Fire Safety and Inkjet Printed Wallcovering Materials

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Abstract

As wallcovering shifts to digital on-demand manufacturing, questions on safety and fire regulations have to be reconsidered. In a world of changing rules, where multiple actors intervene, it becomes important to conduct and extend research to predict fire resistance and behavior of materials once printed and finished. Sihl research aims to provide first insights and draw attention to the next manufacturing advances to be documented in the future.

The shift: regulations and technologies

Fire in a closed space is always a nightmare (watch again "The Tower Inferno" (1974) reality is just worse). Countries having strict regulations (France, Japan) are usually those having experience striking disasters forcing the politicians to pass strict laws.

In the case of France, it has become a ritual for Architects and indoor designers to ask for "M1 building materials", as specified in public tenders.

The new Euroclass standards introduced from 2002, but architects have not converted yet to "Euroclass B-s3, d0" in their daily practice. The European Union is putting in place a comprehensive framework, with unified declaration on materials, to create a single EU market, placing some stress on already very busy professionals confronted with extra work.

At the same time, Digital imaging changes wall covering manufacturing process. Instead of buying off-the-shelf finished and certified products, architects can order custom-made wallpapers. These wallpapers are printed on documented materials, but finished product behaviour when faced with fire has yet to be documented.

The M1 French context

It all started from trauma generated by **Bazar de la Charité,** fire, a disaster that claimed 126 lives in 1897.

This led to what became M1 standards, one applied to wall coverings, one to display materials.

M1 standard applied to wall coverings checks that wallpaper, once glued on a wall-like substrate does not catch fire and self-extinguishes once the flame or source of heat is removed.

M1 standard applied to display materials check that it does not catch fire and self-extinguishes too, but in that case material is exposed to air and flame/heat on both faces.

Routine check conducted in Châteauroux confirms that materials compliant with wall covering M1 would not pass the M1 test for display materials. A banner made with wallpaper would catch fire and propagate it from the backside.

It is not uncommon to see non-compliant materials used for display and advertising in France: with the generalization of sprinklers, fume detectors, price difference between fire resistant and regular materials, temptation to cut costs exists and controls seldom happens.

Architects and indoor decorators on the other hand do care about M1 compliance, if only because of financial and penal liability they would be exposed to in case of incident resulting from usage of non-compliant materials. They show a strong tendency to "play by the book" and check that materials used in their projects have a certificate of compliance.

Sihl has a manufacturer of media for advertising and for wall-coverings is confronted with multiple challenges:

- Understanding and staying up to date with a complex EU regulation framework,
- Checking how it can applies to digitally produced wall-coverings,
- Informing Architects, indoor decorators and other actors operating in the wall-covering world about product compliance and signification in terms of performance when applied in "real life conditions".

The EU Standards:

Unifying different procedures, legislations and professional practices among 28 countries is a challenging task.

At present, common standards are set (the EUROCLASS):

Class	Performance description	Fire scenario and heat attack		Examples of products
A1	No contribution to fire	Fully developed fire in a room	At least 60 kW/m^2	Products of natural stone, concrete, bricks, ceramic, glass, steel and many metallic products
A2	"	"	"	Products similar to those of class A1, including small amounts of organic compounds
B	Very limited contribution to fire	Single burning item in a room	40 kW/m^2 on a limited area	Gypsum boards with different (thin) surface linings Fire retardant wood products
C	Limited contribution to fire	"	"	Phenolic foam, gypsum boards with different surface linings (thicker than in class B)
D	Acceptable contribution to fire	"	"	Wood products with thickness ≥ about 10 mm and density ≥ about 400 kg/m^3 (depending on end use)
E	"	Small flame attack	Flame height of 20 mm	Low density fibreboard, plastic based insulation products
F	No performance requirements	–	–	Products not tested (no requirements)

The EU has also put in place declarative procedures (DOP), whereas manufacturers can provide their clients with compliance certificates.

The project timetable and agenda is public, with time allowed for draft revision, appeals and consultation.

Unfortunately, work with EU it is a rather time consuming process, left in practice to lobbyist and it appears so far that interest and perspective of digital manufacturing is underrepresented.

As a consequence, regulations cover finished products, with derogation for hand-made traditional products, without taking in account digital production.

Digital production specificities:

In case of digital inkjet wallpaper production, we start from an inkjet coated or treated wallpaper base.

The material is then printed, through application of color via inkjet process (water, solvent, eco-solvent or UV types), then eventually varnished or liquid laminated.

The base material itself is treated to become flame-retardant, usually through impregnation of suitable chemistry. During development, possible interactions between fire retardancy chemicals, inkjet receptive coating components have to be addressed as some tends to be hydrophilic, some hydrophobic.

The applied inks affect the surface structure of the wallpaper: in the case of solvent and eco-solvent inks, volatile substances and potentially burnable chemicals could in theory remain into the media and alter slightly the fire retardancy process heavy process.

In the case of UV inks, (polyester acrylate based resins) are added on to the surface of the wallpaper, creating an extra layer.

Last but not least, the imaged wallpaper can be varnished or liquid laminated, with application of 10 to 50 gm/sqm of materials.

The resulting commercial product is this clearly different to very different from base wallpaper, as delivered together with fire rating by the vendor.

It is thus legitimate form Architects and designers to question the performance of the finished product, as their moral and financial responsibility is engaged in case of problem.

Testing methodology:

Sihl researchers defined a grid of test options, with combinations to be explored. Commercial considerations were taken in account to define priorities in initial testing phase. As most of Sihl users operate with water-based (traditional typed or Latex) and Ecosolvent, we started with these.

Regarding UV inks, we noticed a great variety of resins, so that we postponed testing to a second phase.

As for finishing options, we also plan testing with most representative combinations (selective varnish applications) in a second phase.

Ink types / products	Water-based	Eco-solvent	Heavy solvent	UV-inkjet
IJ coated wallpaper unprinted reference	***Persomural 3260***	***Persomural 3259***	3259	3260
Fire-retardant treated material unprinted	***Modified 3260***	***Modified 3259***	Modified 3259	mod. 3260
IJ coated wallpaper printed reference	***Persomural 3260***	***Persomural 3259***	3259	3260
Fire-retardant treated material printed	***Modified 3260***	***Modified 3259***	Modified 3259	mod. 3260

(items in bold have been treated during 1st phase of research)

Tests are conducted with standard printed patterns. Media is applied on a rigid surface.

"With a flame application time of 30 seconds for classes B, C and D, the maximum duration of the test is 60 seconds after the removal of the flame. The test is terminated earlier if no ignition is observed after the removal of the flame source, or the specimen ceases to burn (or glow), or the flame tip reaches the upper edge of the specimen".

Other Euroclass matters such as drips and droplets are noted, but not measured.

As material used is non-woven based, smoke release is not an issue and has this been excluded from testing.

Ink types / products	Water-based	Eco-solvent	Heavy solvent	UV-inkjet
IJ coated wallpaper unprinted reference	***May burn***	***May burn***		
Fire-retardant treated material unprinted	***Self extinguishes***	***Self extinguishes***		
IJ coated wallpaper printed reference	***May burn***	***May burn***		
Fire-retardant treated material printed	***Self extinguishes***	***Self extinguishes***		

The provisional conclusion is that we see no significant differences between printed and unprinted samples, nor a difference of behavior between samples printed with water-based inks and eco-solvent inks. We suspect that traces of solvent present in the finished products are at a level too low to alter the properties of the fire retardant chemistry.

The most disturbing factor was the role played by proper application of glue – when wallpaper present blisters or in areas where paper and wall are not glued together, fire would spread via the backside of the paper.

As a consequence, fire retardancy performance of an interior depends upon selection of suitable materials and professional application (or the industry would have to endorse more expensive media treated on both sides).

To compete testing Sihl researchers added a second impregnation with fire-retardant material on the backside. The compatibility between fire-retardant chemistry and non-woven wallpaper glue (Metylan from Henkel used as reference) was tested and confirmed in the process.

Ink types / products	Water-based	Eco-solvent
IJ coated wallpaper unprinted reference	***May burn***	***May burn***
Fire-retardant treated material printed	***Self-extinguishes may burn on blisters/unglued areas***	***Self-extinguishes may burn on blisters/unglued areas Self extinguishes***
Fire-retardant treated front/back coated wallpaper	***Self-extinguishes even on blisters/unglued areas***	***Self-extinguishes even on blisters/unglued areas***

So far, this point has not been reported as a problem: non-woven wallpapers are not new and millions of square meters have been installed.

Nevertheless, we have the impression that the nature of fire-retardancy and the limitations are underestimated or misunderstood by a large public and that it could lead to risky configurations if the paper is used as an architecture paper, with backside exposed.

In that respect, it is interesting to compare European and Japanese approach, whereas Japan authorities would control fire-retardancy of material and of applied material.

The next milestone would be to check the impact of material addition on fire-retardancy, and a possible correlation between quantity of fire-retardant agent applied, quantity of ink-jetted material deposited and resulting impact on fire resistance performance.

Provisional conclusion:

Sihl researchers reached the conclusion that once printed with water-based or eco-solvent inks, fire-retardant wallpaper probably retain their properties. This could be confirmed at later stage via the testing of samples with high-inkload at official testing centers.

With UV inks, we suspect that the nature and quantity of ink applied might affect the media performance. We plan for 2014/2015 experiments with inks judged as most representative by Sihl clients.

There is also a false feeling of safety associated with usage of fire-retardant media: safety requires proper usage (media is not fire retardant when used outside of wallpaper application) and professional level of installation (a blotched installation job may results into a safety hazard).

It remains to be seen if the industry is ready to act or if it will rather wait for another possible disaster.

References

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[2] M1 standards (in French) – LNE Database service

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Authors Biographies

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