

PROBABILISM, THE WAY OUT FOR PERFORMANCE BASED BUILDING REGULATIONS

Dr.Nico P.M.Scholten, PhD

Foundation Expert Centre Regulations in Building (ERB)

E-mail: N.Scholten@bouwregelwerk.org

ABSTRACT

Performance based regulations emerge increasingly. The actual situation in the Netherlands is described. We observe from our consultancy experience permanent obstruction of innovation and prescription of well known solutions because of a lack of understanding by local authorities. Bureaucracy and disasters force opponents and politicians to blame the complicated and scientific nature of modern democratic performance regulations. Political emphasis on reduction of the body of (technical) regulations however is counterproductive. Expert opinion is that a decrease of regulatory-burden is possible by improving regulatory methodology. Meanwhile, probabilistic thinking is developing. We cannot live nor build without the risk of failure. The acceptance level of risk should be a political decision. Knowledge and understanding of building regulations should increase and be fostered by improving education. Eurocodes show quite some advance; "tight rope" calculations can be made. Application of probabilistic methods in other areas than structural design is still in its infancy or research stage. New regulations of emissions to ground, air and water have to be developed by reason of a sustainable world, but may not hinder re-use of building products. The content of a building product is not important, but the risk that dangerous emissions will damage the environment. By applying performance based principles, using probabilistic methods adequately, we could really advance. Management by incident by issuing new regulations based on one accident is unholy. When disaster strikes, politicians and the regulators usually create a new host of rules to prevent recurrence. Acceptance of effects based probabilistic judgement should be the issue. Poor regulations, conflicts in practice, huge administrative burden and quite some destruction of capital are observed in building practise. Based on our experience we see blockades for the application of innovative technical and organisational solutions, and the use of unsatisfactory solutions that only can be put to level only at great cost. Owner/user orientation ensures acceptance and proper application. Research and education should aim at tools to manage probabilistics in the building industry and assessment procedures.

Keywords: probabilism, performance, regulations

DUTCH SITUATION

The building industry, which provides 9-12 % of the GNP of the Netherlands, does not have any self-guiding capacity. The market is split into a large number of sub-markets, each with its own role and dependent of the other. The building sector has no driving force capable of providing private guidance to ensure that the public is served with a built environment that is safe, healthy, useful, energy efficient and durable. The customer has almost no voice in this: the building owner or user has no choice and few possibilities to influence the quality of the product he is provided with. Mainly because there is a scarcity of buildings, particularly houses, lack of money and only limited possibilities to lend money because of the crises so that the customer is forced to accept what is offered. Architects and builders are unable to match their offer to the demand and certainly not to future demand. In such a situation building regulations play a vital role. Ensuring that publicly required, Figure 1 shows schematically the interfaces that building regulations have in the process of safeguarding the public interest. The inner circle describes the public world. The outer circle - the private market from the

research in building owners. Building regulations is a part of this world. The satisfaction of the built environment and the public interest should be the driving factors of the whole system. It should be born in mind that in Holland the owner is responsible for fulfilling the regulations. After 1995 fundamental research¹ on building regulations stopped². Technical building regulations have not been part of university and vocational training curricula for more than 20 years. In October 1992 new building legislation in the Netherlands was introduced in the form of the revised Housing Act (Woningwet), the Building Decree (Bouwbesluit) and related technical documents.

¹ Research about scientific content en way of expression of regulations, standards e.g.

² In the PhD-study "De juridische en technische grondslagen van de bouwregelgeving – Woningwet en Bouwbesluit", May 2001, TUD, N.P.M. Scholten, Msc a complete overview of all studies is given.

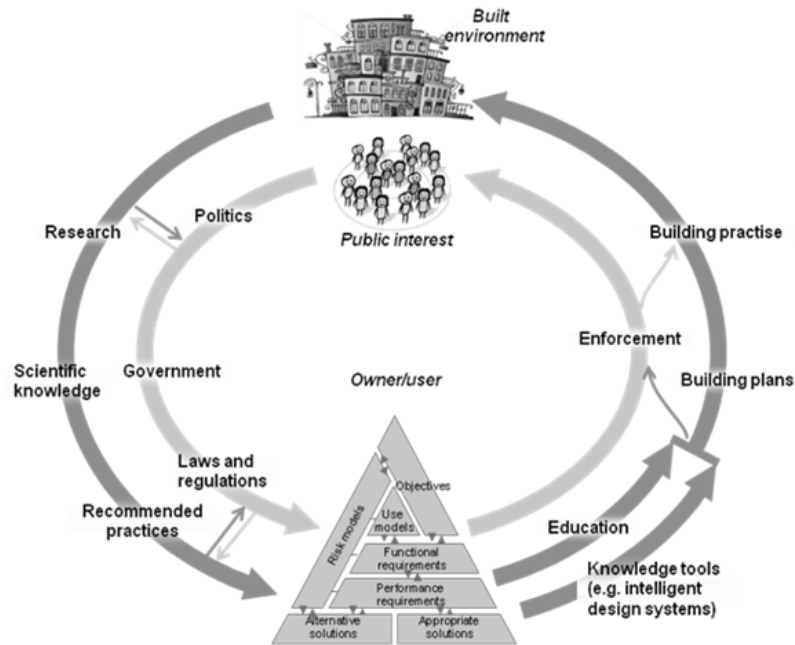


Figure 1. Building regulations and the public interest

Figure 2 shows the relation between the documents under the new legislation. Next to complying with these technical requirements local authority by-laws must also be satisfied. However, these are not

technical. From November 2008 the requirements on fire safe use of buildings have been transferred to national level in the new legislation in the Decree on fire safe use of structures (Gebruiksbesluit).

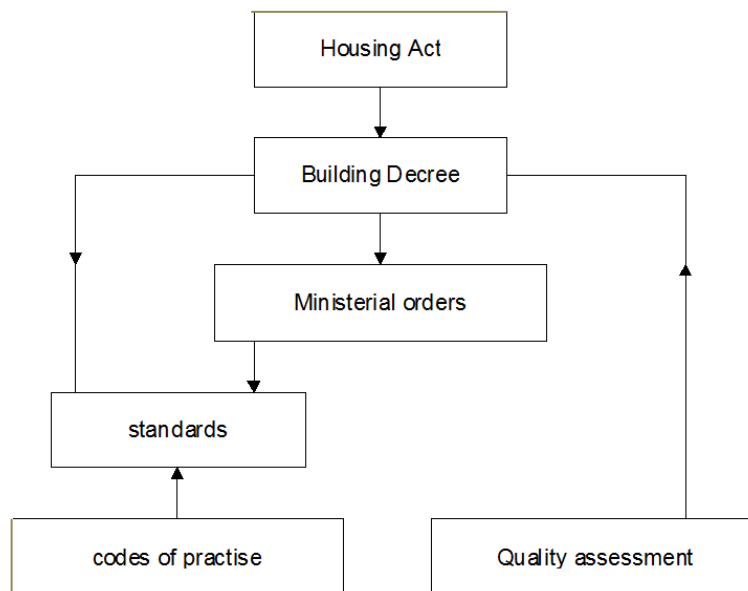


Figure 2. Relations between the documents

In April 2012 a following huge deregulation operation was implemented, the Building Decree 2012. A mixture of the Building Decree 2003, the Decree on fire safe use of buildings, the Decree of building tunnels, all requirements of building bylaws and implementation of European directives. But deregulation caused 25% of the requirements to

be skipped instead of diminishing administrative burden as wished by the public. For renovation the level of requirements was lowered drastically, mostly to the level that by not fulfilling a non-compliance penalty follows immediately. The Building Decree, the general body of administrative regulations based on the Housing Act,

is expressed in performance requirements. The performance requirement is based on a functional statement. The statement is thought to express the intention of the performance requirement. The performance requirement consists of a limit value and a determination method. The limit value is the minimum level of performance that has to be attained. The determination method is usually a Dutch Standards Institute standard, so that (elements of) these standards are also part of the Decree.

This means that the standards in the Decree must meet specific criteria and follow the same conceptual model as used in the Decree. The standards have to be performance based and have objectives that are in line with the Decree. The standard terms and definitions have to be the same as those in the Housing Act and the Building Decree. The boundary conditions in the standards should be clear and the standards should not be in conflict with the government policy. In 1985 policy paper the conditions to be fulfilled were laid down explicitly (MVROM, 1984).

A number of large research and standardisation projects have been carried out in the Netherlands to align the standards with the Building Decree. In the period 1985-1992 the "Action plan Building Decree and standards" reformulated more than 80 standards. Between 1992 and 1995 standards were produced to be used in assessing the existing building works. In 1996 and 1997 the standards were reformulated again to get complete uniformity between the standards and the Decree. Later on Ministerial orders included only few technical clauses requiring standards. The 2012 Building Decree brought about a change in terminology and modelling and required all standards to be revised in 2001 and 2002. The standards have to be in line with the administrative Decree before a Decree can be published. The references to standards have to be correct; otherwise regulations cannot be used in practise. So, research on reformulating standards starts on a pre-Decree version.

Based on the Building Decree quality assessments (technical approvals, certificates) are thought to be an efficient way to verify that buildings and construction materials comply with the performance-based requirements. The Building Decree provides that formal quality assessments issued by accredited bodies, which are recognised by the Minister of Housing, are acceptable as sufficient proof of compliance with the requirements.

Performance requirements give building contractors and suppliers the freedom to make choices to achieve compliance. Nevertheless, there is a need for practical instructions on how to achieve compliance through using current solutions. This need is met by NPR's (Dutch Codes of Practice, Nederlandse praktijkrichtlijnen), which describe the calculated or measured performances of using current solutions. The Building Decree does not refer to these NPR's, but they have been prepared on the basis of the

standards referred to in the Decree. Only a few NPR's have been prepared.

In the period from 1992 until the end January 2012 the Building Decree has changed 31 times. Ministerial orders (in 1992 there were 5 Ministerial Orders and from 2012 only 1) have changed 38 times. A ministerial order is a document, referred to in the Building Decree that can change qua content in time.

REALITY

Introduction

The dissertation (Scholten, 2001) proposes a model to determine if the existing or still-to-be-developed regulations serve their purpose.

In practice the background to the regulatory requirements and their objectives is poorly documented in the explanatory text of the Building Decree. Documentation can be found in the Expertcentre Regulations in the Building library. This is a private initiative. Also the terminology and modelling of the building structure in the 2012 Building Decree does not align with the building industry customs. Moreover, the 2012 Building Decree is written in legal language that is barely understood³ by professionals and normal people. Regrettably, the standards of the Dutch Standards Institute show the same shortcomings.

The determination methods described in the standards need to be target oriented and consequently they are written in scientific language. Furthermore, they must be aligned with the underlying principles of the 2012 Building Decree. For example, they must be able to accommodate flexible building plans and the principle of equal rights. In practice few people understand and correctly apply the 2012 Building Decree, Ministerial orders and associated standards. That is the experience of all teachers of courses given about parts of the regulations. Also the members of standardisation committees are not competent to formulate the content of their technical expertise in the juridical form of the regulations.

Not all the regulations are yet performance based. The Building decree still contains numerous regulations formulated in functional terms, handling those situations that are either too complex, or where insufficient knowledge exists, to specify quantifiable performance criteria. A building permit requestor or a building owner has to demonstrate that the regulations will be met and the local authority has to agree or disagree. The Court adjudicates in cases of dispute. In practice much discussion and dispute arises due to lack of clarity and precision of the Decree and limited knowledge about the content. Even where parties are in

³ From post graduate education experience it is clear that the students do not understand the language of the regulations.

agreement, misinterpretation means that it is uncertain whether their agreement meets the regulations. The reviewing authority can have set the demands too high or has given its agreement wrongly.

Equivalent performance

The administrative burden can increase enormously if tried and tested solutions are passed over in favour of innovative new ones. The 2012 Building Decree and the Decree on fire safe use of structures allow this if proof of equivalent performance is provided. Only if this possibility is driven by common sense, unnecessary costs will be avoided. (Needless discussions in obtaining approvals, unnecessary extra work in building modifications, avoidable costs in (re)constructing buildings for which permission was incorrectly given).

The following are examples from our consultancy:

1. Is a computer controlled ventilation system acceptable that takes into account the number of people in a room at any given time but in which the ventilation levels averaged out over daily and yearly cycles are less than legislated requirements? Is this system acceptable in assessing the energy performance coefficient (epc) of a building? Can a TNO developed computer model be used for this assessment that takes into account the outside climate and the activities of the occupants (Phaff, 1992)?
2. Can the developments in high efficiency boiler technology be taken into account, by which lower exhaust temperatures are emitted when determining the risk of fire starting in a chimney exhaust pipe? How do we ensure that an incorrect boiler is not actually installed thus creating a fire hazard (ERB, 2008; ERB, 2009)?
3. Can "Tritium-Light" emergency exit signs be used instead of the approved traditional ones with their specific colours? Are the standards unknowingly and unjustifiably protecting the manufacturers of traditional signs from competition (Varkevisser, 2009)?
4. What in fact are the criteria for determining adequate emergency routes? What are the criteria for safe operations by the fire brigade? In which cases will it be necessary that the fire brigade comes into action? Can CFD calculations help in demonstrating the circumstances of safe escape or safe extinguishing? Are these calculations comparable to much simpler models such as one and two zone models? We refer then to restricted visibility length due to smoke, temperature and heat radiation, toxicity, etc. (Tonkelaar, 2009).
5. How should a structure fire resistance limits be determined, beyond which it collapses, if instead of using the standard fire curve the

natural fire safety concept is used? How does the positive contribution of a sprinkler system or fire alarm affect the outcome? What are the implications for the safety which is the objective of the currently accepted performance requirements (Herpen et al., 2009)?

6. When evaluating historic buildings, can a risk-based method be used instead of simpler models based on performance requirements (Vandeveld, 2005)?
7. What to do with the existing block of flats with only one entrance and escape route exceeding 1500 m² floor area for living? Rebuilt them totally or do we accept by FSE simple techniques to improve the fire-safety?

If probabilism were the highest level of regulations this question could be solved. The condition is however that we have the skills to use this way of thinking on both sides of the table (the market and the competent authorities).

Exemptions

A source of discussion was the competence that local authorities have in cases of complete or partial reconstruction or modification of the existing buildings, to approve lower performances than required for new buildings. The Building Decree 2012, clause 1.11, regulates local authorities' competence and ability to do this. In the 2012 Building Decree the competence is in practise reduced to zero, but the necessary performance level to get a permit gives unsafe and unhealthy buildings. The Government expects that - market driven - always higher levels should be realised, but at a time that money is very expensive that is hope against better knowledge.

Taking into account the intentions of the regulations this is only logical when buildings are built for a very short lifetime. Standards are subject to economic constraints: for a building with a short life-span, disinvestments should be avoided. Similarly, what is the benefit of a 2.3 m high door in a new extension of an existing building if all the other doors in the building are only 2.1 m high? But buildings should be used also after renovation for many years and have to fulfil the wishes of the end-user. It is waste of money and gives negative environmental performances when buildings short after renovation have to be broken down because they do not fit the market demands. The content of the Building Decree 2012 is so poor that there is full of menace to conclude that for the whole Real Estate we will have big problems in the near future.

Education

Building regulations are not a part of the technical education curricula and this creates practical problems. The regulations should be a lot better understood at all levels in the building industry. Owners and users, architects, consultants, builders,

fitters, suppliers, authorising bodies and assessors are struggling to apply the regulations correctly what is the overall experience of the leading experts in the field of building regulations leading to unnecessary discussions, unnecessary revised superfluous plans and unnecessary rejections, the cost of which is all born by the end-user.

Certifying bodies and those involved in standards meet the same problems.

The limited extra-curricular and post-doc education on the subject adversely affects also further development in the regulations.

Normally all goes well in straightforward cases. But in more complicated cases, when equivalent performance plays a role or a complex determination method is involved, or worse, when the regulations are not quantified, then everybody gets off track.

The most distressing example is the revision of the regulations in the 29th November 2009 Official Journal on safety requirements for renovations of structures that are not buildings (bridges, tunnels, etc.) (Vrouwenvelder, 2009). The safety requirements that applied to the existing buildings were considered acceptable to apply after renovation. There was no appreciation of the risks that were thereby considered acceptable. Following the advice of the Expertcentre Regulations in Building an urgent revision to the regulations was made and published (MJUS, 2010). But by the 2012 Building Decree the donkey had bumped for the second time, but now for all renovations and for all subjects.

Court cases

The situation does not improve when the legal system is used to decide disputes. The General Administrative Law Act (MJUS, 1992) seldom leads to a judgement satisfactory based on purely technical considerations. The judge reviews the procedures that have been followed. Has the local authority decision been arrived at reasonably? In few cases does technical expertise enter the discussion to allow a more substantial consideration of the issues. Frequently understanding of the background to the regulations is needed to judge if unacceptable risks are involved.

The following are examples:

1. Should the fire brigade in a three story artificially ventilated parking garage with a sprinkler installation at any time be able to search the garage and rescue victims close to the fire? An extra investment of € 70.000 for a sectional fire alarm system depends on the answer to this question. If the chance of victims and of a successful search by the fire brigade is sufficiently small then the extra investment may be considered disproportionate. Probabilistic is a tool that

can help decide in such cases (Verdict Arnhem Court, 2009).

2. What should be done in the case of an empty industrial building of 12.000 m² that four squat watchers occupy from 9.00 to 17.00 (an artist using 40 m², an office of 40 m² with a computer table and chair, storage of 50 m² for 100 chairs and a furniture maker with 50 m²)? Should the four squat watchers be forced to vacate the building within 24 hours because there is a danger of fire spreading to an office building 5 m distant? In this case a risk-based approach can help find an answer. The administrator should also set this off against the risk of squatters occupying the building and of fire then breaking out (Verdict The Hague Court, 2010).
3. What is the chance of the first floor of 66 m² collapsing in a restaurant that can accommodate 75 people in a former hayloft? The floor can withstand 3,5 kN/m² while the building regulations require 5 kN/m² - but this is based on a worst-case scenario of a group of dancers in a discotheque. Here also a risk-analysis can end the discussion (Verdict Zwolle-Lelystad Court, 2009).
4. Should a care hotel located close to a gas pipeline be equipped with a 60-minute fire resistant shield if the probability of a fire occurring with a radiation impact of 22 kW/m² on the end wall is 1.10⁻⁶ per year? What is an acceptable level of probability at which we stop investment in further safety measures? Must we be able to withstand all the dangers that could possibly face us, whatever the cost?
5. How should various forms of panic exit devices in a large discotheque be assessed?
6. Should the doors be locked which serve under certain circumstances as emergency exits and under other circumstances as security barriers? For example when a building can be used as well partly (only one or a few rooms) or as a whole (Verdict Zutphen Court, 2009).
7. What to do with a smoke exhaust system with elements from outside Europe, so the system cannot be certified and the Local Authority does not have enough knowledge. Should in that case the premise be closed?

Only when the parties to a dispute (local authorities, fire brigades and building owners) consider their differences in terms of risks and probabilities the number of disputes will drastically reduce. This ability is present at only a few experts and they are not working for local authorities where the decisions are made.

Disasters

Incidents and accidents serve to shape regulations and determine how buildings are appraised and how the regulations are enforced. If probabilistics play a

role then “management by accident” will occur much less and regulations can be far less detailed. In the past 10 years a number of large accidents and disasters have occurred. Volendam (café fire causing 14 deaths and 180 injured), Schiphol (prison fire causing 11 deaths), near collapse of a market square above a parking garage and inadequate structural load capacity in one of the nearby apartment buildings, partial collapse of a parking garage, collapse of a series of balconies (Fig. 3), complete burn-down of the Architectural Faculty building at Delft (Fig. 4), death of three firemen in a boatyard, collapse of a theatre during construction, health complaints in a new residential district due to a faulty ventilation system.



Figure 3. Collapse of balconies in Maastrich



Figure 4. Burn-down of a faculty building in Delft

Recently the roof of the soccer stadium in Enschede and of a multi-storey building in erection in Rotterdam collapsed.

In retrospect we can ask ourselves: how could this happen and how can it be avoided? Are the regulations comprehensive enough? Is it due to inadequate education? Are lessons and experiences from the past coming across to newcomers in the building industry? The lessons we have learnt from the past are not being fed into the improved regulations. A limited number of studies are being undertaken to try to learn from the collapsed buildings and fires (Herwijnen, 2009). Until now too little has been documented, which means that

the basis for a probabilistic approach to building issues is still very small.

GOVERNMENT VIEW

General

The government understands that revision of the building regulations is needed. Political circumstances hinder development aimed at the optimum solution. The government is involved only to a limited extent with the technical content of its regulations. This is a result of “lean government” and the loss of expertise in the Ministries. It is also the result of the way in which communication takes place between the government and the industry (The formal advisory body receives in practise one week before the advice is due in the crucial documents). Feedback from the industry to the government is almost non-existent. The government is mainly concerned with a number of specific political issues: how to reduce the administrative burden for the public? De-regulation is fashionable. This has led to the new Wabo (Law of generic clauses related to regulations having an impact on the environment (Wet algemene bepalingen omgevingsrecht) (MINJUS, 2008) in which all building related permits have been combined (i.e., 25 separate legal statutes from national, provincial and local government). It is now possible to present one single permit request for all permits together, which the local authority has to quickly decide upon.

However, the technical regulations on the background are unchanged and remain as unconnected to each other as they were before. As a consequence the preparations for a building project become more risky because all the preparatory work needs to be done before the submission of the request for a building permit. This can be considered as a disadvantage. The risk of a large number of legal proceedings stopping the project is however reduced. In the mind of the government and Parliament deregulation means fewer regulations. This may have undesirable consequences for the public in an industry that needs regulations to ensure that minimum levels of safety, health, usability, energy efficiency and durability and sustainability are met. Competitive market forces do not exist and therefore cannot provide what the public needs, also with regard to the future.

Government regulators could have learned more from the lessons of 2003: subsequent to the deregulation of balconies and external storage space in housing, apartments have been built without them. This has produced disadvantaged neighbourhoods where people do not want to live but have to, due to the lack of free choice. Parliamentary pressure has resulted in reintroduction of these regulations. Nevertheless,

the government intends still to discard 25% of the existing regulations to diminish the volume. No research has and will be done in the consequences for the built environment and people welfare.

The objective of the course should be a reduction of *regulatory burden*. This is not the same as simply scrapping regulations. Formulating the regulations more understandable and making them less complex can achieve effectively a 25% reduction in regulatory burden.

The outcome of the current politically dominated process in the government is the following – only partly addressing the above mentioned problems:

- combining the legislation on permit requests (Wabo);
- regional pooling of knowledge for local authorities to call on as they wish; in the juridical world the Courts will believe that the regional pool advices stand for material knowledge, but without education the lack of knowledge is not solved. In reality people discuss with each other without the background knowledge of the regulations and that will give bad advice;
- regionalising the fire brigade with the same effects;
- integrating the 2003 Building Decree, local building by-laws, Decree on fire safe use of structures and technical requirements for tunnels and at the same time discarding 25% of the regulations.

The readability and complexity are not addressed, nor the education issue. The regulations will still not be tailored to the needs of their users. The knowledge and misunderstandings of the regulations are not addressed. The end-users are not centralised in the whole renovation of the content and system of the building regulations, although they pay the bill for all the unnecessary discussions that take place and all non-conformities against the regulations that happen in practise.

European influence

The Netherlands is a member of the EU and responsibilities are attached to that. National regulations should not hinder free trade and this means that the Dutch regulations should be aligned with the European standards and quality assessment systems. Multinational companies that pay little attention to legislative principles largely influence the content of these standards. This can lead to market disruption by formulating unnecessary high performances that are not in line with the goals of public regulation. The ERB equivalent performance declaration about Tritium Lights escape signs demonstrates this related to NEN-EN 1838 (ERB, 2009). The need to introduce The European Regulation for construction products (Council Directive, 1988 and 2003) forms an illustration of

the disruption caused by the CPD and in the future the CPR (Regulation, 2011).

Introduction of the Eurocodes in the Netherlands will not help reduce the regulatory burden. On the contrary, it will increase because the Eurocodes are ambiguous and a mix of technical, legal and administrative provisions. Consultation needs and discussion with the competent authorities will increase and the cost of all this will be for the owner/consumer. These negative local effects for the Dutch national market are accepted because of the possibility to freely operate in the whole EU in the advisory practise. That was the outcome of the discussion between the responsible Minister and the Parliament and can be read in the Parliament documentation and the documentation of the mirror standardisation committee 351 001 “TGB-Plenair” and the working group “Implementation Eurocodes”, 351 001 00 01.

Europe is also working on standards for durability and sustainability as part of implementation of the CPD (Council Directive, 1988 and 2003) and CPR (Regulation, 2011). Environmental regulations are aimed at pollution of air, water and ground. Regulations based on the content of materials frustrate material recycling and so cause unnecessary environmental pollution. Influential European member states do not seem to understand this. Instead of putting society interests up front fear of the unknown is creating excessive environmental demands; if something is not included in a product it cannot cause any harm. This way of thinking kills innovation and consequently also the environment. Where do we put all our building rubbish if we cannot recycle it? In the documentation of CEN TC 351 ‘Sustainability of construction works’ documentation about the tough discussions can be found.

THREE RECOMMENDATIONS

Three important Dutch publications have been made concerning rethinking building regulations:

1. The Dekker committee report (Dekker Committee, 2008).
2. The Mans committee report on improving enforcement (Mans Committee, 2008).
3. The report of the Expertcentre Regulations in Building (ERB, 2009).

The Dekker report makes a number of recommendations of which the Minister of MIA is not convinced. In particular, the recommendation to privatise a part of the enforcement process (for example, discontinuing preventive checks on building structures) which would lead to informed solutions. The Dekker committee assumes a beneficial working of market forces that up to now has not proven to be the case. For decades the responsibilities for those in the industry have been clear, but the government supervision is still required to ensure that the public interest is

safeguarded. This report will not suddenly change this. A situation where new buildings would have to be closed immediately, because a repressive enforcement system revealed that the building regulations had not been followed, will not be acceptable and will raise political problems. That would be a waste far exceeding the cost of the present system. Authorities will not have the courage to enforce break down completely recent works.

The Mans committee concludes that most local authorities are too small to upkeep their knowledge adequate and up-to-date. Yet, we have to accept local authority autonomy. Pooling knowledge is now actively being pursued, but for the local authorities still voluntary to consult. This is a desirable objective also in the field of building regulations.

The Expertcentre report puts the user centre stage. Regulations should be tailored to the users' needs, because the user/owner is in the end responsible for fulfilling the Law. This requires a quite radical and comprehensive re-write of the regulations. Knowledge expansion and integration of regulations in technical education curricula is indispensable. The most urgent priority is to document why the regulations exist and what their objectives are. Also the permit system should be changed radically. No permit for an administrative building plan at the

start of a project, but an independent demonstration to the local authority by full documentation of the whole building process that all governmental requirements are fulfilled just before the moment the (renovated) building will be used. The permit to use will be blocked when the documentation is unconvincing. The full responsibility lies by the owner, who will deposit the liability full to the contractor. The documentation should be topical at every moment in the lifetime of a building, also in the case by selling or renting a building. By that system the involved parties cannot hide themselves and a quality push will take place to the benefit of the end-user.

THE WAY OUT IS PROBABILISM

To solve the various dilemmas as sketched above, the actual regulations should, according to the opinion of the ERB-experts, be developed in three levels once the objectives are properly stated. Objectives that satisfy the just needs of the owners and users. Detailed into use and risk models the regulatory provisions should be divided in probabilistic, deterministic and deemed to satisfy sets.

The top of Figure 5 is thus representing the objectives in un-quantified terms. These can be translated in functional requirements to be fulfilled.

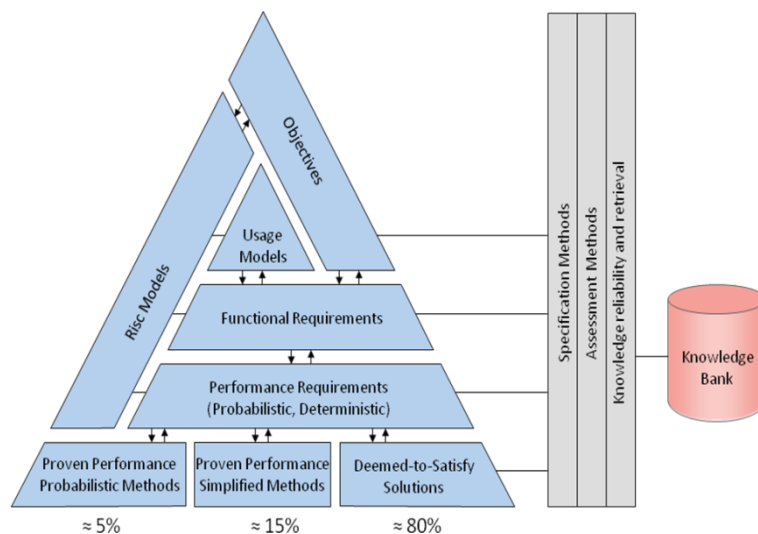


Figure 5. Structure of the future building regulations

The highest level of performances should be given in a probabilistic way by formulating the acceptable risk level in the clauses of the regulation.

Structural safety is already covered in that way by the standard NEN-EN 1990 (NEN-EN, 1990) by reliability-indices. Acceptable models already exist covering a number of other subjects (see summaries of the research of TNO for different products and publications of ERB (Scholten, 2009; ERB, 2009). For others research is necessary to develop

appropriate models, the basis for which is the risk = probability * effect. The regulations have to specify the acceptable risk of not achieving the objective. The details will depend heavily on statistics. One expects that at approximately 5% of the building projects or 5% of the disputes about the existing buildings will involve this kind of regulation. For 80% of the building projects and the existing stock we have to document how plans or existing works can be reviewed in the most straightforward way

(deemed to satisfy) in deciding whether or not they meet the regulations. For the remaining 15% of the building projects and the remaining part of the existing stock, regulations will need to be simplified performance based (the middle between probabilistic and deemed to satisfy). Regulatory solutions are not readily available. So, an opportunity must be created and resources made available.

RESEARCH PROGRAMME

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Referring to Figure 1, the ideal regulatory framework needs the feedback loop to be closed and a body of knowledge to be built up. The backlog in documenting the background must be quickly resolved into a memory data bank or else too much experience and knowledge will be lost, since the existing regulators are dying out. A new dedicated research programme is needed for this, providing the cradle for future oriented knowledge as well as for breeding of a new generation of regulators.

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