Calibration factor c_a = 1,0

Table A1. Calculation of exposure index for the decking details shown in Figure A1.

Detail	$c_a \cdot k_{s1} k_{s2} \cdot I_{so}$	Distance from ground, mm	k_{s3} Table 4	Detail rating Table 7	k_{s4}	I_{sk}	γ_d	$I_{sd} = \gamma_d I_{sk}$
A	1,26	200	1,5	1	0,9	1,70	0,9	1,53
B	1,26	>300	1,0	2	1,0	1,26	0.8	1,01
C	1,26	>300	1,0	4	1,4	1,76	0,9	1,59
D	1,26	>300	1,0	4	1,4	1,76	0,9	1,59
E	1,26	>300	1,0	5	1,6	2,01	0,9	1,81

Resistance index (for all details)

Material: larch (heartwood, resistance class C) I_{Rd}=2,0

Verification of performance

The design criterion

$$I_{Sd} \leq I_{Rd}$$

is therefore fulfilled for the details considered in the decking. The margin is however narrow especially for detail E. It is also very important that the material in the decking does not contain sapwood. If that cannot be guaranteed the value I_{Rd} = 1,5 should be taken (average between class C and D). In that case the design is not acceptable.

Example 2: Design of cladding

Two details are identified to demonstrate the guideline for cladding, see Figure A2. It is assumed that the coating is correctly maintained on the building and fulfills the coating requirements specified in section 3.5.3.

Consequence class 2 γ_d=0,9

Exposure index

Location Växjö, Sweden I_{S0}=1,22 (calculated from Meteonorm)

Local conditions, medium rating k_{s1} = 1,0

Detail A (cover boarding with rib flanges)

Sheltering: Eave length 0,5m, detail position 6 m, e=0,083·d<0,15 d k_{s2}=1,0 (Table 4)

Distance from ground: >300 mm k_{s3}=1,0 (Table 5)

Boards with designed fully ventilated cavity behind boards, end grain with gap unsealed and coating correctly maintained (rating good) k_{s4} = 0,6 (Table 8)

This gives (Eq. 2 with c_a = 1,0)

I_{sk} = 1,0·1,0·1,0·0,6·1,22·1,0= 0,73 and

I_{sd}= $\gamma_d I_{sk}$ = 0,9·0,73 = **0,66**

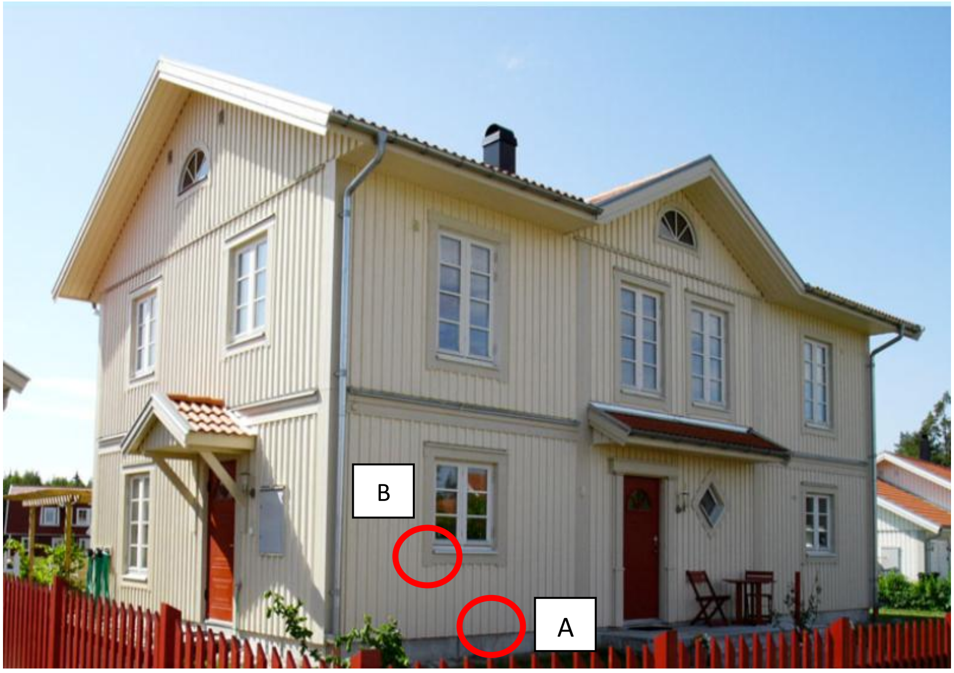

Figure A2. Cladding with design details.

<u>Detail B (casing for window, end to side grain)</u>

Sheltering:

Eave length 0,5m, detail position 5 m, e=0,1·d — k_{s2}=1,0 (Table 4)

Distance from ground: >300 mm — k_{s3}=1,0 (Table 5)

End grain protection: Vertical end to side grain, without gap but sealed, coating with correct maintenance k_{s4}=0,9 (Table 8, rating medium).

This gives (Eq. 2 with c_a = 1,0)

I_{sk} = 1,0·1,0·1,0·0,9·1,22·1,0= 1,10 and

I_{sd}= $\gamma_d I_{sk}$ = 0,9·1,1 = **0,99**

<u>Resistance index (for all details)</u>

Material: spruce. From Table 9: I_{Rd} = **1,0**

Thus it is safe to use spruce for the general cladding area, but the detail for the casing around the window has a low safety margin.

Service life of wood in outdoor above ground applications
Engineering design guideline

This engineering design guideline is intended for wood in outdoor above ground applications, i.e. use class 3 according to EN 335. It is based on a prescribed limit state for onset of decay during a reference service life of 30 years. Onset of decay is defined as a state of fungal attack according to rating 1 in EN 252. The approach is to determine the climate exposure as a function of geographical location, local exposure conditions, sheltering, distance to ground and design of details. The exposure is then compared with the material resistance defined in five classes and the design output is either OK or NOT OK. The present version of the guideline covers applications for decking and cladding. The data included in the guideline have partly been derived with the help of a dose-response model for decay, which was used to derive relative measures of decay risk between different locations and between different detail solutions. Other elements in the guideline have been estimated in a semi-subjective manner based on expert opinions as well as experience from field testing. The guideline has been verified by a number of reality checks of real buildings, which show that the output from the tool agrees well with documented experience. The guideline has also been presented in a computerized Excel format, which makes practical use convenient. It is believed that many building professionals will appreciate a tool within the area of wood durability which has an approach similar to other design tasks in building projects. An advantage is that in applying the method the designer will go through a check list where he/she becomes aware of the importance of appropriate detailing solutions. In addition the user will have to consider the target service life as well as the consequences of non-performance in the design of a construction.