



Within the “**digital transition in the building industry**” a project aiming to facilitate code checking for buildings

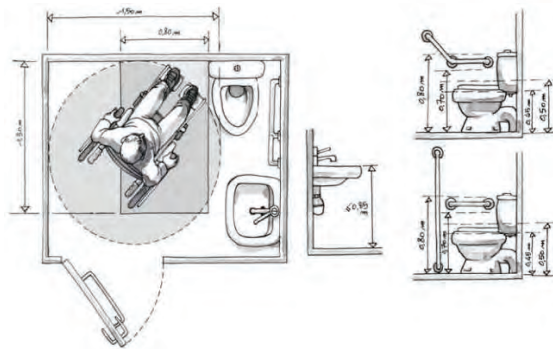


A large and heterogeneous set of documents

- Codes / Standards / Eurocodes / Calculation methods / Professional Rules / Guides
- Different structures / different « customs » or habits -> different vocabularies



Inclinaison	Sites neufs (longueur max)	Sites existants (longueur max)	Observations
< 4 %	non limitée	non limitée	
≥ 4 % et < 5 %	10 m	15 m	Pour des longueurs de pente plus importantes, nécessité d'un palier de repos horizontal tous les 10 m (sites neufs), tous les 15 m (sites existants)
En cas d'impossibilité de respecter les prescriptions ci-dessus les solutions présentées ci-après sont techniquement tolérées.			
≥ 5 % et < 8 %	2 m	6 m	
≥ 8 % et < 12 %	0,50 m	2 m	
≥ 12 % et < 16 %	-	0,50 m	
33 %	12 cm	12 cm	
100 % (45°)	2 cm	2 cm	Traitée par chanfrein

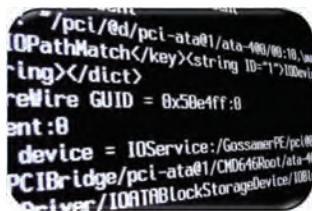


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Texts in natural language



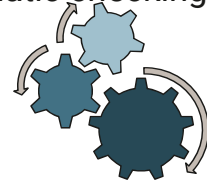
Computer Code
Formal and BIM compliant



Building Digital Mockup
in « OpenBIM » (IFC) format



Automatic checking (Kroqi)



Analysis report

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Initial Rule

Establishments wholly occupying the building with the lowest floor of the highest storey located more than 8 meters from the access level of the fire brigade shall have a 1-hour fire-resistant structure and fire-rated floors of the same degree.



Semi-Formal Rule

```
si hauteur du "plancher_bas_etage_plus_eleve" par rapport au "niveau_access_pompier" > 8 m
si "structure" "Stable_Feu" < 1h alors_non_conforme
si plancher "Coupe_Feu" < 1h alors_non_conforme
```

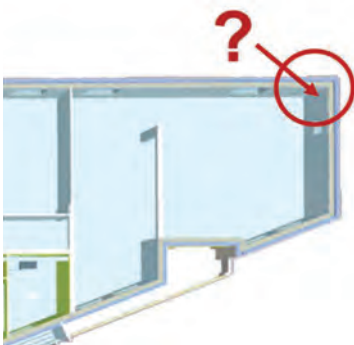
Formal Rule

```
SELECT ?gid ?e
WHERE {
  ?e a :Structure ; :hasProperty ?p ; :in ?s ; :gid ?gid .
  ?s :inStorey ?b .
  ?b :hauteurPlancherBas ?hauteurPlancherBas .
  ?p :name "Stable_Feu" ; :value ?Stable_Feu .
  FILTER (?Stable_Feu < 1)
  FILTER (!/hauteurPlancherBas > 8000)
}
```



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- **The Controlled Vocabulary:** Cover the concerned regulatory domain and align the regulatory concepts with the entities of the OpenBIM (IFC)
 - ⇒ Creation of a dictionary based on the BIM standard (IFC) and containing 4000 French terms
 - ⇒ Definition of maintenance/enrichment process to support the life cycle of such a semantic structure



- **Integrated service to the French KROQI platform**

- ⇒ Use of advanced semantic & cloud technologies
 - ⇒ Transparent for the end users
 - ⇒ Independant from any proprietary solution





- What are the various regulatory topics and which are the ones most adapted to digitalization and at what cost?
- How to leverage the French initial work and bring the tools created at a higher stage?
- Status & Life cycle maintenance of a Japanese&French controlled vocabulary? (proposal for an international standard?)
- How to make use of a common checker or a shared repository of regulatory constraints?
- Could we develop jointly a “Regulatory Editor” making use of the Controlled Vocabulary and producing natively constraints written in a semi-formal way ?
- What could be the barriers to have such formalization approach for regulatory texts that go beyond the scale of the building to the urban scale?
- How to deal with new regulations in order to make them “digital compliant” and easy to check against pre-identified requirements?

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Digitalization of Construction regulations

In France, since 2015, the digital technologies have been identified as the right tools to “*improve the effectiveness of those involved in all the steps from design to maintenance, including development, manufacturing of equipment and products, installation, management and servicing, and also improve the quality of projects while significantly affecting the value chain*”. In such context, the ministry in charge of the construction sector has launched a National plan called “Plan de Transition Numérique du Bâtiment” (PTNB - Plan for the digital transition in the building industry). Within the scope of this plan, different initiatives have taken place among which a feasibility study focusing on the digitalization of Construction regulations.

The challenges raised by this project are complex and of various natures. The methodology we adopted consisted into two major phases that are necessary to bridge the gap between the natural language and the formal expression of rules that can be automatically processed against a building digital model.

1. The first phase consists in a simplification of the regulatory initial text into a so-called “semi-formal” representation. This step involves mainly regulatory domain experts who are supported in the re-writing process by a toolbox containing methodological guidelines and a text editor especially tuned for their specific needs. The specific configuration of the text editor consists in the definition of syntax highlighting and autocompletion based on a controlled vocabulary.

The controlled vocabulary is composed of French terms that are corresponding to the building elements or properties used to describe digital models of buildings. The backbone of the controlled vocabulary is ensured by the OpenBIM ontology (IFCOWL) proposed by BuildingSmart. The French terms are the ones already available in the IFC documentation, they could also come from other initiatives (like bSDD) or are extra translations added in the frame of this project. The exercise for the domain experts is to simplify the constraints expressed in natural language. To this end, the proposed methodology relies on simple actions / recommendations aiming at disambiguating the way these constraints are formulated. The controlled vocabulary is the reference vocabulary and provides as such a unique source of expressiveness. This centralized approach avoids misunderstanding by using only controlled words that have a clear definition and are also linked to the IFC.

2. The second step of this transformation brings the regulatory constraints from the semi-formal to the formal stage. This step is performed by computer scientists familiar with BIM and with the semantic technologies. To benefit from all the functionalities and the richness of the semantic web technologies, the BIM files are translated from IFC into RDF-graphs following the transformation validated by BuildingSmart in order also to ensure a bijective correspondence between the two worlds (IFC & IFCOWL). Then to minimize the size of the data resulting from this transformation, several aspects are not kept or are simplified (such as detailed geometry description). The resulting data are stored in a semantic database (triple store).

This feasibility study demonstrated already the potential of the semantic web technologies to support the code checking needs. These technologies are mature enough to allow the formal representation of regulation constraints and they are perfectly suited to bridge the gap between the IFC vocabulary and the regulatory vocabulary. Of course, the well-defined framework must be established in order to confront an IFC file against a set of formal rules to check its compliancy to a specific regulatory domain. It means that BIM implementation charters have

to be explicitly defined based on the same controlled vocabulary mentioned above and these charters must be closely followed by the persons in charge of exporting IFC files.

Based on such experience and taking into account the existing work made under the umbrella of BuildingSMART, the vocabulary produced during this feasibility study is (also) aligned with bSDD. As such, this French framework is ready to be extended at the international level following the IFD principles.

In that context the proposed items of collaboration are the following:

Topics	Potential research area
Regulatory topics	What are the various regulatory topics and which are the ones most adapted to digitalization and at what cost?
Controlled vocabulary	How to set up, enrich and maintain a Japanese/French controlled vocabulary aligned with OpenBIM concepts?
Semantic Regulatory Checker	How is it possible to share a common regulatory checker (same engine and possible but not mandatory national rules)?
Semi-formal Regulatory Editor	Based on the use of the controlled vocabulary mentioned above, is it possible to develop a Regulatory Editor supporting the production of new regulatory text, natively produced under a semi-formal controlled form ensuring a direct interoperability with the BIM?
From Building to City scale	What could be the barriers to have such formalization approach for regulatory texts that go beyond the scale of the building?
New methods for construction regulations	How to deal with new regulations in order to make them “digital compliant” and easy to check against pre-identified requirements?