



# Water resistance of rigid polyurethane

## SUMMARY

Rigid Polyurethane foam shows very little propensity to absorb water due to its closed-cell structure and hydrophobic nature. The water absorption in small scale test in laboratory is usually below 2%. For this reason, rigid polyurethane foam outperforms other insulation materials regarding water resistance e.g. in wall or roof applications.

In situ rigid polyurethane foam tested according to EN 12865 (large scale test which simulates real exposure) is water resistant up to 1800 Pa, which corresponds to a wind speed of 197 km/h. Therefore, following the new Spanish regulation, in situ rigid polyurethane foam is the only insulation material which can achieve the maximum water resistance level on masonry façades without any other requirement.

## BACKGROUND

Water resistance of rigid polyurethane foam is a very important property which can give some advantages in certain applications. Thanks to its closed-cell structure and hydrophobic nature, rigid polyurethane foam shows very little propensity to absorb water. There is a lot of information which indicates that water absorption is usually below 2% in volume. However, these are small scale tests such as EN 12087 or EN 1609 carried out in

static conditions and do not show real exposure of rigid polyurethane foam to rain or wind, which is desirable in order to assess the water resistance potential of the material in real conditions.

For that reason there was an interest to carry out some medium scale testing reproducing as realistically as possible a typical application using rigid polyurethane foam.

## TEST CHOICE AND RESULTS

In 2006 a new regulation, the Technical Code for Buildings (CTE), came into force in Spain to be in line with the European Construction Directive. In order to collect technical data, the Spanish government asked the Instituto Valenciano de la Edificación (IVE) [1] to start a study for assessing the water resistance of the most common construction solutions, most of them including thermal insulation. The IVE followed the EN 12865:2001 standard, "Hygrothermal performance of building components and building elements. Determination of the resistance of external wall systems to driving rain under pulsating air pressure", to carry out the study. Thus, this standard has been chosen as the reference test to assess the water resistance of in situ rigid polyurethane foam. According to this standard, a medium sized wall (1.2 m width, 2.4 m height 105 mm thickness) sprayed with in-situ rigid polyurethane foam on one of its

sides (inner face) can be tested.

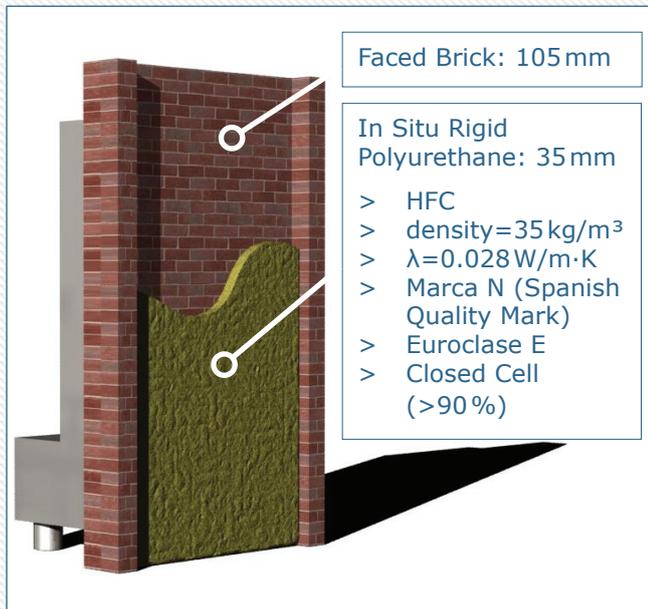


Figure 1: test specimen 1.2m width and 2.4m height

Once the wall was built, a pressure chamber was attached to the external face (the one not sprayed with polyurethane) and the test started. Water was projected inside the pressure chamber through nozzles with increasing pressure pulses which simulated rain at different wind speeds. The test stops when water penetration is observed in the inner face of the wall or when the pressure reaches its maximum (1800Pa) with no water penetration at all. The test was carried out at CIDEMCO facilities in Azpeitia (Spain). [2]

The construction solution with in situ rigid polyurethane foam showed no water penetration during the test (see **Table 1**). As a result polyurethane is demonstrated to be water resistant up to a pressure of 1800Pa, which corresponds to a wind speed of 197Km/h.

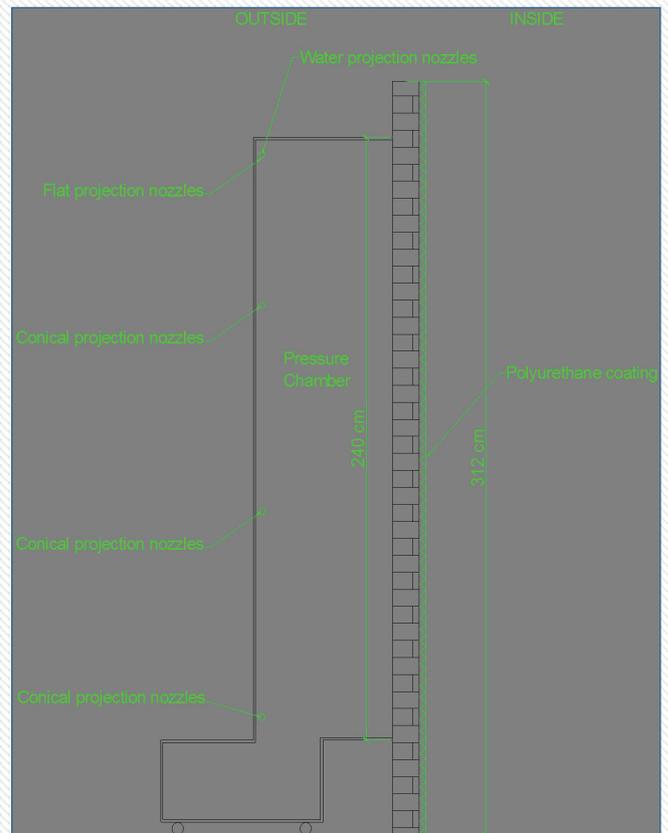


Figure 2: pressure chamber attached to test specimen

Difference in Pressure (Pa)	Time interval (min)	Total time (min)	Water penetration
0	20	20	Not observed
0-150	10	30	Not observed
0-300	10	40	Not observed
0-450	10	50	Not observed
0-600	10	60	Not observed
0-750	10	70	Not observed
0-900	10	80	Not observed
0-1050	10	90	Not observed
0-1200	10	100	Not observed
0-1350	10	110	Not observed
0-1500	10	120	Not observed
0-1650	10	130	Not observed
0-1800	10	140	Not observed

Table 1: water penetration at different time and pressure

## CASE STUDY – SPAIN AND ITS NEW BUILDING REGULATION (CTE)

Since 2006 the Technical Code for Buildings (CTE) is the required regulation for buildings in Spain. CTE is divided in several Basic Documents (DB) which give a guidance for easier use. Among them the one dealing with fitness (DB-HS) establishes the water resistance requirements for façades. Depending on the pluviometry (measurement of rain incidence) and wind of a given geographical area, the water resistant requirement for façades ranges from grade 1 (the lowest) to grade 5 (the toughest).

The results obtained according to EN 12865:2001, which take into account the two parameters (rain and wind) mentioned above, indicate that a typical construction solution in Spain using in situ rigid polyurethane foam (**Figure 3**) will comply with grade 5, and therefore is valid in all scenarios.

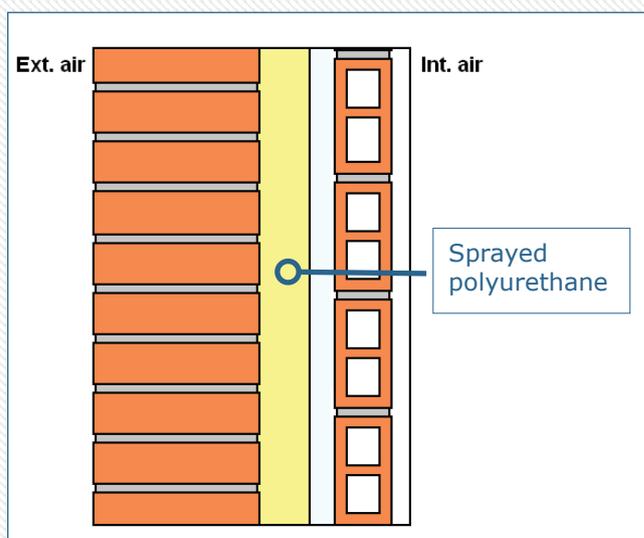


Figure 3: typical constructive solution in Spain

In this particular case, the water resistant nature of the in situ rigid polyurethane foam is a tremendous advantage against other insulation materials. In situ rigid polyurethane foam is the only insulation material which can achieve grade 5 without the need of a concrete layer in the inner face of the masonry wall.

### References

- [1] [www.five.es/actividades/investigacion.php](http://www.five.es/actividades/investigacion.php). IVE is an aseptic private institute financed by the Regional Government among others
- [2] [www.cidemco.es](http://www.cidemco.es). Report 13752-1 from 27/06/2006

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