

Focus on STRUCTURAL engineering

Performance-based building regulations and their usage in South Africa

A building code or regulation is a document used by a local, state or national government body to control building practice through a set of statements of 'acceptable' minimum requirements of building performance. This is usually a legal document. Acceptable requirements are typically established on the basis of socio-political and/or community considerations. Building standards, on the other hand, are essentially technical documents that standardise, generally in terms of quality or performance, but sometimes in terms of size or procedure, some activity in relation to building and construction. They serve as a form of benchmark.

Building regulatory systems may be described as being:

- *Prescriptive*, in terms of which a collection of codes and standards are used to describe how buildings should be designed, built, protected and maintained with regard to the health and safety of the public
- *Functional*, in terms of which qualitative functional statements are made but no quantitative user or technical performance requirements are prescribed
- *Performance-based*, in which qualitative functional requirements are established; quantitative user and technical performance criteria are provided; and acceptable solutions and evaluation and design tools are offered.

In the prescriptive approach, the building parts are described, specified and procured, resulting in a building with a unique but implicit set of attributes. In the performance approach, the building attributes are described and specified, and many combinations of different building parts can be procured for which it can be demonstrated that the specified attributes will be satisfied.

The performance concept is driven by nominated requirements which are intended to satisfy a society's needs and expectations. Its key objective is to articulate societal needs and expectations, then properly capturing these requirements, translating them into required building attributes and performance criteria, and providing the means by which nominated performance requirements can be verified. Societal needs differ from one nation to another and can differ significantly within a nation, particularly where there are great disparities in incomes. It is well recognised that economic realities affect people's stated needs and expectations.

PERFORMANCE-BASED REGULATIONS

Performance-based building regulations have their origins in the Nordic five-level structure, which is illustrated in figure 1. The Nordic five-level structure consists of a hierarchy of five levels. Objectives or goals are located at level 1, that is, at the top. The objectives presented at this level represent broad statements of intent of what the building regulations

are intended to provide, for example the need to safeguard people and protect adjoining buildings and property. Other examples of objectives include health and accessibility.

Functional requirements, which set out how a building can be expected to satisfy objectives, may be found in the next level (level 2). Functional statements are requirements stated in qualitative terms that set out what is required without specifying the method of construction techniques, dimensions or materials to be used. These statements as such indicate what steps need to be taken to achieve stated objectives or community expectations.

Performance requirements are located at level 3. Performance requirements outline a quantitative level of performance which must be met by building materials, components, design factors and construction methods for a building to satisfy the relevant functional requirements and, in turn, the relevant objectives.

Performance requirements (ie quantitative performance criteria which enable functional requirements to be satisfied in relation to nominated values) cannot be formulated in isolation from the needs and expectations of the people whom the performance-based regulations are intended to serve. Accordingly, technical performance criteria need to be established and satisfied for a given user performance level, that is, for nominated performance parameters that are deemed acceptable to a particular category of user.

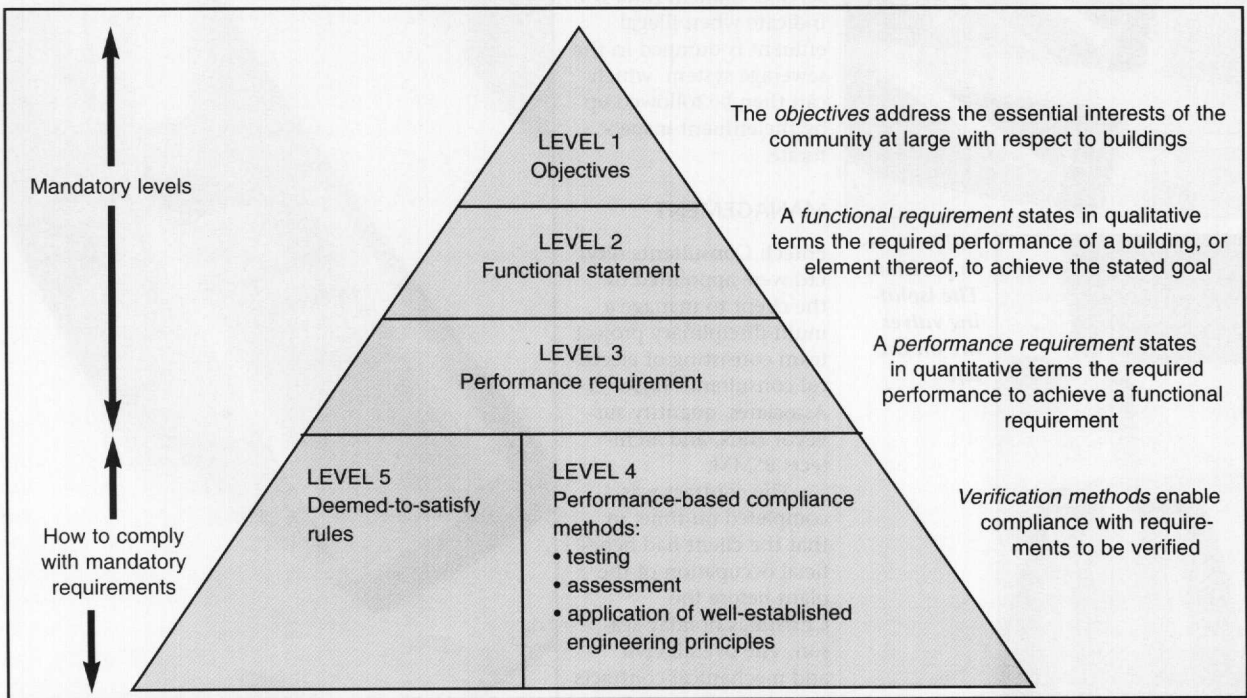


Figure 1 Nordic five-level structure for performance-based codes



Table 1 Principal differences between the two user performance levels

TECHNICAL ASPECT	DIFFERENCES BETWEEN USER PERFORMANCE LEVELS
Size and type of building	User performance level 1 buildings are restricted to those which have no basements, have floor areas of less than 80 m ² and have a maximum length between intersecting walls or members providing lateral support of 6,0 m
Maintenance cycles	Buildings built in terms of user performance level 1 may require more frequent maintenance
Earthquake	Nil
Windstorms	Nil
Deflection and deviation from the horizontal and vertical	User performance level 1 deflections and deviation from the horizontal and vertical are greater than those associated with user performance level 2 and may be visible/noticeable to a trained eye although structural performance and safety are not impaired
Expected damage in walls and floors	The degree of expected damage will generally be greater where user performance level 1 is selected; such damage will nevertheless be of a minor nature and be repairable during the course of normal redecoration
Behaviour in fire	Restrictions will be placed on the size and layout of the building in the case where user performance level 1 is selected
Severe condensation and consequential mould growth	No prohibition placed on the use of buildings with poor thermal performance in areas with high winter rainfall and humidity such as the Southern Cape Condensation Problem area, provided that it can be demonstrated that the building is upgradable to user performance level 2 without having to rebuild the structure
Attack by biological agents	Nil
Abrasion resistance	Nil
Rising damp	Nil
Resistance of walls and roofs to rain penetration	Minor ingress may be experienced in infrequent major storms but not to the extent that any permanent damage may be caused
Hail resistance	Where user performance level 1 is selected, elements other than normal glazing may be more susceptible to hail damage in severe hail storms
Resistance to local damage/soft body impact	The resistance to local damage when struck by sharp-edged objects and the ability to hold fittings and the impact resistance to soft-body impacts will be lower in the case of user performance level 1 than that for user performance level 2. The reduction in performance does not compromise the safety of the structure in any way under all normal circumstances of use
Accuracy of construction	Tolerances will be greater (ie relaxed) in user performance level 1 buildings

In developed countries, a single-user performance level is usually used to set technical performance criteria with a result that such performance levels are framed around low maintenance, no penetration of water into interiors, deflections which are not discernible, negligible levels of cracking, etc. However, where capital is scarce and labour is in abundance, as is the case in developing countries, more than one user performance level is required to establish technical performance levels to make buildings more affordable and to regulate indigenous construction. If this is not done, only buildings within the 'formal' sector can be regulated.

Levels 4 and 5 at the bottom contain the means by which performance requirements for a given technical and user performance level can be satisfied by analysis, testing, service experience or a combination thereof (level 4) and deemed-to-satisfy rules (level 5).

Deemed-to-satisfy design and construction rules typically include examples of materials, components, geometric configurations and construction methods, which if complied with, provide satisfactory evidence that the applicable performance requirements have been met. Such provisions are essentially prescriptive in that they explain step by

step what is necessary to demonstrate compliance. Put in another way, they are a recipe for minimum construction that satisfies all requirements and constitute one option for verifying that applicable performance requirements have been met. Unavoidably, deemed-to-satisfy provisions are conservative in their formulation and only cover the most common forms of construction.

On the other hand, assessments by competent persons can be applied to any form of construction to provide satisfactory evidence that a performance requirement is satisfied for the nominated performance requirements. Such assessments are likely to be less conservative. Competent persons can be either natural or juristic persons, eg registered engineers who have competence by virtue of their experience and training, or certification agencies such as Agrément South Africa that engage technical experts to evaluate building systems comprising materials and elements whose properties, characteristics and behaviour are not well known.

ISO REQUIREMENTS FOR PERFORMANCE-BASED STANDARDS

ISO 6240 (1980) (Performance Standards in Building Contents and Presentation)

requires that each performance requirement be defined in terms of a function which is to be fulfilled, together with the properties on which verification and assessment will be based, and that each requirement must have specified methods of assessment or verification of performance values, namely

- the means (measurement, calculation, test or method of examination) by which the achieved performance of the component or assembly will be assessed or verified, and
- the means of predicting the performance over time of the component or assembly

ISO 6241 (1984): 'Performance standards in building - Principles for their preparation and factors to be considered' suggests that the method of assessment or verification of each performance requirement may be made by means of a test, calculation or judgement.

THE PRESCRIPTIVE VERSUS THE PERFORMANCE APPROACH

The prescriptive approach only requires a simple check whether or not the product or design matches the deemed-to-satisfy provisions of the code. In the per-

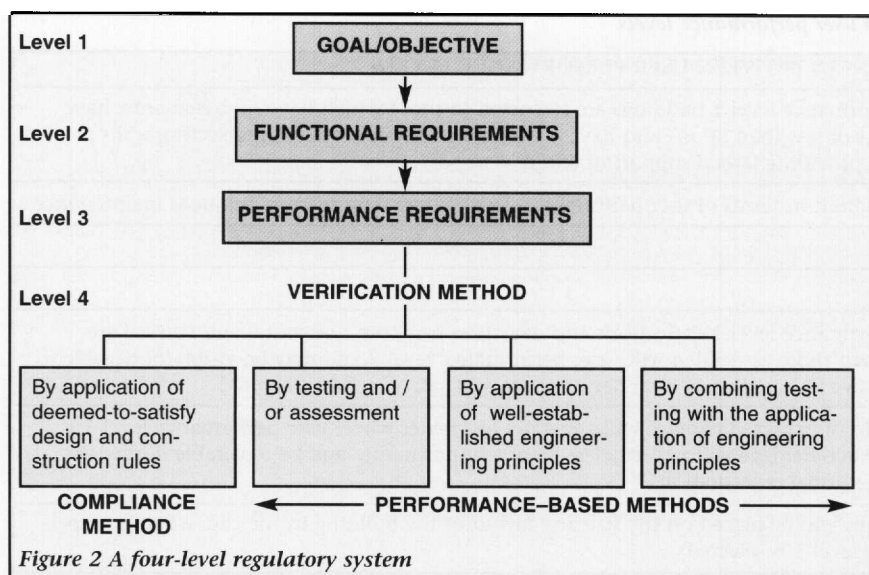


Figure 2 A four-level regulatory system

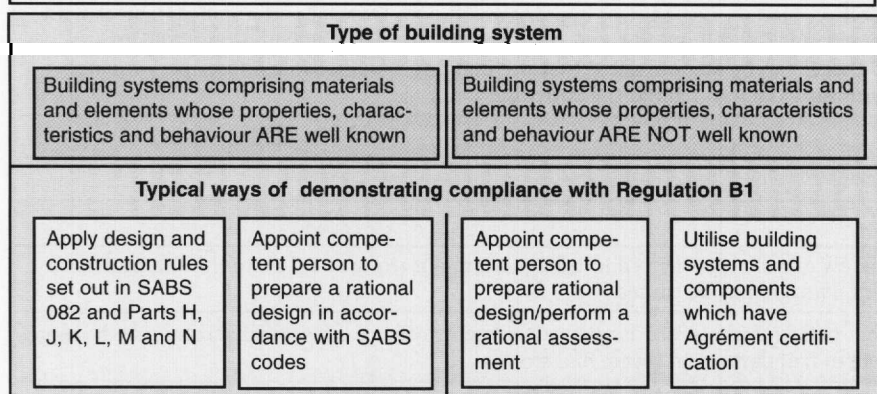


Figure 3 Ways in which an owner of a building may satisfy Regulation B1 (Structural Design)

formance approach, testing, calculation, or combined testing and calculation can evaluate proposed solutions. The prescriptive and performance-based solutions are intended to produce the same in-service performance as specified in the performance criteria. It is obvious that without acceptable performance evaluation tools and methods, the performance concept cannot be satisfactorily implemented properly.

INTERNATIONAL TRADE REQUIREMENTS

The major non-tariff trade barriers that inhibit building and construction trade are prescriptive or deemed-to-comply building codes and standards. To address this issue, the World Trade Organisation (WTO) has included Clause 2.8 of the Agreement on Trade Barriers to Trade (WTO 1997), which states that 'whenever appropriate, members shall specify technical regulations based on product requirements in terms of performance rather than design or descriptive characteristics'.

This clause in effect requires signatories to the WTO General Agreement on Tariffs and Trade (GATT) to use performance requirements in evaluating a product's fitness for purpose and in accepting new and/or innovative products in their markets. Performance-based building standards, that is, standards that describe the target performance rather than the solution (as is the case with deemed-to-

comply standards), free the building regulatory system from the above limitations.

SOUTH AFRICAN BUILDING REGULATIONS

The South African national building regulations are generally functional in nature but contain elements of performance-based regulations (eg Part K, 'Rain penetration requirements for external walls', Part P, 'Drainage, and Part T, 'Fire protection') and make provision for prescriptive-based requirements through deemed-to-satisfy requirements.

In South Africa, objectives (level 1) (see figure 1) are captured in section 24 of the Bill of Rights of the Constitution of South Africa (Act 108 of 1996). Functional statements (level 2) and some qualitative aspects of the performance requirements (level 3) are provided in the national building regulations issued in terms of the National Building Regulations and Building Standards Act (Act 49 of 1995). The current version of SABS 0400 (The application of the national building regulations, 1990) does not contain quantitative performance requirements (level 3) and only provides performance-based methods (level 4) and deemed-to-satisfy rules (level 5) for the design of elements.

SABS 0400 is currently being updated and revised to address these shortcomings and to provide for deemed-to-satisfy

construction rules. Two user performance levels are also being introduced in a limited number of building occupancies, as illustrated in table 1. The revised SABS 0400, when read in conjunction with the building regulations, will provide a performance-based four-level regulatory system for building control in South Africa, as set out in figure 2. The ways in which an owner will be able to satisfy the regulations relating to structural design are illustrated in figure 3.

COMPETENCE AND INTEGRITY

A standing committee on structural safety in the United Kingdom, established by the Health and Safety Executive, ICE and IStructE, is tasked with giving warnings where unacceptable risk is believed to exist. This committee aims to identify, in advance, trends in the construction industry that may have an adverse effect on structural safety. Two important findings of its thirteenth report are:

- The control of risks to structural safety depends primarily on the competence and integrity of individuals and organisations. The possibility that individuals or organisations might not be competent, or that their competence might be affected by commercial or other pressures is a risk to structural safety and needs to be controlled.
- The certification of structural safety-related work should be entrusted only to appropriately qualified and experienced engineers.

Performance-based building regulations require those persons who make determinations regarding compliance with functional regulations for specific performance requirements to have both integrity and competence. It is for this reason that most building regulatory systems require such person to be professionally registered with a statutory registration body and demonstrate their ability to make such determinations through their training and experience.

In South Africa, the tendency has been to confuse competency with professional registration. Professional registration is intended to manage integrity and to recognise the attainment of minimum standards of education and training and an ability to work independently. It does not assess competence to verify that a building complies with performance-based building regulations. The current laws and regulations pertaining to building control define a person in qualitative terms, that is, a person who is qualified by virtue of his experience and training. No guidance is provided as to how this may be verified. This is an area that needs to be urgently addressed by the professions, as persons who are not competent to make determinations as to whether or not a building, or part thereof, satisfies performance requirements, undermine the intent of the law and compromise the constitutional rights of South Africans to live in a safe and healthy environment.

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