FIT CLASSIFICATION FOR ROOFING SYSTEMS

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A simple system to classify roof membranes by their level of performance was introduced in France in 1989 called the FIT classification.

This classification provides information on roofing systems based on their type of usage, taking into account the most important performance criteria determined by fatigue (F), indentation (I) and temperature (T), stresses that these systems are exposed to.

The FIT system defines, in relation to these three parameters, the roof performance requirements. This system can be used to determine what membrane/insulation systems will perform on specific types of roofs.

For each characteristic, a numerical index of 1 to 4 or 1 to 5, describes either the requirement of the roof or, symmetrically, the performance of the appropriate membrane. The index increases with the severity of the requirement, and with the performance capacity of the membrane.

Based on test results, membranes are classified FxIyTz. A group of experts, based on their experience and knowledge, have classified performance requirements of roofs as FxIyTz. Examples of FIT requirements adopted in France since 1989 will be presented.

KEYWORDS

Classification, fatigue, performances, puncture, requirements, roofing systems, temperature.

INTRODUCTION

In France, the FIT performance classification for roofing systems is a direct result of research done on roofing techniques, with an emphasis on quality.

From the 1970s to present, the proportion of claims for damages in building construction attributable to low slope roofing have been reduced from 18 percent to five percent; even less than one percent if only the field of the membrane is under examination.*

This remarkable progress is based on the idea of roofing systems rather than of materials, taking into account the specificities of the substrates, and selecting SBS-modified bitumens roofing membranes instead of disappointing air blown bitumen.

This evolution towards thinking about systems is reflected in the French technical documentation, Codes of practice DTU for continental France,[1] Professional guidelines for tropical and equatorial areas concerning France overseas,[2] Guidelines for roofing in mountain areas,[3] UEAtc (Union Europeenne pour l'Agrement Technique dans la Construction) general and specific guidelines,[4,5] and agréments of roofing membranes.

The peculiarities of the substrates are evaluated following the UEAtc guidelines for roof insulating substrates,[6] and in France, the agréments formulated to those substrates.

The organization of the French technical documentation consists of:

- Codes of practice DTU or professional guidelines, if any, describe the principles of a sane design.
- Agréments on insulating and roofing systems examine the general fitness for use of the products, and the producer's recommendations for their installation, to include adjustment capabilities to the DTU principles, or to induce their evolution in a rational way.
- The technical codification is prepared in joint authorship between representatives of building owners, designers, contractors and CSTB, taking into account the results of the research. Obviously, the high quality of this documentation reflects the technical communication between building partners, each of them preserving his own strategy.

In this general framework, both the CSTB,[7] on behalf of social public housing bodies, and the CSNE,[8] on behalf of roofing contractors and producers, have drawn up a classification system conceived as a complementary way for communication. In the FIT classification, the building owner or designer defines the resistance to fatigue, indentation and temperature the roofing project requires, and clearly expresses his choices using the FIT requirement indexes. This way, the roofing contractor can easily prove that his proposal corresponds to the requirements of a particular membrane by using the FIT performance indexes.

In this dialogue, the agrément of the roofing system is a vector of information, expressing the capability of the insulation and the roofing membrane to adjust the general requirements of a durable waterproofing. Next, expressing the FIT classification of the roofing membrane to be compared with the particular requirement of the project.

The FIT classification system has been in place since October 1989. The first applications began in spring 1990 and progressively extend via a request by important building owners, and public (Army, Navy, Social Housing) and private (motor car industry) groups.

**In France, the 10-year guarantee and the obligation of insurance is applied by law to building construction. Claims, during this period of time, are centralized by insurance boards and may be analyzed. The base for the data are the number of claims presented every year, which are 10,000 to 15,000.*

THE FIT CLASSIFICATION

General

The FIT classification of roof membranes determines their fitness for use with respect to the following parameters:

F—Fatigue

I—Indentation (puncture)

T—Temperature

Each letter is assigned a numerical index, providing a brief, yet precise, indication of the parameters; either the requirements to be satisfied by the roof system in question, or, symmetrically, the performance capacity of the appropriate roof membrane.

The index increases with the severity of use required of the roof system and with the level of performance offered by the roofing membranes.

For each parameter (letter) of the classification, the roofing membrane must have a performance index at least equal to the requirement index of the roof system in question.

Classification of Roofing Membranes

The classification of nontraditional roofing membranes is given in the agrement technical documentation. Only membranes from manufactured sheets have been classified thus far. Classes are determined on the basis of satisfactory results obtained in testing.

The classification F (fatigue resistance) index is based on the results of the fatigue test (resistance to substrate movement, see Figure 1).

This test, conventionally conducted on adhered roofing membranes at a selected temperature, characterizes the membrane resistance to movement of the substrate at a given amplitude consisting of 500 cycles for unaged membranes and 200 cycles for aged membranes. Table 1 indicates the conditions under which indices one to five are determined.

The classification I resistance to indentation (puncture) index is based both on the static puncture test and the dynamic puncture test (see Figure 2).

Table 2 depicts the conditions under which the L subclassification indices 1 to 4 are determined (resistance to static puncture). Table 3 shows the conditions under which the D subclassification indices 1 to 3 are determined (resistance to dynamic puncture). Table 4 indicates the conditions under which the classification I indices 1 to 5 are determined (resistance to static and dynamic puncture) based on a combination of subclasses L and D.

Classification T (temperature stability) concerns slippage resistance under the effect of temperature (see Figure 3). Determination of the classification T index is based on the roof membrane slippage test. Table 5 specifies the conditions under which indices 1 to 4 are determined.

Classification of the Membrane Uses According to the Intended Purpose of the Roof and to the Membrane Substrate

Classification of the roof system, established by a group of experts, is based on experience acquired with a certain number of roofing membranes and knowledge of their performance.**

***This group of experts is currently in charge of approving Agrements of Roofing Systems, Codes of Practice. It is composed of 30-35 people including scientists, designers, building quality control boards, producers and contractors.*

The ascending order of the indices assigned to each of the FIT letters, corresponds to increasingly severe conditions of use.

Table 6 provides total classification envisaged for the system, including:

- The F classification for the roof with respect to the fatigue level of the membrane, in view of the following:
  - Movement of the membrane substrate which mainly results from heat stresses, with or without ballast.
  - The roof system is considered to be an adhered system when the membrane is not ballasted, and a loose laid system when the protective surfacing is a ballast or concrete pavers. Mechanically fixed systems are not classified at this moment.

  The fatigue criteria have been grouped together in three classes of risks from 3 to 5.
- The I classification of the roof system with respect to the puncture of the membrane in service, related to the intended purpose of the roof. The puncture criteria have been grouped together in four classes of risks from 2 to 5.
- The T classification of the roof system with respect to the risk of slippage of the membrane in the field of the roof. This classification takes into account the thermal resistance and thermal mass of the membrane substrate, the protective surfacing on the membrane and the roof slope. Under the climatic conditions of continental France, the thermal stability criteria have been grouped together in three classes of risks from 1 to 3.

Based on the premise of increasing performance capacity, a membrane classification greater than that of the intended use is a wise precaution. This is particularly true when the FIT parameters, under which the membrane is used, are more severe than usual.

For drafting performance-based bids on "roof waterproofing work," architects, engineers and users should note that the bid should consist of:

- An indication of the type of deck (see Table 6).
- The presence or absence of an insulation substrate set on the deck and, in this case, the thermal resistance required.
- The intended use of the roof and the type of surfacing (see Table 6).
- The FIT classification required for the roof membrane.

Determination of the FIT Performances Test Conditions

The test conditions for the determination of the classes F, I and T are described in the FIT classification documentation[9] and correspond to the CIB/RILEM Roofing Membranes Joint Committee Recommendations.[10] It is currently envisaged to replace the fatigue test method by calculation, using a model, if any model should be agreed upon by the European Organization for Certification (EOTR).

REFERENCES

1. Document Technique Unifié DTU série 43 Travaux d étanchéité de toitures, Cahiers du CSTB, 4 avenue du Recteur Poincaré, F 75116 Paris
2. Règles Professionnelles Travaux d'étanchéité de toitures en climats tropicaux ou équatoriaux, mai 1990, CSNE, 9 rue Lapérouse, F 75016 Paris, 61pp.

[5] Guide des toitures en climat de montagne, Cahier du CSTB n 2267, sept. 1988, 39pp.

[4] Directives générales UEATC pour l'agrément des revêtements d'étanchéité de toitures, Cahier du CSTB n° 1812, nov. 1982.

General directive for the assessment of roof waterproofing systems, MOAT n 27/1983, British Board of Agrement, P.O. Box 195, Bucknalls Lane, Watford, WD2 7NG UK.

[5] Directives Particulières UEATC pour l'agrément des revêtements d'étanchéité en bitume modifié, en PVC plastifié, en EPDM, Cahiers du CSTB n° 246-3 et-4 janv. 1984, n° 1813, nov. 1982, n° 2299 aout 1988.

Special directives for the assessment of waterproof coverings of modified bitumen, PVC sheets, vulcanized EPDM, MOAT n° 30-31-29-46.

[6] Directives UEAtc pour l'agrément des systèmes isolants supports d'étanchéité de toitures, Cahier du CSTB n° 1750, déc. 1981, 26pp.

[7] CSTB: Centre Scientifique et Technique du Batiment, organisme public.

[8] CSNE: Chambre Syndicale Nationale de l'Etancheité, union professionnelle des producteurs et entrepreneurs françcais.

[9] Classement FIT des étanchéités de toutures, Cahier du CSTB n° 2358, sept. 1989, 12pp. (French and English issue).

[10] Rilem 75—CIB W83 Joint Committee Roofing Membranes, Elastomeric, Thermoplastic, and Modified bitumen Roofing Membranes, Nov. 1988, a NBS/NRCA report.

J.C. Marechal, M. Ghaleb, and D.Bonnet, Viellissement des revêtements d'étanchéité en bitume élastomère SBS, Cahier du CSTB n° 1831, mars 1983, 27pp.

et: Comportement mécanique des revetements d'étanchéité associés a un support isolant, Cahier du CSTB n° 2105, oct. 1986.

B. Fabvier and A. Chaize, Mechanical behavior of roofing applied on insulation board, development of a mathematical model, symposium on mathematical modeling of low slope roof system, ORNL Roof Research Center, Oak Ridge, Tenn., USA, Sept. 1988.

Class F	Initial width of joint (mm)	Amplitude of joint movement (mm)	Test temperature (°C)
F_1	1	−.5 to + .5	+20
F_2	1	−.5 to + .5	0
F_3	2	−1 to + 1	0
F_4	2	−1 to + 1	−10
F_5	2	−1 to + 1	−20

Table 1 *Conditions under which indices 1 to 5 are determined for classification F.*

Subclass L	Load (kg)
L_1	◄ 7
L_2	► 7
L_3	►15
L_4	►25
Note: It is presently suitable to consider, in the case of single-ply membranes, a classification L3S which has a resistance at least equal to 20 kg.	

Table 2 *Conditions under which the L subclassification indices 1 to 4 are determined for classification I (resistance to static puncture).*

Subclass D	Energy (J/cm2)
D_1	◄10
D_2	►10 ◄20
D_3	►20

Table 3 *Conditions under which the D subclassification indices 1 to 3 are determined for classification I (resistance to dynamic puncture).*

Roofing class I	Subclasses L/D	
I_1	L_1	D_2
I_2	L_2	D_2
I_3	L_3	D_2
I_4	L_4	D_2
I_5	L_4	D_3
Note: It is suitable, for single-ply membranes, to consider a classification I3S for the subclasses L3SD2.		

Table 4 *Conditions under which the classification I indices 1 to 5 are determined based on a combination of subclasses L and D.*

Classification T	Slippage amplitude	Test temperature (°C)
T_1	►2	+60
T_2	◄2	+60
T_3	◄2	+80
T_4	◄2	+90

Table 5 *Conditions under which indices 1 to 4 are determined for classification T.*

Membrane substrate	Slope	Roof Use and Type of Protection: Not Functional (maintenance) Factory applied surfacing	Not Functional (maintenance) Ballast (coarse gravel)	Functional (access) Roof Pedestrian Vehicles Slabs-pavers		Functional (access) Roof Pedestrian Protection slabs on spacers	Gardens Direct drainage layer	Equipment Maintenance Walkways Factory applied surfacing	Walkways Slabs (above coarse gravel)
thermal insulation	0	$F_4I_2T_2$(3)(4)	$F_3I_3T_1$(5)			$F_5I_4T_3$	$F_3I_5T_1$	$F_4I_4T_2$	$F_3I_3T_2$(5)
	low slope	$F_4I_2T_2$(3)(4)	$F_3I_3T_2$(5)	$F_4I_4T_2$	$F_4I_4T_2$	$F_5I_4T_3$	$F_3I_5T_2$	$F_4I_4T_2$	$F_3I_3T_2$(5)
	pitched	$F_4I_2T_2$(6)						$F_4I_4T_2$(6)	
concrete	0	$F_4I_2T_2$	$F_3I_3T_1$			$F_5I_4T_3$	$F_3I_5T_1$	$F_4I_4T_2$	$F_3I_3T_2$
	low slope	$F_4I_2T_2$	$F_3I_3T_2$	$F_4I_4T_2$	$F_4I_4T_2$	$F_5I_4T_3$	$F_3I_5T_2$	$F_4I_4T_2$	$F_3I_3T_2$
	pitched	$F_4I_2T_2$						$F_4I_4T_2$	
concrete + protected membrane	0		$F_3I_3T_1$			$F_3I_3T_2$(2)	$F_3I_5T_1$		$F_3I_3T_1$
	low slope		$F_3I_3T_2$	$F_3I_3T_2$		$F_3I_3T_2$(2)	$F_3I_5T_2$		$F_3I_3T_2$
cellular concrete	low slope	$F_4I_2T_2$	$F_3I_3T_2$					$F_4I_4T_2$	$F_3I_3T_2$
	pitched	$F_4I_2T_2$						$F_4I_4T_2$	
wood and derived panels	low slope	$F_4I_2T_2$	$F_3I_3T_2$					$F_4I_4T_2$	$F_3I_3T_2$
	pitched	$F_4I_2T_2$(6)						$F_4I_4T_2$(6)	
existing membrane	0	$F_4I_2T_2$	$F_3I_3T_2$			$F_5I_4T_3$	$F_3I_5T_1$	$F_4I_4T_2$	$F_3I_3T_2$
	low slope	$F_4I_2T_2$	$F_3I_3T_2$	$F_4I_4T_2$	$F_4I_4T_2$	$F_5I_4T_3$	$F_3I_5T_2$	$F_4I_4T_2$	$F_3I_3T_2$
	pitched	$F_4I_2T_2$(6)						$F_4I_4T_2$(6)	

1. Index I becomes I3S for single-layer membranes
2. Index I becomes I4 for single-layer membranes
3. Index I becomes I3 for mineral wool on concrete and cellular concrete
4. Index I becomes I3 on Rth ►2m2.°C/W mineral wool***
5. Index I becomes I4 for mineral wool on concrete and cellular concrete and for expanded polystyrene
6. Index T becomes T3 if Rth ►2m2.°C/W (see Note)

Note: Slope "pitched" indicates roofs with slopes greater than 3 to 5 percent.
***Rth means thermal resistance.►$2m^2°C/W$ means unusual values of high insulation.

Table 6 *FIT classification recommended classes F-I-T.*

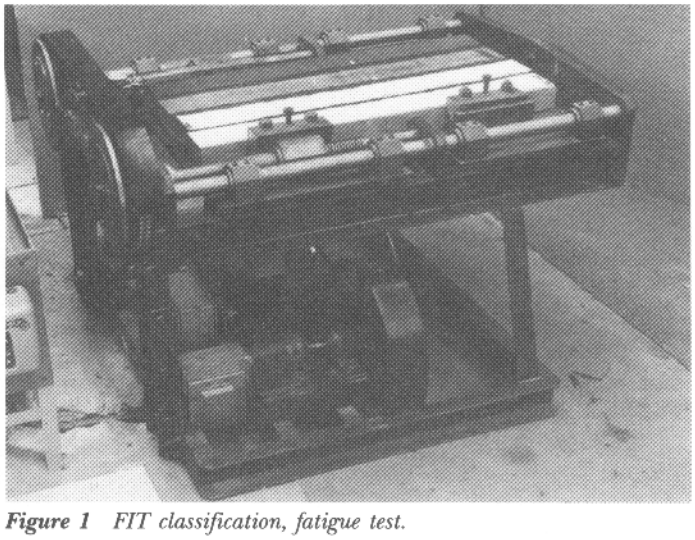

Figure 1 *FIT classification, fatigue test.*

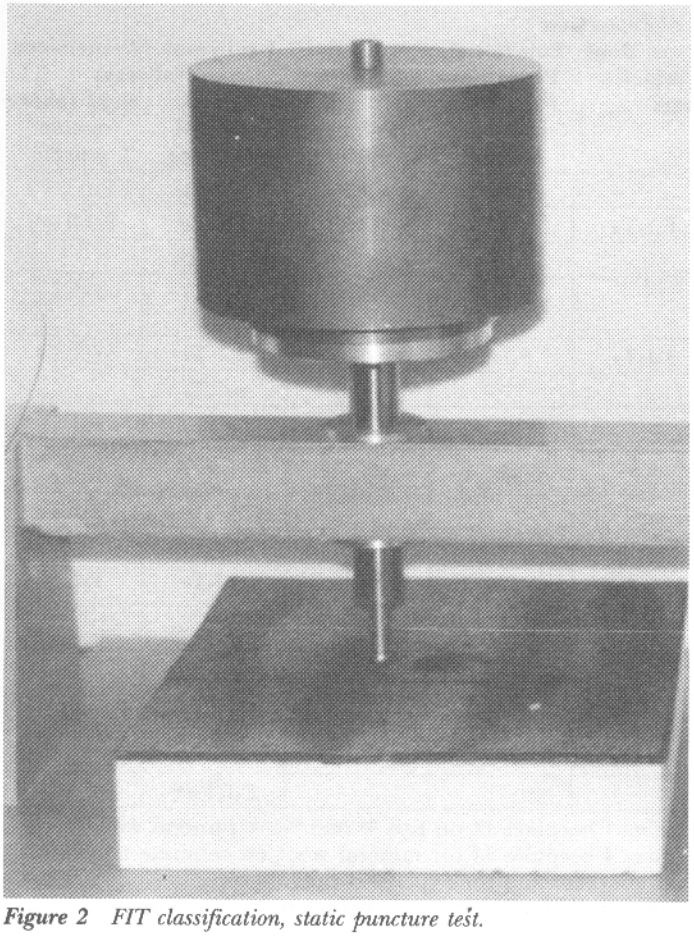

Figure 2 FIT classification, static puncture test.

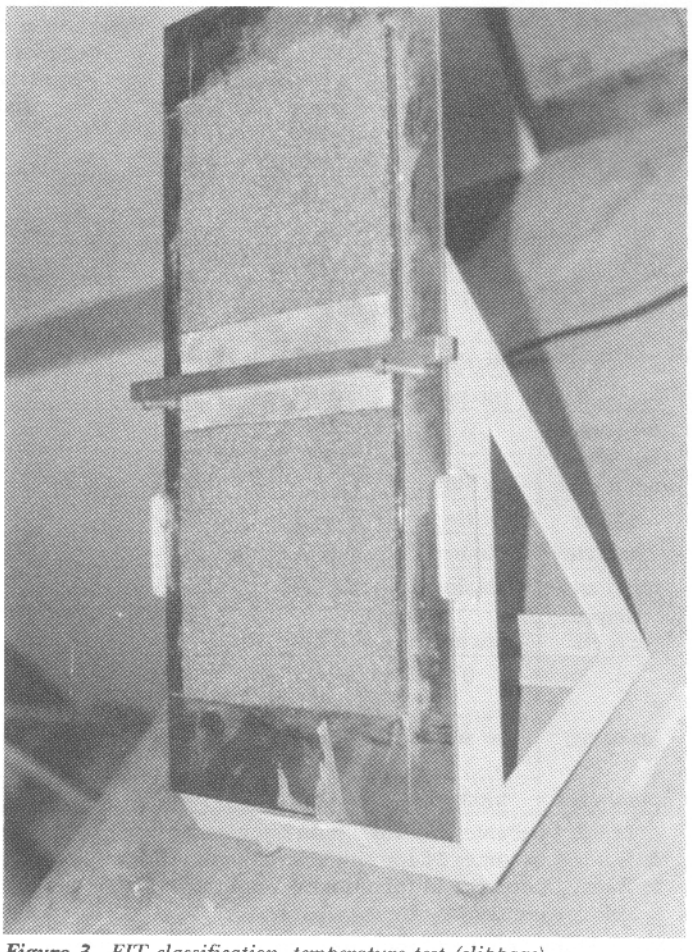

Figure 3 FIT classification, temperature test (slippage).