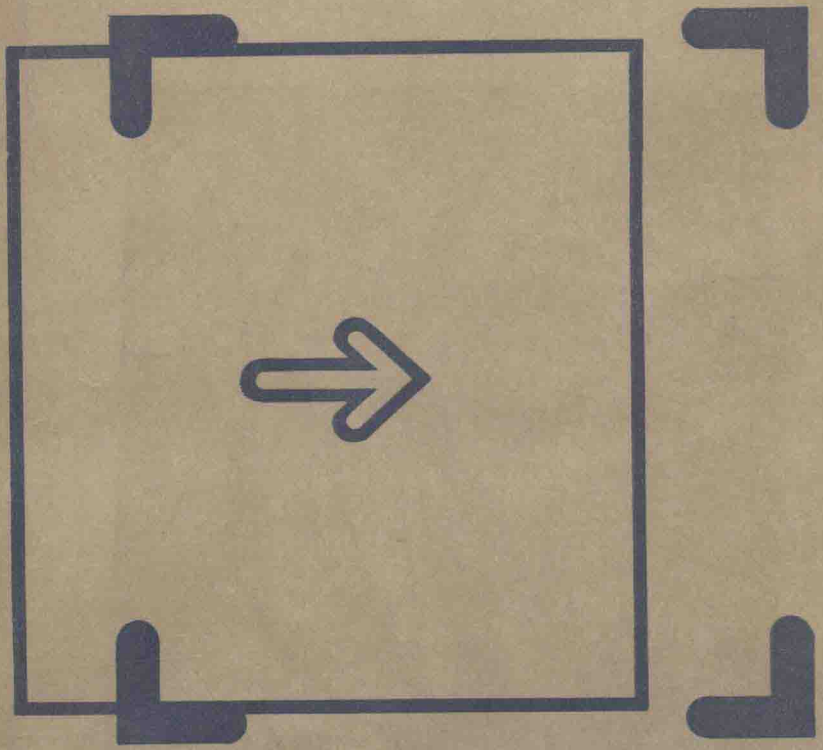
A. SHEPELEV

Glazing Practice



MIR PUBLISHERS

GLAZING PRACTICE

А. М. Шепелев

СТЕКОЛЬНЫЕ РАБОТЫ

Москва «Высшая школа»

A. SHEPELEV

Glazing Practice

MIR PUBLISHERS MOSCOW

First published 1987
Revised from the 1984 Russian edition

Translated from the Russian
by Alexander KUZNETSOV

На английском языке

Printed in the Union of Soviet Socialist Republics

Contents

Preface

This book has been produced to fill a long-existing need for a simple, concise, and complete treatise on working with glass.

It is written in simple, straightforward language, and many actual on-the-job practices are well illustrated. Each of the book's eleven chapters describes in detail every aspect of a group of related subjects.

The volume contains a description of all tools, equipment, and materials required for the cutting, installation, and repair of glass and glass articles.

Here, you will find complete and detailed instructions that will enable you to do a good-looking, professional job, even without previous experience.

With over 80 illustrations, the book makes even the most complex procedures clear. Each illustration shows in easy-to-follow detail just what step to tackle next on any job and how to tackle it. In many instances, you can do a complete job by just following the step-by-step illustrations, without ever referring to the text.

It is hoped that the book will be a welcome and valued aid to glazier apprentices, vocational education students, home owners, and many others.

Chapter One

Purpose of Glazing. Window Components

1. Purpose of Glazing

Almost any residential, office, public, or industrial building needs natural lighting. This purpose is served by windows, monitors, roof lights, etc. Naturally, provision should be made for letting light in and keeping the weather out. This is where glazing comes in.

Window openings should be placed so as to ensure maximum illumination (and ventilation for that matter) at minimum thermal losses. Yet, long-time exposure to sun rays may overheat the rooms in summer, which is hardly a healthy practice. Also, rooms with too many windows are rather difficult to keep warm in winter, which is a serious drawback as regards both thermal comfort and heating bills.

The illumination intensity necessary for visual comfort in residential, office, public, and industrial buildings is specified in relevant standards.

Depending upon the type of building and climatic conditions, window openings may have single, double, or triple glazing, or be glazed with multiple glass units, glass blocks, or specially shaped glass.

2. Window Components

The two principal parts of a window are the frame and the sash. The frame is the outer part of the window which is solidly fixed to, or built into, the wall and supports the sash. The sash carry the glass and may be fixed in position (in which case we speak of fixed sash) or may be

arranged to open*. The frame consists of four principal parts: the two vertical side members called the jambs, the horizontal member at the top called the head, and the horizontal member at the bottom called the sill. There may be one or more sash in a frame arranged in various ways, as described later in this article.

The sash is usually rectangular and consists of two side members called the stiles, a top member called the top rail, and a bottom member called the bottom rail. It may carry one light or pane of glass or may be subdivided by means of vertical and horizontal members, called muntins, to carry several lights of glass.

Sash and frames can be made of wood, metal, reinforced concrete, or plastics and come in a variety of shapes and sizes. In recent years, composite wood/aluminium windows have been finding ever increasing application. There exist single-, double-, and multiple-casement windows, with or without ventilators. Folding windows (as casement windows are sometimes referred to) are often equipped with fanlights (either fixed or operable) separated from the casements by a transom.

Rabbets of various depth and width are cut in the stiles and rails of a sash to accommodate a pane of glass. They may be plain or stepped. Glass is held in position by glazing sprigs and fixed by means of putty or glazing beads of various shape (Fig. 1*a* through *d*).

In casement windows, each light of glass is carried by a casement of its own. Casement sash are often arranged in pairs, two narrow sash being used instead of one wide sash. Here, the frame may be subdivided by a vertical member called the mullion. The position of the sash in the frame or opening is specified by the designer. Rabbets of appropriate width and depth are cut in the frames to house the sash.

Of late, what may be called double casements consisting of two casement sash hung on the same hinges have been gaining in popularity. Here, the inner sash is additionally hinged to the outer one, and the two sash are held together

---

* Sash which are hinged on one side are called casements.— *Translator's note.*

by screws. Lights of glass are placed on the inside with the inner sash and on the outside with the outer sash. The entire casement is carried by a single frame (Fig. 1*e*).

The sash should be made of dry materials. The rabbets should be equally deep to ensure the desired contact between

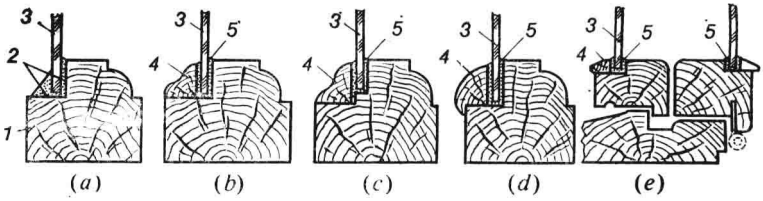


Fig. 1. Panes of glass fixed in the rabbets of window sash (*a*) by bed and face putty; (*b*) by bed putty and glazing bead; (*c*) by bed putty and glazing bead in a stepped rabbet; (*d*) by bed putty and glazing mould; (*e*) by bed putty and glazing beads in a double casement; (*1*) rail; (*2*) rabbet; (*3*) pane of glass; (*4*) glazing bead; (*5*) glazier's putty

the glass and the sash and also to save putty. The casements should fit tightly to keep rainwater from leaking in.

The sash should be given a coat of drying oil and allowed to dry. It will also be a good idea to give them a coat of paint. Glazing beads should likewise be coated with drying oil or paint and fixed firmly to the sash.

Sash and casements should be stored indoors (a suitable barn will also do) stacked on pads and covered to protect hem from water and dirt.

Chapter Two

Materials

3. Properties and Types of Glass

Properties. Major properties of glass are density, strength, hardness, brittleness, thermal conductivity, thermal stability, and optical properties.

Density is defined as the mass per unit volume of a substance. It depends on the chemical analysis of glass and may range from 2.2 to 7.5 g cm^{-3}. To some extent, it depends on temperature, falling down as the temperature rises.

Strength has to do with the ability of a material to resist load in compression, tension, etc. For glass, the ultimate compressive strength ranges between 500 and 2 000 MPa, and the ultimate tensile strength, between 35 and 100 MPa.

Hardness is the ability of a material to resist local penetration by a harder material. The Mohs hardness of glass is usually 7, although some types of glass may have a hardness of 5 to 6 on the Mohs scale.

Thermal conductivity gives a measure of a material's ability to conduct heat. It is numerically equal to the number of watts passed through an area of 1 m^2, 1 m thick under a temperature difference of 1°C between the two sides. The thermal conductivity (or K-value) of glass equals 0.74 W $m^{-1}°C^{-1}$.

Thermal expansion refers to an increase in linear dimensions of a heated body. Quantitatively, it is expressed in terms of the coefficient of expansion which is rather low for glass, being around 8.8×10^{-6} per degree Celsius.

Thermal stability is the ability of a material to sustain sudden changes in temperature without destruction. It plays an important role in construction, because there always exists a substantial temperature difference between the interior and exterior parts of structural members. Thermal stability is customarily expressed in terms of the limit of temperature to which a specimen can be heated without loosing its strength upon sudden cooling. For ordinary glass, this temperature is from 80 to 90°C. The thermal stability of glass mostly depends on its chemical composition. For example, quartz glass can sustain a temperature drop of up to 1 000°C.

Optical properties of glass include light transmission (usually expressed in terms of the transmittance), light absorption (this is the inverse of light transmission, sometimes given by the absorption coefficient), refraction (usually given by the refractive index), and reflection (expressed in terms of the reflectance). Clear window glass transmits

about 88% of incident light. To make glass highly transparent, the amount of staining impurities in the raw materials should be kept to a minimum. The light transmission of glass can be improved by giving it a high polish. Scratches and dirty spots markedly spoil the transparency. It should also be noted that transparent glass transmits all colours of the spectrum equally well.

In construction practice, use is generally made of clear window glass, plate glass, wire glass, figured glass, glass blocks, multiple glass units, and structural glass shapes.

According to surface quality, flat glass may be classed as polished or unpolished (ground). It may be tempered, annealed, or chemically (or otherwise) strengthened. A special type of glass is wire glass—rolled flat glass having a layer of meshed wire incorporated approximately in the centre of the sheet. Glass may be plain or coloured. Also, it may be smooth, figured, or bent.

Glass sheets should be rectangular in shape and have a uniform thickness and flat surface. They may be slightly curved lengthwise and still be acceptable, but the sag should not exceed 0.3% of the sheet's length. The sheet surface should be adequately smooth and free from iridescent and dull spots or similar defects. The edges should be straight with unbroken corners free from spalls and cuts. Each sheet should be uniformly annealed (if at all). Otherwise, the glass will refuse to break along cuts. Window glass may have a waviness, provided it does not distort vision and is noticeable only when viewed at an acute angle or in reflected light. Window glass may also contain a small number of transparent (air) or opaque (alkaline) bubbles. The quality of glass is adversely affected by the presence of unfused particles, scratches, and striae visible in passing light.

The requirements that a particular type of glass is to meet can be found in appropriate standards.

Types of Glass. In building construction, use is generally made of flat glass, glass blocks, multiple glass units, and various glass shapes.

Flat glass. Clear window glass (or sheet glass, as it is also called) is used for glazing various buildings and structures. The leading particulars of commercially available Soviet-made glass can be found in Table 1.

Finished glass is packed in boxes and containers on which the number of sheets and the area in square metres are indicated.

The dimensions quoted in Table 1 refer to quantity-pro-

Table 1. Leading Particulars of Clear Window Glass

Sheet thickness, mm	Length and width, mm		Light transmittance
	minimum	maximum	
2	500×400	1 300×750	0.87
2.5		1 550×750	
3	600×400	1 800×1 200	0.85
4		2 200×1 300	
5		2 200×1 600	0.84
6		2 200×1 600	

duced glass. Also available are glass sheets which are precut to suit customer's requirements. In Soviet practice, precut glass is available in widths from 275 to 925 mm and in lengths from 320 to 1 880 mm, the thickness being the same as given in the table. Precut panes of glass are used to glaze standard windows and balcony doors. They need not be cut on the job and require only minor trimming, which markedly cuts down waste and improves labour productivity.

Plate glass, both *polished* and *unpolished*, is employed for glazing shop-windows and also window openings in exhibition halls, cafes, restaurants, railway terminals, airports, factory buildings, etc. Polished glass transmits more light than unpolished plates.

Variations in thickness may exceed 0.2 mm for both polished and unpolished glass, depending on the plate thickness. Plate glass is shipped in boxes of max. 70 m^2 each.

The standard thickness of Soviet-made unpolished plate glass equals 6.5 mm. Unpolished plate glass is sold in the following sizes (mm): 3 950 × 2 950, 2 950 × 2 950, 2 950 × 2 650, 2 950 × 2 350, 2 950 × 2 200, 2 950 × × 2 050, 2 950 × 1 950, 2 950 × 1 750, 2 650 × 1 950, 2 350 × 1 950, 2 200 × 1 950, and 1 950 × 1 750. The

transmittance of unpolished plate glass is around 0.84. This kind of glass is available in two grades according to the amount of blemishes.

Soviet-made polished plate glass comes in the following sizes (mm): 4 450 × 2 950, 3 950 × 2 950, 2 950 × 2 950, 2 950 × 2 650, 2 950 × 2 350, 2 950 × 2 200, 2 950 × × 2 050, 2 950 × 1 950, 2 950 × 1 750, 2 650 × 1 950, 2 350 × 1 950, 2 200 × 1 950, 2 000 × 1 380, 1 950 × × 1 750, 1 940 × 1 450, 1 940 × 1 400, 1 450 × 1 340, and 1 380 × 1 340. The standard thickness of all plate-glass sizes is 6.5 mm, with the exception of plates measuring 4 450 × 2 950 mm and 3 950 × 2 950 mm whose thickness is 8 mm. Plates less than 2 000 mm long may be made 5.5 mm thick. The light transmittance varies from 0.83 for glass 6.5 and 5.5 mm thick to 0.80 for plates 8 mm thick.

Rolled figured glass is a kind of glass in which the vision is more or less obscured either by the roughened surface produced in rolling or by the impression of a large variety of designs in one or both surfaces of the sheet. It is used for glazing windows, doors, and partitions. Figured glass may be plain or coloured. The colour may be produced by adding staining agents to the batch or by depositing a film of various oxides.

Soviet-made figured glass is sold in sheets 400 to 1 600 mm wide, 600 to 2 200 mm long, and 3, 4, 5 and 6 mm thick. On request, standard sheets may be precut at the factory.

Wire glass is rolled flat glass having a layer of wire mesh placed approximately in the centre of the sheet. The glass is produced with processed, figured, and polished surfaces. It is used in residential, office, public, and industrial buildings to glaze monitors, roof lights, balcony and stair railings, lifts, and other components subjected to vibration and various dynamic loads, including impacts. Clear wire glass is available in sheets 400 to 1 500 mm wide, 1 200 to 2 000 mm long, and 5.5 mm thick. Coloured wire glass sheets have a maximum length of 1 500 mm, a maximum width of 800 mm, and a maximum thickness of 6 mm. Standard sheets may be precut at the customer's request.

Uviol glass which can transmit as much as 25 % of incident ultraviolet rays is fabricated from batches having a

reduced metallic-oxide (iron, titanium, and chromium) content. It is commercially available in sizes from 250 × 250 to 2 000 × 2 000 mm, 2 to 6 mm thick. Uviol glass is mostly used for health farms, sanatoria, solaria, roofed swimming pools, green houses, and the like. Uviol glass is subject to ageing—it grows yellow with time and transmits less ultraviolet rays.

Heat-absorbing glass is a special coloured glass formulated to screen substantially the infrared portion of the solar spectrum without materially reducing visible transmittance. This effect is achieved by increasing the percentage of metallic oxides (iron, cobalt, nickel, etc.) in the batch or by giving the glass a coat of suitable metallic oxides. The colour of heat-absorbing glass may vary from greyish-blue to bluish-violet, depending on the type of oxide used. Heat-absorbing glass is widely used for glazing purposes in hot climatic regions. Soviet-made glass is commercially available in sizes from 250 × 250 to 2 000 × 2 000 mm. The standard thickness is 6 mm, irrespective of the sheet size.

Diffusing glass is used where light is to be passed with the vision partially or completely obscured. The two most common varieties are opal and matt glass. Diffusing glass is also available in a variety of colours. Standard sizes of Soviet-made glass are from 250 × 250 to 1000 × 1 800 mm, the thickness being from 3 to 6 mm.

Flat coloured glass is fabricated by adding small percentages of certain metal compounds to plate- and sheet-glass batches. It may have a smooth, corrugated, or patterned surface on one or both sides. Coloured glass is mostly employed for kindergartens, amusement parks, exhibition halls, and the like. It comes in a variety of sizes, the standard thickness being 3 mm.

Flat tempered glass features a high mechanical strength and heat resistance. It is employed for glazing shop windows and show-cases. Also, it is an excellent choice for glass doors, ceilings, partitions, and other components which must stand up well to impact loads. Glass products to be tempered are fully shaped in advance, because tempered glass cannot be cut, ground, drilled, or otherwise worked. In Soviet practice, it is sold in five standard thicknesses from 4 to 6 mm at 0.5-mm intervals.

Radiation-absorbing (*X-ray*) *glass* is available in Soviet practice in the form of rectangular and round sheets. Rectangular sheets have a length of 146 to 600 mm and a width of 134 to 500 mm. Round sheets are 30 to 250 mm in diameter. The standard thicknesses of Soviet-made rectangular and round sheets of X-ray glass are 10, 15, 20, 25, and 50 mm. Sheets of X-ray glass have polished surfaces, ground sides, and chamfered edges.

Glass products. *Glass blocks* are hollow translucent masonry units formed by fusing, at a high temperature, two sections which have been cast separately. Their primary function is to transmit light through walls and thereby to replace windows. Glass blocks may be plain and coloured.

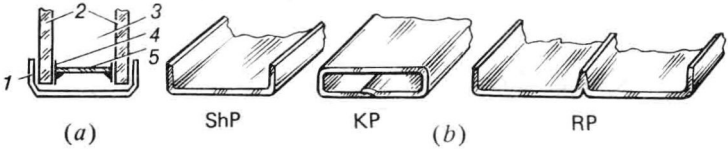


Fig. 2. Multiple glass unit and structural glass shapes
(*a*) single-space multiple glass unit; (*b*) structural glass shapes (ShP—channel, KP—box section, RT—ribbed section); (*1*) perchlorvinyl film; (*2*) glass sheets; (*3*) air space; (*4*) copper coating; (*5*) lead strip

Various patterns (five of them in Soviet practice) are available for the exposed faces. Soviet-made glass blocks have patterns on the interior surfaces, and their exposed surfaces are left smooth to permit easy cleaning. In the USSR, standard glass block sizes are 294 × 194 × 98, 244 × 244 × 75, 244 × 244 × 98, and 194 × 194 × 98 mm. These blocks range from 2.8 kg to 4.3 kg in mass.

Glass lenses, *prisms*, and *tiles* offer a higher mechanical strength than hollow glass blocks which are not suitable for carrying loads other than their own weight. These units are used as pavement lights in floors over basements, as roof lights in industrial buildings, supermarkets, stadiums, etc. In Soviet practice, solid glass units are manufactured in two standard sizes, namely 200 × 200 and 250 × 250 mm. The three standard thicknesses are 25, 50 and 100 mm.

Multiple glass units (Fig. 2*a*) are assembled of two or more sheets of glass joined around the periphery in such a way