

■ Recommendations for assessing workmanship quality

Basic principles of exposed concrete evaluation

Only an experienced concrete expert can assess whether a regular type of exposed concrete has been used or whether the finish matches the quality the client can expect. Terms such as fitness for purpose, value and warranted characteristics are no longer used. According to the German regulations for contracts and execution of construction works (VOB) the assessment is based on the

agreed quality and the expected fitness for use. The requirements for a clear and exhaustive description of the expected workmanship are crucial for being able to substantiate any deficiencies via an actual versus target comparison if necessary. This article describes an assessment scheme for exposed concrete deficiencies with regard to the validity function.

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One of the sources that have led to a discussion of the subject of exposed concrete assessment is section 7.4.3 of the German BDZ code of practice on exposed concrete. If remedial work leads to a deterioration of the visual impression of an exposed concrete surface the remaining deviation has to be assessed.

Visual flaws can have many forms, such as colour and structure deviations, soiling, dimensional and fitting inaccuracies, unevenness, faults such as spalling, chips, cracks and scratches.

Anything that cannot be measured or weighed, is not contained in a DIN standard and has not been agreed clearly and exhaustively between the client and the contractor has to be assessed subjectively. Each exposed surface has a unique appearance due to permissible dimensional tolerances and weather conditions.

Individual aspects are inspected and assessed based on rules, taking into account the fact that certain irregularities are unavoidable in practice. Various codes of practice, guidelines and technical regulations containing recommendations and guidance relating to concrete are available. The term "rule" is based on the Latin word *regula* = guideline. Ultimately it is immaterial whether the term rule, regulation or standard is used. They all cover the same basic idea, i.e. specification of generally binding rules of conduct and workmanship.

Exposed concrete classes, weighting

The exposed concrete code of practice distinguishes four exposed concrete classes for visible surfaces (SB 1-4). The

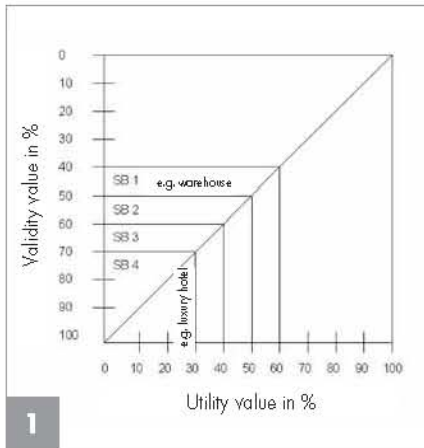
aim is to retain an element of flexibility for component or room assessment. For example, an ordinary basement room will generally have a lower weighting than a living space or a hotel foyer (Table 1).

Table 1: Weighting of utility and prestige function

Exposed concrete class	Utility function in %	Utility function in %
SB1	60	40
SB2	50	50
SB3	40	60
SB4	30	70

Tabelle 2: Exposed concrete classes

SB1	Low design requirements, e.g. for basement areas or areas with predominantly industrial utilisation	
SB2	Normal design requirements, e.g. for staircases	
SB3	More stringent design requirements, e.g. for building façades	
SB4	Particularly stringent design requirements, e.g. for prestigious building components	



1 Weighting of exposed concrete classes

When assessing visible surfaces special attention is required with regard to the weighting of the texture/joints, porosity, colour uniformity, evenness and construction and formwork joints. The individual weightings will depend on viewing distance, light conditions, components

(e.g. precast elements, in-situ concrete etc.), utilisation and other factors. The author of this article is currently undertaking detailed studies on the issue of weighting, the results of which will be published in due course.

Porosity, for example, may be less significant at a larger distance from the façade, e.g. from across a front garden or a lawn in front of a building, than in a hotel foyer with the observer standing very close to the surface. Means of assessing porosity include digital photographs and postprocessing using special image processing software. Evenness of an exposed concrete surface may be less significant for precast concrete elements than for in-situ concrete surfaces, since large surfaces are repeatedly subdivided into smaller surfaces (precast elements), thereby concealing any potential unevenness.

Viewing distance

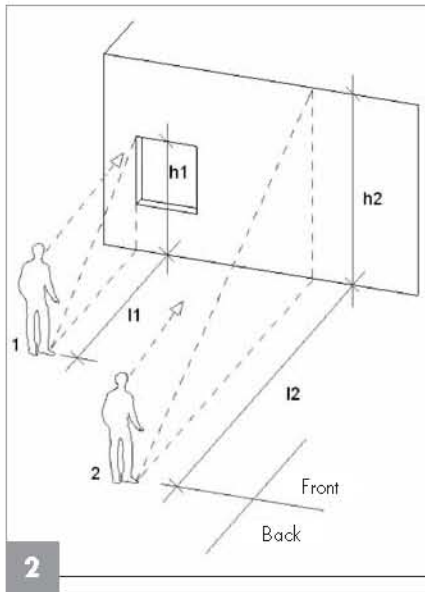
Visible surfaces should generally be inspected from a distance corresponding

to common utilisation. The usual viewing distance is comparable to viewing a painting. Smaller paintings require a smaller viewing distance, larger paintings a larger distance. Accordingly, the overall appearance of a façade is not assessed from a scaffold, but as follows: eaves height = viewing distance or ground floor-window: height = distance.



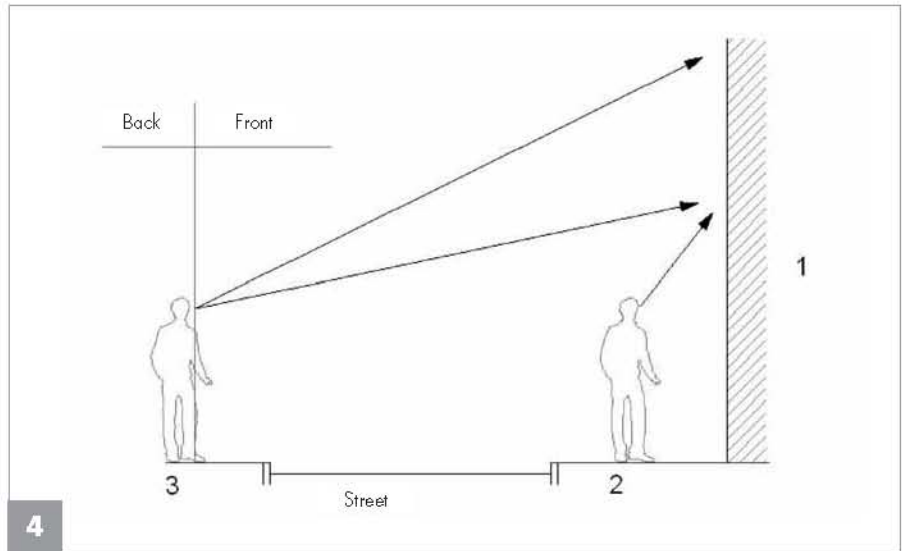
Dipl.-Ing. Joachim Schulz, publicly appointed and sworn expert for exposed concrete, author of: "Sichtbeton-Planung, Sichtbeton-Mängel und Architektur der Bauschäden" (exposed concrete design, exposed concrete deficiencies, and architecture of structural damage - in German), initiator of the Exposed Concrete Forum www.Sichtbeton-Forum.de

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2 Viewing distance and overall appearance

The standard utilisation does not always have to match the actual utilisation. If possible, the assessment distance should not be less than 1 m. While binoculars may be useful for determining the cause of a defect, they do not represent the usual viewing distance. Any inspection for defects should be carried out perpendicular to the surface, if possible. If a front garden or lawn (e.g. landscaped yard) that is usually not walked on is present, the viewing distance should be adapted accordingly.



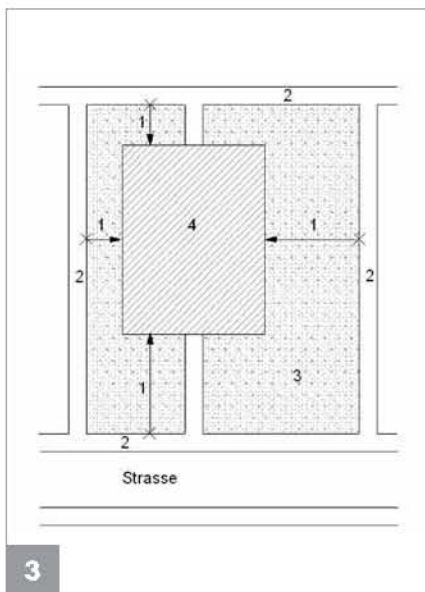
4 Overall façade appearance from the pavement on the opposite side of the road compared with a viewpoint directly in front of the object.

Light source

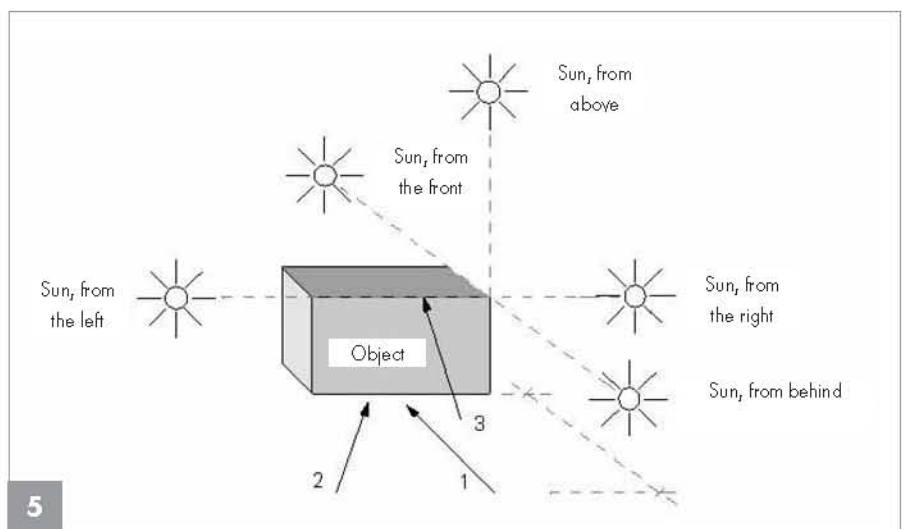
Inspections should be carried out under "normal" daylight conditions. Any irregularities that are only visible for a limited period of time due to lateral incidence of natural sunlight should generally be accepted. Artificial sidelighting is not acceptable for the purpose of assessment. The electrical design (halogen ceiling or wall spotlights) therefore requires special consideration in the context of exposed concrete design. Artificial sidelighting represents a more stringent requirement and should be agreed separately.

Specification of the light source position is particularly important in order to make the "visual assessment" (appraisal) reproducible. This can only be achieved if the assessment is based on the same conditions (in this case the light source). Light sources with different angles of incidence relative to the object may lead to different findings/results.

Sunshine from above highlights projections and recesses within the façade more clearly than light from the back. Sunshine from the side makes horizontal irregularities stand out more than in a shaded façade.



3 Viewing distance and overall façade appearance



Sun positions

- Point 1: Usual perpendicular observation with viewing distance "l"
- Point 2: Non-standard observation from the side
- Point 3: Non-standard observation directly in front of the object from below

de. This kind of information should be documented in a checklist when the condition of the object is determined.

Target condition

Extract from the exposed concrete code of practice: "...compiled recommendations do not represent an absolute parameter. The work should be specified clearly, put out for tender properly, and carried out by qualified contractors."

Clear statements should be based on DIN 820 and the following modal verbs. Exposed concrete must be defined (i.e. described) based on a requirements profile: A clear and exhaustive invitation to tender ("designed with words"), working drawings according to DIN 1356-1, and a definition of exposed concrete are therefore essential.

Table 3: Modal verbs according to DIN 820-T23

Modal verbs	Meaning		Reasons for selecting the modal verb (examples)
must	Order	Unconditional strongly requesting	External constraint such as legal provision, safety requirement, contract, or internal constraint such as uniformity or consistency requirement
must not	Prohibition		
should	Rule	conditional strongly requesting	Voluntary obligation based on arrangement or agreement. Any deviation must be justified.
should not			
may	Permission	exempting	In certain cases deviations from the order, prohibition or rule may be acceptable, e.g. an equivalent solution may be chosen
does not have to do not have to			

Table 4: Requirements profile, schematic

Exposed concrete class	SB1, SB2, SB3, SB4
Formwork classes	smooth, textured
Concrete composition	e.g. coloured concrete
Tolerances	evenness
Joint arrangement	Elevation drawings
Anchor holes	closure type
Mounting points	nail and screw holes
Slab joints	closure, edging
Construction joints	time and concreting options
Porosity	porosity classes, shrinkage cavities
Complaints	repair limits
Contract	"tolerate", arbitrator's expert opinion





Practical examples

Actual condition

Individual criteria and technical faults and deficiencies are based on planning, material, formwork, release agent, reinforcement, and concrete processing. Further information about the individual criteria relating to a utility function assessment can be found in the book on exposed concrete deficiencies [2], where exposed concrete deficiencies are classified based on expert criteria, and recommendations for remedial work and concrete repair are provided.

Overall appearance/ visible surface assessment

The object should be viewed from a "common" distance. Any visual impairment should be documented in an easily reproducible manner, e.g. description of faults such as "meshed cracks"; viewing distance; light source; photographs. General statements such as "The façade has cracks" are not sufficient. Precise information about the location of the defect, any crack pattern (diagram), crack width, crack depth etc. must be provided.

Façade soiling

If it is known that a lack of certain design features (e.g. gradient) will lead to deviations and damage the planner must respond accordingly. Soiling must not be treated as equivalent to "patina". Soiling of the façade surface should not be concealed through structuring, but avoided through appropriate design such as gradient. Structural requirements have priority over design aspects when it comes to designing connections and finishes. This often leads to conflicts between architects

and structural engineers. Nature often makes it quite obvious what is wrong or right! The exposed concrete code of practice therefore includes the following statement: "For exposed surfaces that are subject to weathering controlled rainwater drainage must be provided in order to prevent soiling of the concrete surface."

Uncontrolled soiling of the façade can be prevented in the long run through proper design of structural details. Design companies have to pay special attention to proper construction. But who teaches it? The exposed concrete atlas offers a wide range of detailing suggestions. Meanwhile there are court judgments that regard façade soiling as a flaw. The author of this article is currently undertaking studies on the issue of façade soiling, the results of which will be published in the near future.

Actual versus target assessment

The façade is the "face of the building". The surface is described through prestige functions (visual function). The function is satisfied if the overall visual appearance of the façade or the surface matches the design intent specified in the building design and detailed in the construction documentation and specification. This can be achieved if the individual sections are free from unintentional irregularities in terms of colour, structure and shape. The requirement of undisturbed appearance applies to all surfaces, irrespective of the building material, although certain allowances have to be made for exposed concrete. Since variations in brightness (colour shades) or colour of the concrete may not always be intended by the plan-

ner, the practical limitations must be known and taken into account in the specification. Precise specification of the acceptable tolerance based on a on-site sample surface is advisable. Reference to an existing building is helpful but not sufficient for calculating any reduction.

References

- [1] Schulz, Joachim: Sichtbeton-Planung, Vieweg Verlag / GWV-Fachverlage GmbH, 3. Auflage, Wiesbaden 2006
- [2] Schulz, Joachim: Sichtbeton-Mängel, Vieweg Verlag / GWV-Fachverlage GmbH, 2. Auflage, Wiesbaden 2004

