Regulation of Alternative Building Materials and Systems in South Africa

W.I. de Villiers
Department of Civil Engineering
Stellenbosch University, wdv@sun.ac.za
+27 21 808 4072

Keywords: alternative building materials; alternative building systems; performance-based regulation; low-cost housing; sustainability; certification

Abstract
The need for environmentally and economically sustainable building materials and systems is widely accepted and a number of alternative building materials and systems (ABMS) have been developed and are commercially available in South Africa. However, as yet, a large scale implementation of ABMS has not been realised in South Africa for a number of reasons. For ABMS to succeed in the market, certain conditions are required. Firstly, government housing and development policies need to create the correct environment in which the demand for ABMS can grow and in recent years progress has been made in this regard. The second condition necessary for the successful development of ABMS is a robust regulatory framework for non-standardised building materials and systems, coupled with the necessary expertise to implement it. This paper examines the role and appropriateness of performance-based design in regulating and certifying ABMS in South Africa for the low-cost housing sector.
Introduction

The need for environmentally and economically sustainable building materials and systems is widely acknowledged. The manufacturing processes of cement and steel, the dominant conventional building materials, contribute over 9% of worldwide CO₂ emissions (Baumert et al, 2005). South Africa has a housing stock shortage in excess of 2.4 million (Mokopanele, 2012), most of which is likely to be provided by building traditional block and mortar houses. Alternative ways need to be found to address this shortage, in the interest of environmental sustainability. A number of alternative building materials and systems (ABMS) have been developed and are commercially available but, as yet, a large scale implementation of them has not been realised in South Africa. For ABMS to succeed in the market, a number of factors need to be taken into consideration. These can be broadly grouped in the following categories:

**Financial:** The financial resources and investor confidence (Fox & Skitmore, 2007), as well as the right economic and market conditions (Blackley & Shepard, 1996) need to be present to enable the diffusion of ABMS into the market.

**Institutional:** The necessary government policies, strategies and institutional support (Fox & Skitmore, 2007), together with regulatory frameworks and standards (Blayse & Manley, 2004; Meacham, 2010; Blackley & Shepard, 1996) need to be in place.

**Industry:** The industries, into which these technologies need to be diffused, should have a culture of innovation and be self-reliant and transparent (Dulaimi et al, 2002; Fox & Skitmore, 2007).

**Client:** Clients fulfil the role of creating the demand and expectation for these alternative solutions (Gambatese & Hallowell, 2011; Meacham, 2010).

**Procurement:** The procurement systems used need to be enablers for technology diffusion, and not barriers (Blayse & Manley, 2004; Dulaimi et al 2002).

**Research and Development:** The research and development surrounding these technologies should be a coordinated effort across the industry, with an increase in government’s role in this activity (Dulaimi et al, 2002).

**Expertise:** Finally, the ability of experts to accurately predict the conditions and resulting performance of an ABMS is essential to its success (Meacham, 2010).

All of these factors are strongly interdependent, and cannot be analysed in isolation, but two of them will be highlighted and discussed in further detail in this paper, namely institutional influences and the expertise surrounding ABMS.

**Institutional Influences and Expertise**

Over the past two years, the South African government has made a clear shift in policy concerning the housing crisis in the country. Whilst providing 3 million RDP houses over the past 18 years (Mokopanele,
2012) is laudable, the government has realized that this approach is unsustainable. This is most notable in the renaming of the Department of Housing, to Department of Human Settlements. The government’s role is changing from provider of free housing to enabler of human settlements. This shift in policy significantly broadens the scope within which developers, communities, organisations and individuals can create housing opportunities.

This new political mind set encourages the development of different formats of housing, such as densification and rental systems. It also widens the net to address the severe shortage of affordable housing stock. With the government shifting its policy with respect to human settlements, it is creating an environment more supportive of ABMS. The other dominant role that government has to play in the successful development of ABMS is in establishing a robust regulatory framework for non-standard building materials and systems. The diagram in Figure 1 gives an overview of South Africa’s technical infrastructure.

![Figure 1: South Africa’s technical infrastructure (DTI, 2008)]
This leads to the second factor under discussion. Government can only establish such a regulatory framework with the support of experts who can accurately predict the performance of ABMS. This paper examines the role and appropriateness of performance-based design in regulating and certifying ABMS in South Africa for the low-cost housing sector.

**Performance-Based Regulation**

Many building material related regulations in South Africa are prescriptive. These regulations enforce consistency and reliability by means of applying a set of rules (May, 2003). They are restrictive and bureaucratic by nature, allowing little scope for innovation, but are straightforward in interpretation and application, thereby also allowing less room for error.

By comparison, performance-based regulations, such as the South African National Building Regulations (Watermeyer & Milford, 2003), are focused on what the required level of performance of a building or material is, rather than stipulating how this level is to be achieved. The strength of performance-based regulations lies in their flexibility, thereby encouraging the diffusion of innovative materials and technologies. However, their weakness lies in the transformation of vague performance objectives into quantifiable performance criteria (May, 2010). Too often professional judgement of the designer is heavily relied upon, in accurately predicting the performance of a material or technology. These regulations are particularly weak in aspects such as forecasting durability (May, 2010).

In addition to these weaknesses, the weakest link in performance-based regulation is often times the lack of accountability (May, 2010) and the regulatory systems surrounding them (Meacham et al, 2005). A general lack of critical assessment of performance-based regulations (May, 2010) compounds the problem. Despite this, it is argued that a performance-based regulatory framework will ultimately produce a preferable solution, due to the greater freedom of choice in materials and systems, provided that the regulations are applied correctly (Sexton & Barett, 2005). This freedom of choice and flexibility has led to the use of performance-based regulations gaining support internationally, especially in the regulation of ABMS in the housing sector. The sole purpose of the Inter-jurisdictional Regulatory Collaboration Committee (IRCC) is to promote the use of performance-based regulations, conduct research in the improvement and applications of these regulations and create a platform for international collaboration in this field.

Members of the IRCC are (IRCC, 2012):

<table>
<thead>
<tr>
<th>Country</th>
<th>Organization</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Australian Building Codes Board</td>
<td>ABCB</td>
</tr>
<tr>
<td>Austria</td>
<td>Austrian Institute of Construction Engineering</td>
<td>OIB</td>
</tr>
<tr>
<td>Canada</td>
<td>Institute for Research in Construction, National Research Council</td>
<td>NRC</td>
</tr>
<tr>
<td>China</td>
<td>China Academy of Building Research</td>
<td>CABR</td>
</tr>
<tr>
<td>England and Wales</td>
<td>Department for Communities and Local Government</td>
<td>DCLG</td>
</tr>
</tbody>
</table>
Membership of the IRCC is achieved on an application basis and admittance is based on the experience, expertise and contribution of the head regulatory body of the applicant country. Despite implementing performance-based regulation, South Africa is not a member of this leading international body (IRCC, 2012). However, the work done in adopting a performance-based regulatory approach in South Africa is recognized by the IRCC, and used as an example where performance-based regulation is used successfully to address a broad range of socio-economic objectives (Meacham et al, 2005).

The development of performance-based regulations worldwide is generally modelled on the Nordic 5 level system, including the recently published SANS 10400: The Application of the National Building Regulations (Reynolds, 2007). This system was first developed by the Nordic Committee on Regulations in 1963, in an attempt to harmonize the building regulations of the Nordic countries (Oleszkiewicz, 1994). The Nordic system has gained much recognition, and has been adopted by the United Nations Economic Commission for Europe as a basis to harmonize building regulation systems. The model, shown in Figure 2, describes a 5-tier hierarchy, according to which qualitative performance objectives and functional statements (Levels 1 & 2) are translated into quantitative performance requirements, compliance methods and deemed-to-satisfy-rules or acceptable solutions (Levels 3, 4 & 5).

Figure 2: Nordic 5 level structure for performance-based regulation
Oleszkiewicz (1994) argues that the steps between the levels are too large and more explicit detail is required to enable the flow of logic along the hierarchy. Meacham et al (2005) agree on the point of lack of detail, and the IRCC has developed the following 8-tier hierarchy to address this:

![8-tier IRCC performance-based building regulatory system hierarchy (Meacham et al, 2005)](image)

**Figure 3:** 8-tier IRCC performance-based building regulatory system hierarchy (Meacham et al, 2005)

However, there is little evidence of this 8-tier system being implemented. Most countries, including South Africa, have retained the 5-tier approach. Table 1 shows how this approach Nordic 5-tier system is applied to the South African context.

**Table 1: Nordic 5-level hierarchy applied to the South African context (assimilated from Watermeyer & Milford, 2003)**

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Objective</td>
<td>National Building Regulations and Building Standards Act (Act 107 of 1977)</td>
</tr>
<tr>
<td>2</td>
<td>Functional Statement</td>
<td>National Building Regulations 1999</td>
</tr>
<tr>
<td>3</td>
<td>Performance Requirement</td>
<td>Generally lacking or understated</td>
</tr>
<tr>
<td>4</td>
<td>Performance-Based Compliance Methods</td>
<td>South African Bureau of Standards; Council for Scientific and Industrial Research; Agrément South Africa; engineering principles or rational design</td>
</tr>
<tr>
<td>5</td>
<td>Deemed-to-Satisfy or Acceptable Solutions</td>
<td>SANS 10400: The Application of the National Building Regulations</td>
</tr>
</tbody>
</table>
It is important to note that the Level 3 Performance Requirements are considered understated or generally lacking. The performance that is required of an ABMS is therefore not quantified adequately, and the evaluation of an ABMS cannot be made against a recognised and documented level.

**Performance-Based Regulation and ABMS in South Africa**

On a practical level, all housing construction in South Africa, low-cost or otherwise, is regulated by the National Home Builders Registration Council (NHBRC), the establishment of which is enshrined in The Housing Consumers Protection Measures Act (Act No. 95 of 1998) (NHBRC, 2012). The NHBRC is mandated by this act to protect the interests of housing consumers, in particular those in the subsidy housing sector (Act No. 95, 1998, 3j) and stipulates general home building technical requirements, as well as design and construction standards (NHBRC, 1999, Part 1) in the form of the Home Builders Manual. This manual is based on the National Building Regulation and Standards Act, 1977 (Act No. 103 of 1977) (NHBRC, 2012), which is performance-based in nature.

In broad terms, the structural building materials and systems provided for in the Home Builders Manual are concrete foundations, masonry walling and timber roof constructions. If a non-standardised material or system is to be used in the building of a house, the NHBRC (1999) prescribes that the material or system

- must be evaluated against performance-based criteria, such as in an Agrément South Africa certification process, or
- a Competent Person must submit a Rational Design of the system.

A non-standardised construction is one for which there are no standards, specifications or codes of practice, or which are not referred to in the National Building Regulations (NHBRC, 1999). As stipulated in Act No 95 (1998, 1iv), a Competent Person is “a registered person in terms of the Engineering Profession of South Africa Act, 1990 (Act No. 114 of 1990), or a person registered in terms of section 11 of the Natural Scientific Professions Act, 1993 (Act No. 106 of 1993)”.

However, based on the Appendix E questionnaire of the Home Builders Manual which a Competent Person is required to submit together with the Rational Design report, if any material used in the structural system is non-standardised, “the only manner in which approval may be sought is through Agrément Certification” (NHBRC, 1999, Part 1, Appendix E). Therefore the only way in which an alternative building material can gain entry into the market in South Africa, is through Agrément Certification, i.e. by means of performance-based evaluation.
Agrément South Africa

The definition of Agrément, as set out in the National Building Regulation and Standards Act, 1977 (Act No. 103 of 1977) is as follows: "Agrément certificate means a certificate that confirms fitness-for-purpose of a non-standardised product, material or component or the acceptability of the related non-standardised design and the conditions pertaining thereto (or both) issued by the Board of Agrément South Africa."

Agrément South Africa is mandated and funded by the Department of Public Works (Agrément, 2012) to promote innovative building products, and protect consumers against unacceptable ones. This is done by testing non-standardised products against performance-based criteria to determine their fitness-for-purpose. The aspects that are taken into consideration as far as building materials and systems are concerned are structural strength and stability, behaviour in fire, water penetration, thermal performance, durability and the maintenance required, the likelihood of condensation forming on the inside of the building, acoustic performance and the applicant’s quality system, as specified by Agrément (2012).

This directly reflects Clause B1 of the National Building Regulations (1990): “any building and any structural element or component thereof shall be designed to provide strength, stability, serviceability and durability in accordance with accepted principles of structural design, and so that it will not impair the integrity of any other building or property.”

On a practical level, Agrément South Africa operates within the Council for Scientific and Industrial Research (CSIR), located in Pretoria. A clear distinction is made between the roles of the CSIR, Agrément and the South African Bureau of Standards (SABS), as is also shown in Figure 1, in which Agrément South Africa would fall under ‘conformity assessment’. The CSIR focuses on research and development of new technologies and developing the performance criteria and test methods used during an Agrément certification. Agrément administers the certification process of products for which no standards or codes of practice exist, and maintains an up-to-date register of active Agrément certificates. The SABS is tasked with developing standards and codes of practice. On occasion, the knowledge and data gained during the Agrément certification process is used in the development of standards by the SABS. Under the new Standards Act, No. 8 of 2008, it is clearly specified that the SABS has no regulatory function (DTI, 2012).

Expert opinion is used to determine the necessary performance criteria, based on the intended use of the product. The best suited testing and assessment methods are selected, with which to measure the actual performance of the product. The measured performance of the product is compared to the chosen criteria, and the Agrément assessor determines whether or not the level of performance achieved by the product is sufficient for the intended use of the product. Which aspects of the product are critical to the performance of the product, and are therefore subjected to assessment, is also left to the judgement of the Agrément assessor.
To have a building product certified by Agrément can cost up to R300 000 and it can take between 3 months and 3 years to complete the process, from application to issuing of the final certificate (Agrément telephonic communication, 2012).

**International Accreditation**

The international certification of a product can be expensive and time consuming. Ideally, the certification provided by a national body should be recognized internationally. This would enable South African entrepreneurs and developers to export their product, without having to attain certification in every individual country. Similarly, if a national body recognized certification by other countries, foreign technologies could be imported and implemented in the country without duplicating the certification process. This in turn would encourage more foreign investment and increase the number of ABMS’s available on the South African market. International harmonisation of regulations and standards is seen as the most important driver in the diffusion of ABMS into the market (UEAtc, 2012)

Agrément is a member of the World Federation of Technical Accreditation Organisations (WFTAO). The aim of WFTAO is to encourage international technical regulatory harmonisation and improve the mobility of alternative technologies on the global market place. However, membership of this organisation does not translate into automatic mutual recognition of organisations between member countries. Members still need to initiate bilateral or multilateral agreements between each other. The only member to have taken this initiative through WFTAO is a Japanese accreditation body, Building Centre of Japan, and Agrément South Africa is not a part of this initiative. Agrément South Africa is therefore not part of any international bilateral or multilateral agreement. Agrément South Africa does recognize certificates issued by the British Board of Agrément in certain instances, but validation of the certificate is still done by Agrément South Africa to test for local conditions (Agrément telephonic communication, 2012).

South Africa has been a member of the World Trade Organisation (WTO) since its inception in January 1995 (WTO, 2012) and is a signatory to the WTO’s Agreement to Technical Barriers to Trade. The main purpose of this agreement is to ensure that technical regulations, standards and testing and certification procedures of products do not create unnecessary barriers to international trade. As such, South Africa is obliged to align its technical regulations with international ones, to encourage the global mobility of products. By implementing a performance-based regulatory framework for ABMS, South Africa is aligning itself with the international trend of using performance-based regulation for this purpose. Certain changes to the recently published performance-based SANS 10400: The Application of the National Building Regulations, generally to make them less restrictive, were made to accommodate this greater openness to trade (Reynolds, 2007).
International Experience with Performance-Based Regulation

According to May (2010), one of the main reasons for the shortfalls in performance-based regulation is a lack of critical assessment of the system. Van der Heijden and de Jong (2009) conducted a study of articles published between 1997 and 2007 in a random sample of five leading international journals in the building and construction: Building Research International, Environment and Planning B: Planning and Design, Structural Safety, Journal of Safety Research and Journal of Construction Engineering and Management. It was found that of the 2800 articles published in this period, only 15, or 0.5%, dealt with the topic of building regulations in any significant detail. The conclusion was drawn that the study of building regulations is neglected. By implication, the study of performance-based building regulation is even more neglected.

The most commonly cited failure of performance-based regulation of ABMS is the so-called New Zealand leaky buildings crisis (May, 2010; van der Heijden & de Jong, 2009; Thorns, 2004; May 2003). The high demand for cost-effective and low-maintenance residential building materials led to the use of un-treated timber cladding. Coupled with New Zealand’s wet climate, the weather tightness of these houses was compromised resulting in cracking, partial collapse and in some cases total collapse of the buildings. Some 18000 houses are estimated to have been effected. The underlying cause was found to be the simultaneous change in New Zealand building regulations from prescriptive to performance-based and introduction of private-sector, competitive building regulation control. A specific causal factor that was identified was the lack of performance criteria (van der Heijden & de Jong, 2009), similar to the situation in South Africa.

A recommendation made to address the shortcomings of performance-based regulation is to create a hybrid of performance-based and process-based regulations or performance-based and prescriptive-based regulations (Han et al, 1998; May, 2010). However, the practical implementation of such a hybrid remains a challenge.

Conclusions & Recommendation

The drawbacks of performance-based regulation are numerous. Generally there is a lack of accountability in the implementation of the regulations as well as an absence of critical assessment of the regulatory framework. In South Africa in particular the definition and quantification of performance requirements are lacking or understated and there is a shortage of expertise to accurately predict the performance of ABMS, especially in aspects such as durability. However, this regulatory framework is widely considered the most effective in enabling the diffusion of ABMS into the market, and it is well aligned with the WTO Agreement on Technical Barriers to Trade.

It is essential to find a balance between achieving reliability and consistency but not hampering innovation and further development of ABMS (May, 2003). The identified drawbacks to performance-based regulation
need to be addressed and a critical assessment conducted of the performance requirements and the system of accountability.

References


Inter-jurisdictional Regulatory Collaboration Committee (IRCC) [Online]. 2012. Available at http://www.irccbuildingregulations.org/.


