

SETTING

Operators often use the term 'workmanlike' as if there was a rule to define the parameters in the art of window installation. Installation must always be supported with a project, planned as follows:

- Structure/ supporting elements
- Components

During installation these two parts of the project often are carried out by different people, who may have undergone different or even opposed training and tradition. Installation is most important for those kinds of elements such as doors and windows. Good project and good construction may be invalidated by rough and superficial installation.

'Not-workmanlike' installation underlines any faults of doors and windows.

Installation is when the user is told that the installed element meets all the requirements and fulfils expectancies.

In the last years, installation has been under discussion both nationally and in Europe, laying the groundwork for the instruction of normative processes which usually refer to practical codes.

Main components of installation:

- Transport conditions
- Package features
- Installation precautions
- Accuracy and installation
- Timing
- Finishing
- Relation with customers
- Cleaning of the installation yard
- Knowledge of problems and performances of the element.

General provisions

The following aspects must be verified:

- Building plan and doors and windows abacus and their actual correspondence
- Access ways to the different floors
- Availability of external scaffoldings
- Availability of lifting means
- Type, form and position of internal and external balconies
- Masonry finishing
- Characteristics of the boxes, of roller shutters or traditional blinds
- Kind of windowpanes
- Kind and orientation of windows opening
- Kind of windows fixing to the wall
- Special installation provisions according to acoustic insulation requirements
- Special installation provisions according to thermal expansion values

Thermal expansion calculation

As everybody knows, the linear thermal expansion of PVC profiles is higher than in other materials, which are traditionally employed for external doors and windows (wood and aluminium). This factor must be taken into consideration when designing and installing door and window systems, especially for large windows or windows banks.

The coefficient value generally is of 7×10^{-5} mm/mm °C, i.e. 0.07 mm. of shortening or expansion for a 1 m profile for a temperature increase or decrease of one °C degree.

The aforementioned thermal expansion value has a purely theoretic value and can be applied to a profile undergoing a uniform and constant heating process without any kind of ventilation. It is therefore a mere material characteristic and cannot be taken into consideration for the calculations made for traditional windows, installed in completely different situations.

PVC windows present different characteristics for the following reasons:

1. The presence of chambers in extruded profiles often favours internal air convective motions that distribute and make the temperature homogeneous in the different parts of the frame, so that surface thermal peak are rapidly reduced. Moreover, the numerous screwing links of PVC extruded profiles with other materials forming the different components of the system, contribute to the distribution of expansion so that the result is an "average" expansion. The reference temperature to assess the value of expansion must therefore be an average of the surface temperature of the internal and external profile sides.
2. The expansion of PVC is reduced with the insertion and fixing of metal reinforcements on the profiles and through the insertion of ironware on the wings, with appropriately distanced screws. As far as the fixed frame is concerned, it will be fixed to the surrounding masonry wall and this will therefore influence its behaviour. The expansion and shortening values of a fixed frame will correspond to about to 2/3 of the theoretic ones, as shown in practice.

The expansion and shortening value must therefore be based on the following parameters:

- A profile exposed to sunrays can reach an external surface temperature of about 44 °C (white and light colours) and 70°C (dark colours).
- A minimum external temperature of about -16 °C will be taken into consideration based on the normal Italian climatic conditions.
- The internal temperature of a room is generally fixed at + 20 °C, with slight differences between summer and winter.
- This means that the mean temperature in the middle of the profile will undergo the following changes:

Light profiles

$(20^{\circ}+44^{\circ})/2=32$ °C in summer

$(20^{\circ}-16^{\circ})/2=2$ °C in winter

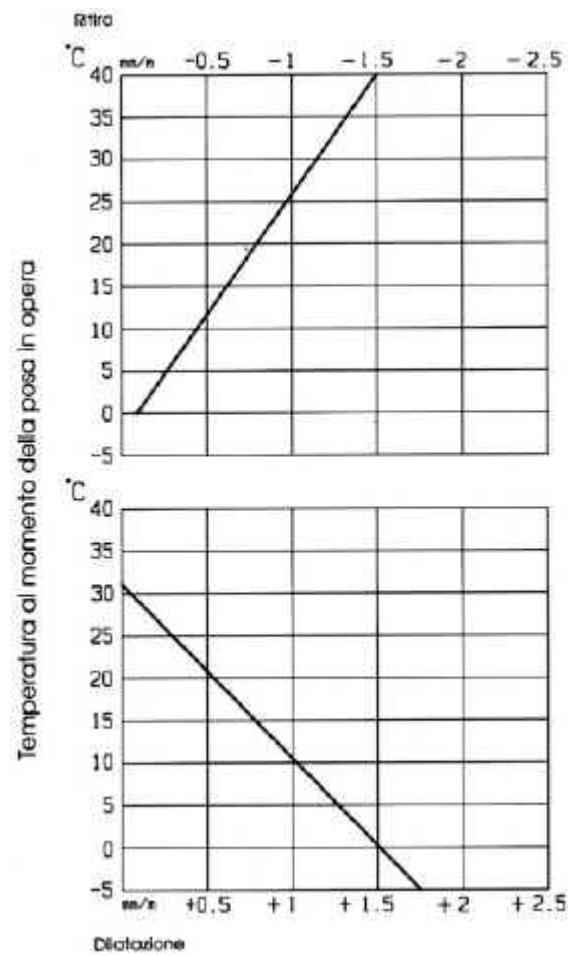
Dark profiles

$(20^{\circ}+70^{\circ})/2=45$ °C in summer

$(20^{\circ}-16^{\circ})/2=2$ °C in winter

It is clear that only the temperature at which the window is installed will determine the value of expansions and shortenings.

Thanks to the graphs of the following table (Tab. 4.4.2.A) it will be easy to assess the possible shortening value, so that windows can be installed with appropriate expansion joints.

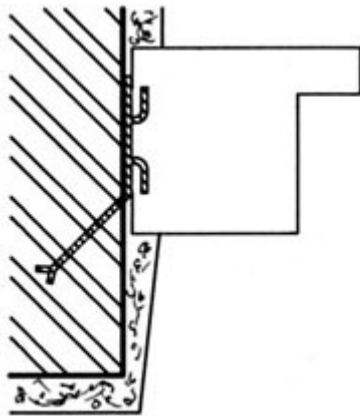


Tav. 4.4.2.A - Expansion and shortening (temperature at the moment of installation – Expansion)

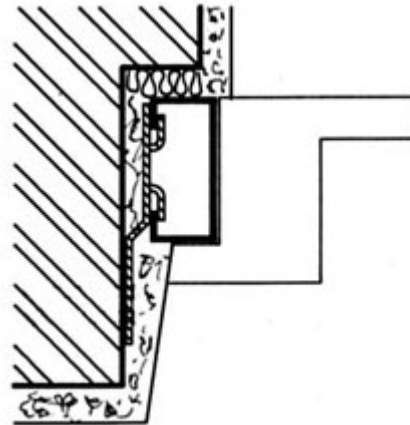
Fixing to the wall

Windows are fixed to the wall in four different systems:

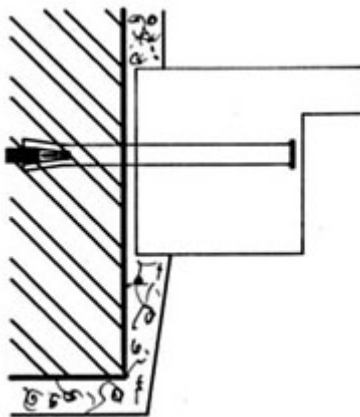
- Fixing with screwed or walled metal clamps
- Fixing with expansion inserts
- Fixing to the sub-frame with special screws
- Fixing to an old case (renovation)



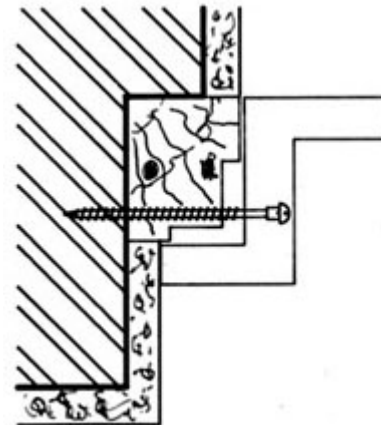
Walled metal clamps



Metal clamps fixed to the subframe

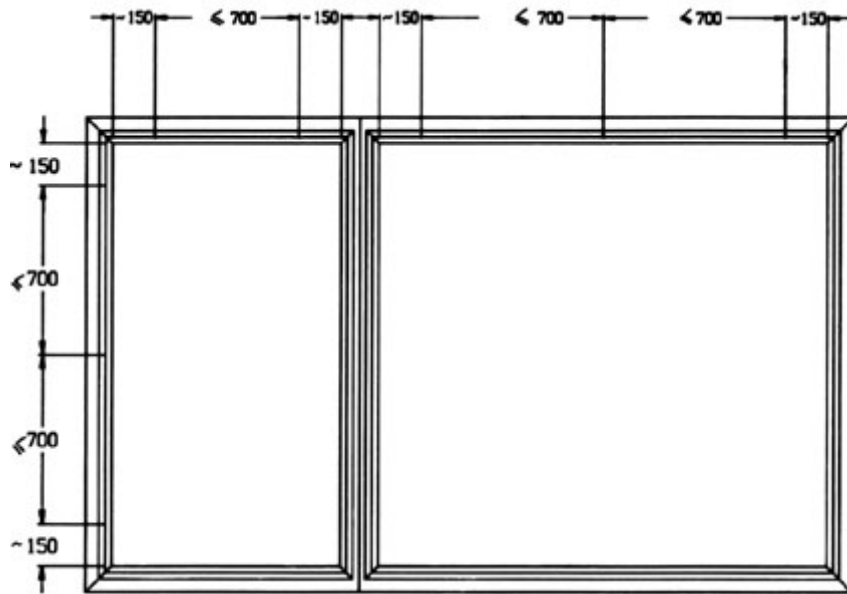


Fixing with expansion inserts



Fixing to an old case (renovation)

The fixing points must not be far more than 70 from each other and must be far no more than 15 cm. from the window angles and from the fixing points of the fixed frame with transoms and posts. The vertical elements of frames must have at least to wall fixing points. The fixing points layout is shown in the following table (Tab. 4.3.3.A)



Tav. 4.3.3.A
Window fixing points to the wall

Preparatory works

The following preparatory work must be carried out:

- Measure the holes and compare them to the measures indicated in the project
- Verify the access ways to the different floors and the possible use of existing external scaffoldings and cranes
- Agree with the clerk of works on the couplings, on sealing systems, on the window fixing to the walls and other details.
- Assess the expansion joints dimensions according to the windows width and colour.

Windows setting

Before actually installing the windows, it is necessary to assess if tolerance limits have been respected for the window openings. Windows must then be installed perfectly vertical and in line. The correct adjustment and the temporary fixing of windows will be obtained with wedges. The latter will then be removed and the window will be definitely fixed to the wall.

There are two kinds of windows installation interventions:

1. Installation of a window in a new building
2. Installation of a renovation window on an existing wooden case used as anchoring support

In the intervention on new buildings, the window is installed on a perfectly squared window opening. The window opening can have a flat surface or have a ledge where the secondary frame and the case can be placed. The presence of a masonry ledge enables to realise better connection technical solutions, because it is a protection of joints and enables to better position the sealing beads and possible insulation materials.

In the case of window openings with a flat reveal, the installation of the window in line with the external profile must be avoided because with this solution the joints case/walls will be directly exposed to atmospheric agents. A distance of 10-12 cm. between the external masonry edge and the window is a sufficiently safe margin.

When the old wooden case is used as supporting element to anchor the new window in renovation interventions, the stability and solidity of the coupling of the case to the wall must be carefully verified together with the case general conditions. If these conditions are not fit, a rehabilitation intervention is required.

In the event of window replacing, special attention must be given to the question of sealing. Some examples of sealing applications are listed hereunder:

- The dimension of the sealing bead must be compatible with the possible movement of the elements and with the sealant
- The application surface must be perfectly clean
- The sealing lines should be protected against the direct exposure to sun rays and heat

Windows fixing to masonry works

As previously stated the fixing points of the case to the wall are chosen according to the following criteria:

- Their number must not be lower than 4
- Their distance does not exceed 700 mm
- The distance of corners is about 150 mm
- They must be positioned as close as possible to the wing hinge points

Wall anchoring

Table 4.4.7.A helps to define the width of the joint between the case and the wall, according to the length of the frame. This applies both for light coloured windows and coated windows (dark).

Material	Element length	Joint width
PVC Light	< 1,5 m	10 mm
	1,5 ÷ 2,5 m	15 mm
	2,5 ÷ 3,5	20 mm
PVC Dark	< 1,5 m	15 mm
	1,5 ÷ 2,5 m	20 mm

Tav. 4.4.7.A - Joint dimensions

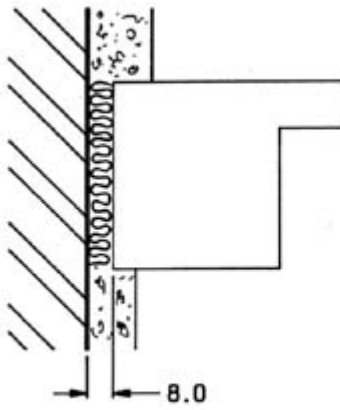
In order to determine the joint configuration, the thermal expansion and shrinkage of the frame must be assessed, with reference to the temperature at the moment of the installation and to the window colour. The effective shrinkage or expansion is obviously meant (see Tab. 4.4.7.B). The maximum value between expansion and shrinkage will be taken into account.

Temperature during the installation	Expansion		Shrinkage	
	Light PVC mm/m	Dark PVC mm/m	Light PVC mm/m	Dark PVC mm/m
25 °C	0,40	1,10	1,10	1,75
20 °C	0,60	1,25	0,85	1,55
15 °C	0,75	1,45	0,70	1,30
10 °C	0,95	1,60	0,50	1,20
5 °C	1,20	1,80	0,30	1,00

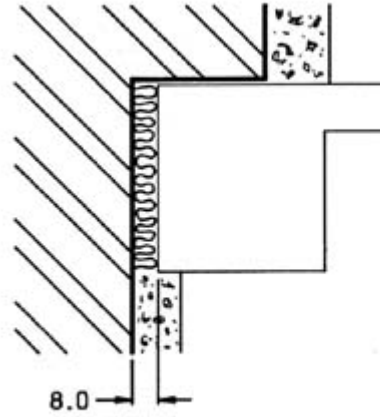
Tav. 4.4.7.B - Thermal expansion and shrinkage (length variation)

Tables 4.3.7.C - 4.3.7.D - 4.3.7.E show the joint conformation according to this value.

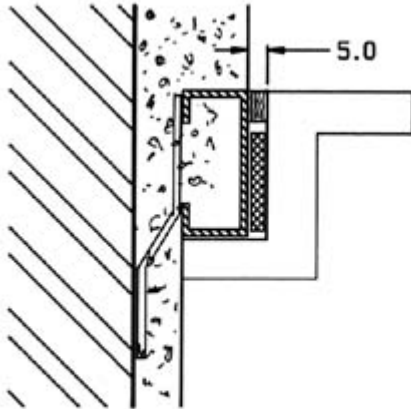
1) SU MURO MOZZO



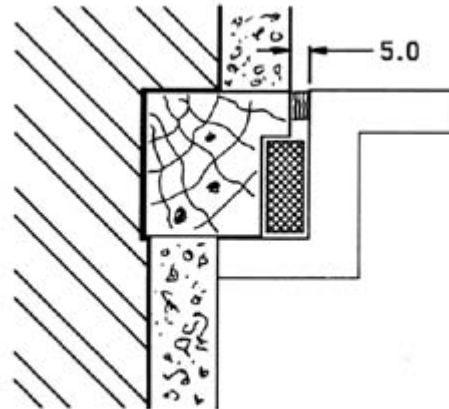
2) SU MURO CON MAZZETTA



3) SU FALSO TELAIO



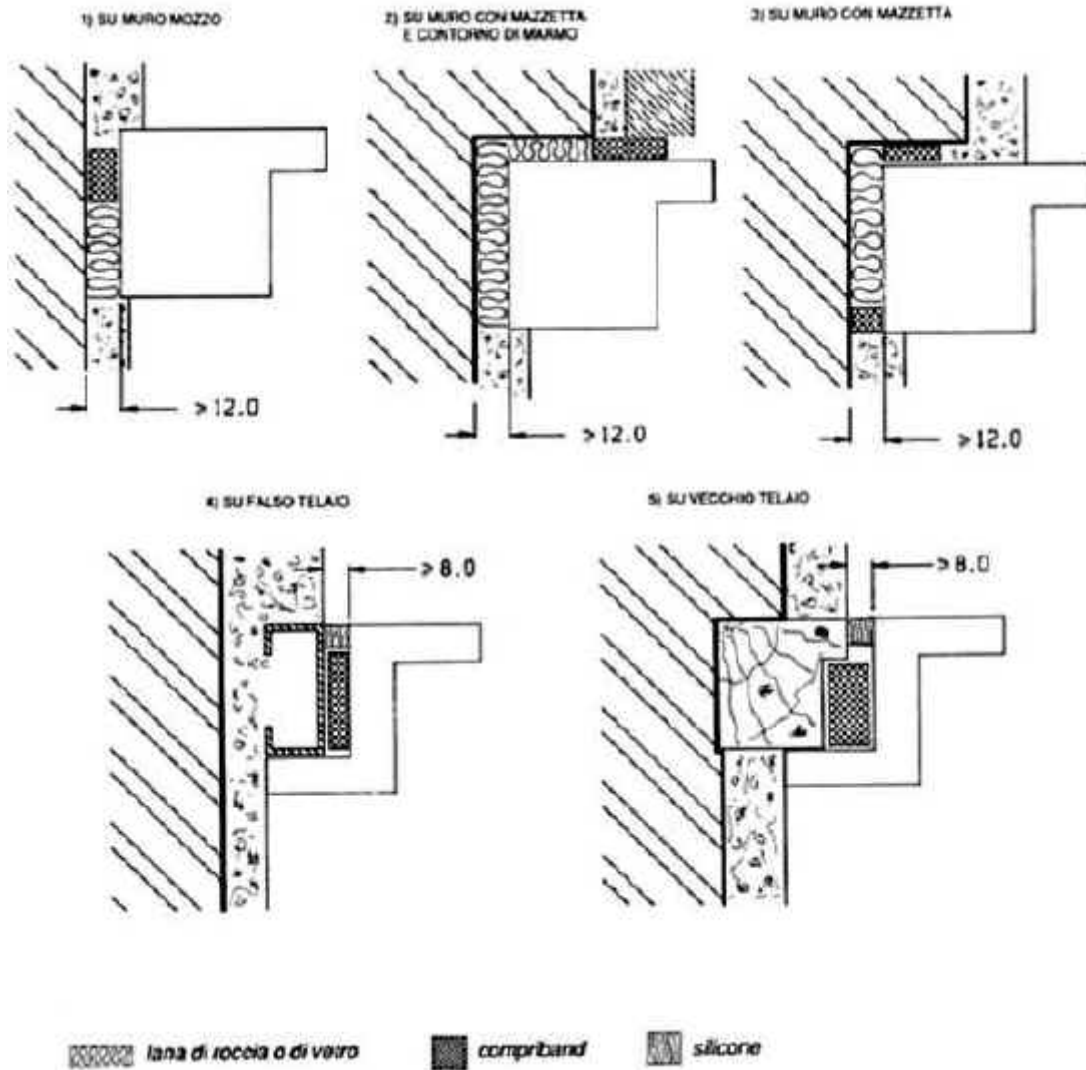
4) SU VECCHIO TELAIO



 *lana di roccia o di vetro*
  *comriband*
  *silicone*

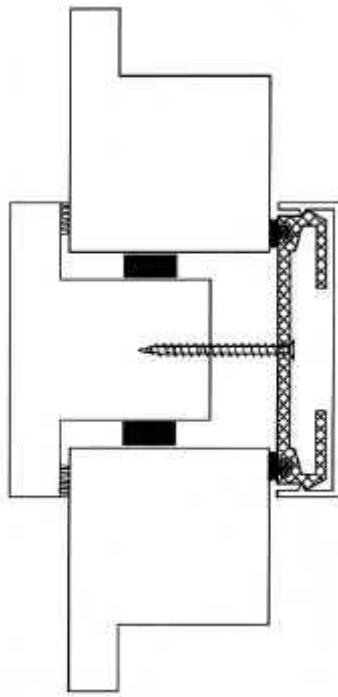
Tav. 4.3.7.C

Windows joint conformation with expected expansion < 1 mm



Tav. 4.3.7.D

Windows joint conformation with expected expansion from 1 to 4 mm



Tav. 4.3.7.E

Example of median joint for large windows with expected expansion > 4 mm

Complementary items

Special attention must be attached to the choice of installation complementary materials. The materials can be divided into three different categories:

- Gaskets, sealants and glues
- Screws and fixing dowels
- PVC profiles for staff beads and coatings

The most common sealing gaskets are made of prestressed expanded foam bands, saturated with watertight or bituminous liquid (compriband). This impregnating mixtures guarantee excellent resistance against aggressive agents, of chemical or bacterial nature; this material is highly deformable and has therefore great sealing and bond capacities also with uneven surfaces. It has furthermore good thermal and acoustic insulation characteristics. Its physical characteristics make it fit for temperatures going from – 20 °C and + 100 °C. Prestressed bands of different size are available in commerce.

The sealing materials are employed along the fixing lines of the window, in order to realise junction and sealing elastic elements. There are also several silicone sealants. For the use in combination with PVC it must be verified that to the basic silicone polymer no plastic or solvent substances have been added, which could damage the PVC. The need to join profiles, staff beads and PVC profiles for coating performances, might require the use of glues. The most common glue is a quick setting cyanoacrylic single component one.

For the installation of windows it is necessary to use, according to the needs, self-threading screws or screw anchors treated against corrosion. For the finishing of windows, complementary profiles and staff beads are required. Staff beads can be assembled in different ways: snapped insertion, screwing, gluing, etc. These methods are all suitable for the installation of a window on new buildings.

There is however another kind of installation, called "renovation". In renovation, the PVC frame is installed perfectly vertical and in line and is then screwed to the existing case, generally made of wood, with the same procedure adopted for sub-frames, as previously explained. To cover the old case, frames equipped with a special tongue are generally adopted. If there is no tongue, then different staff beads and angular covering must be employed. If the existing case is made of wood, the covering profiles must have holes in order to guarantee the wood ventilation and avoid its decay with the passing of time.