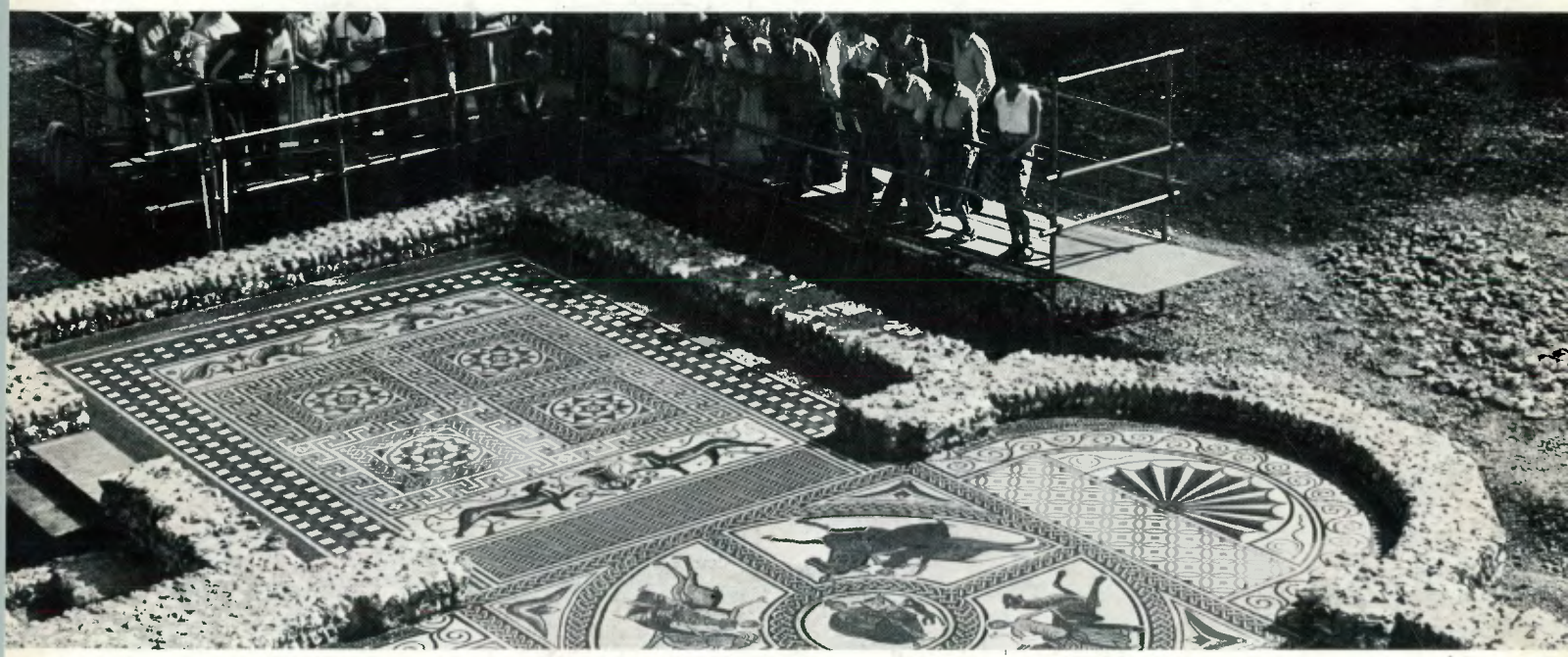
mosaics n°2



safeguard

carthage 1978 perigueux 1980

ICCROM

Publications of the International Committee for the Conservation of Mosaics.

In French

Mosaïque No 1: Détérioration et conservation
Mosaïque No 2: Sauvegarde

In English

Mosaics No 1: Deterioration and Conservation
Mosaics No 2: Safeguard

In Arabic

Mosaics No 2: Safeguard (in preparation)

The Committee also publishes a newsletter in French and English. All these publications are available from the International Centre for the Study of the Preservation and the Restoration of Cultural Property (ICCROM), 13 Via di San Michele, 00153 Rome, Italy.

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Véronique Demaret designed the cover.
Forrest Selvig organized the text of this English edition.
Cover photos: mosaic of Littlecote, U.K., after restoration; details during work on Littlecote mosaic.

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CONTENTS

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This English version of the book has been produced by Forrest Selvig, Cynthia Rockwell, Susan Inman, William Novis, and Gaël de Guichen.

We would like to thank all these generous contributors for their valuable assistance.

The Board

FOREWORD

Concerned at the lack of interest in the conservation of mosaics by those responsible for them, ICCROM organized a conference on the subject in November 1977. The results of that conference were beyond our expectations because from it emerged a Committee for the Conservation of Mosaics. The Board of that Committee has since published the papers presented at that conference, first in French as *Mosaïque No 1: Détérioration et conservation*, and later in English. The Board subsequently met in Carthage and Périgueux. This volume, which was issued first in French as *Mosaïque No 2: Sauvegarde,* is the result of discussions in those places. A reading of these reports demonstrates that an evolving mosaic methodology is replacing experimentation.

The Board also publishes a newsletter, five issues of which have been sent to more than three hundred readers.

The committee plans to deal further with wall mosaics in the future.

All this is very encouraging. It shows that ICCROM can be the means of uniting specialists in a neglected field of expertise and can help them to work together to preserve our cultural heritage.

It is only through a joint effort that conservation specialists can meet the formidable challenge that faces our generation: to pass on to others, as intact as possible, the heritage we have received.

Cevat Erder
Director, ICCROM

INTRODUCTION

The following text is the result of the work of an international group of specialists, begun during a conference at Carthage and finished at Périgueux. It does not attempt to be a complete conservation manual. It presents, instead, a systematic approach to floor mosaic conservation based on the experience of a team of art historians and technicians.

The text is concerned only with pavement mosaics. It does not discuss wall mosaics or such related subjects as gilt tesserae, Cosmati work, *opus sectile,* or round and square stones.

The methods discussed can be adapted to local conditions. The method chosen will also be influenced by the materials that are obtainable.

Although we believe that, in general, every effort should be made to conserve a mosaic *in situ* and not detach it, certain conditions sometimes make such action necessary. Thus we describe various methods of lifting and the selection of new supports for the mosaic.

Some general concepts governing intervention are outlined in the following parts of this introduction.

Lifting

For a mosaic, as for every work of art, the general rule is that the less intervention there is, the better it is for the work itself.

Concerning materials, generally it is best to avoid using natural organic adhesives, such as animal and vegetable glues, which are easily attacked by micro-organisms.

In the case of new supports, we should remember that they must be built by specialist technicians. Otherwise, the supports may be too heavy, too expensive, and less durable.

If mosaics, after being lifted, must remain movable for exhibition or storage, it is best to use sandwich panels. If, on the other hand, the mosaics are to be returned to their original site, a more economical system can be used. This consists of resetting them in a new bed made of lime mortar. Tesserae should never be set into, or make contact with, neat Portland cement.

Problems concerning the accessibility of mosaics *in situ*

Although providing a walking surface was one of the original functions of a pavement mosaic, this is best avoided because of the pavement's often fragile state.

Even with felt slippers, walking on a pavement produces a slow but inexorable wearing away of the surface. This, combined with the mechanical effect of foot traffic following always the same path, leads inevitably to the destruction of the work of art in the long run.

Final presentation

There are three aspects to the question of how a mosaic should ultimately be displayed.

The first concerns cleaning, which includes the removal of all material extraneous to the original without damaging it in any way.

The second arises when the surface is very dilapidated and nearly indecipherable. Opinions differ on this point but it is an indisputable fact that all abrasion, even the most delicate and the most refined, destroys a part of the original material. Instead, we must try, after a very careful cleaning, to bring the colour back by applying, or impregnating the work with, appropriate substances. Even if the resulting image is not the clearest, at least the mosaic has not been damaged.

The third aspect of the intervention concerns an operation which is not indispensable but is useful to the legibility of the work. This consists of how to treat the lacunae. No satisfactory solution has yet been found to the problem. Subjective interpretation is a danger here, even when motivated by legibility and aesthetic aims, and solutions which permit this must be avoided. Instead, we suggest studying the characteristics of the lacunae, working only at the technical level without imposing our interpretation. The mosaic will thus retain the natural aspect of its present state of preservation.

To simplify the analysis, we can apply to mosaics the system used for wall paintings. This system divides the lacunae into two categories according to their dimensions and location: those that can be filled and those that cannot.

More on this subject may be found in "*Mosaics No 1*", ICCROM, 1978, pp. 83-87, and *La conservation des peintures murales*, Ed. Compositori, pp. 347-369.

However, theoretical analysis does not always simplify practical application. That is why we will examine a bit more closely the technical problem in relation to the specific characteristics of pavement mosaics.

Large lacunae which cannot be reintegrated. These may be of different kinds, depending on the state of preservation of the work itself:

a) tesserae missing but the setting bed still in good condition and still retaining the imprint of the stones;

b) the loss at varying depths of the underlying layers;

c) the total absence of the layers underlying a mosaic.

The first case is ideal because the lacunae are filled perfectly and naturally. The only problem is to strengthen thoroughly the bordering tesserae without framing them in cement. That is a very common method but unacceptable from the formal and aesthetic point of view.

In the second case, all lacunae could be filled to the level of the existing setting bed with material which imitates the original. A small line should separate the original material from the new filling.

The third type of lacuna should be filled, like the preceding one, to be level with the highest of the underlying layers.

Naturally, as we have said, theory is easier than practice. The problem of lacunae is particularly acute when visitors must be allowed to walk on a mosaic. Tesserae along the edges of the lacunae very quickly work loose from the setting bed, and further destruction of the mosaic follows rapidly.

In this case, local technical traditions must be followed. Great care must be taken, however, in choosing the filling material so that the lacuna is as unobtrusive as possible.

Another very frequent solution is that of filling the lacuna with gravel set in lime mortar. The size of individual pieces of gravel should be the same as that of the tesserae. The colour of the addition should agree with that of the original mosaic. After it has been cleaned off, the addition should harmonize with the total work.

Lacunae which can be reintegrated. These can consist of the loss of one tessera, of several tesserae in a row, or of a small group of tesserae, as long as they are not part of a figurative or decorative pattern of the mosaic where any reconstruction would be hypothetical.

Lacunae can attain considerable size but they are always smaller than the remaining surface of the mosaic.

If the lacuna is considered reintegratable, it must be restored in the smallest detail, the object being not to disrupt the unity of the total work.

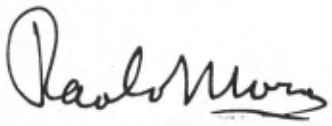
Reintegration could be carried still further if we had a simple method of showing the new additions as distinct from the original tesserae. To avoid any risk of deception, we can suggest two methods:

— special treatment of the surface of each new tesserae;

— very exact manufacture of new tesserae particularly with respect to the dimensions of the originals.

Despite the many different aspects and the complex problems of treating lacunae, we are directing our research toward simple and practical solutions which are also acceptable from the theoretical and historical point of view.

In conclusion, we must acknowledge that the techniques of mosaic conservation and restoration still receive little study. Progress can come only from experimentation and by the exchange of experience. We hope that the proposals presented here will be widely discussed and that readers will share their experiences with us, whether they support or refute our propositions. We thank them in advance.



Paolo Mora
President of the International
Committee for the Conservation of Mosaics

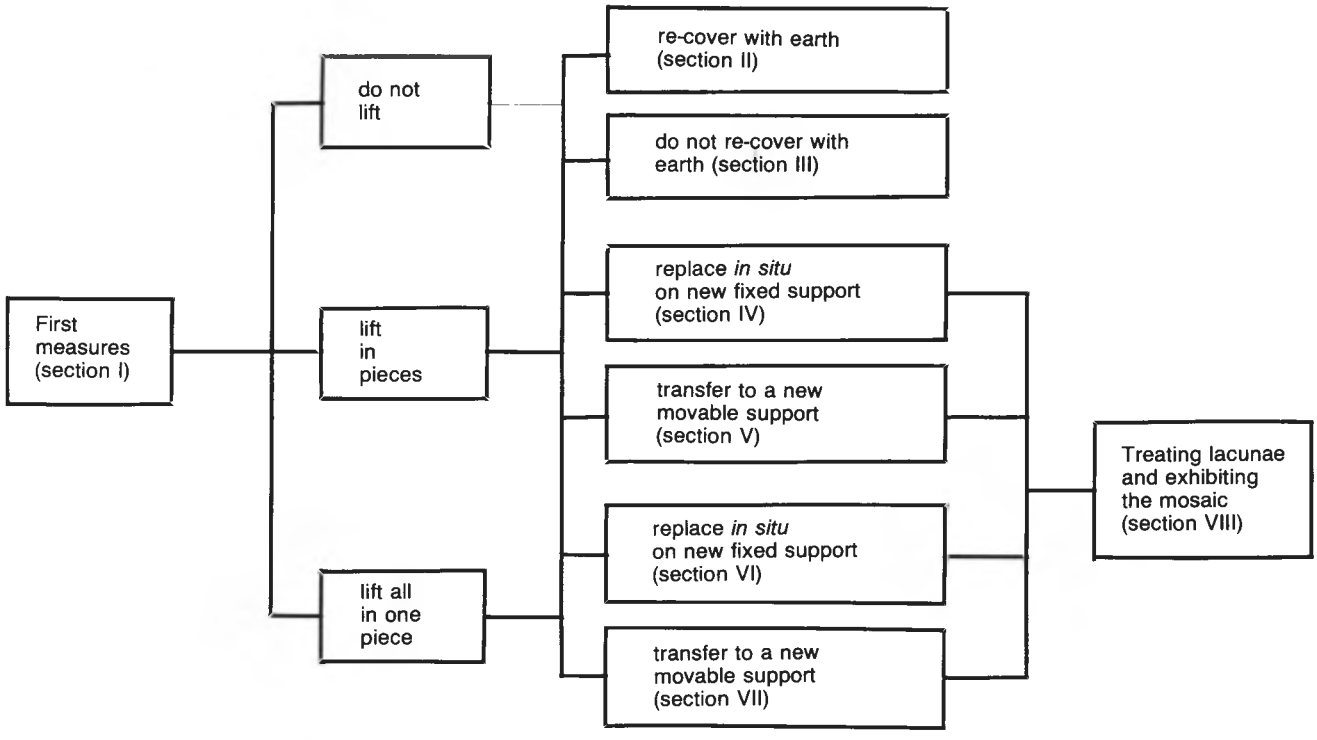
PART I

THE DISCOVERY OF A MOSAIC: WORK PLAN

INTRODUCTION

When an ancient pavement is discovered — especially if it is a mosaic pavement — it is crucial to notify the appropriate authorities immediately, so as to avoid the danger of alteration or destruction.

Any kind of intervention involves risks, even when done by a specialist. Although there are no hard and fast rules, we list the basic actions which will need to be undertaken.*



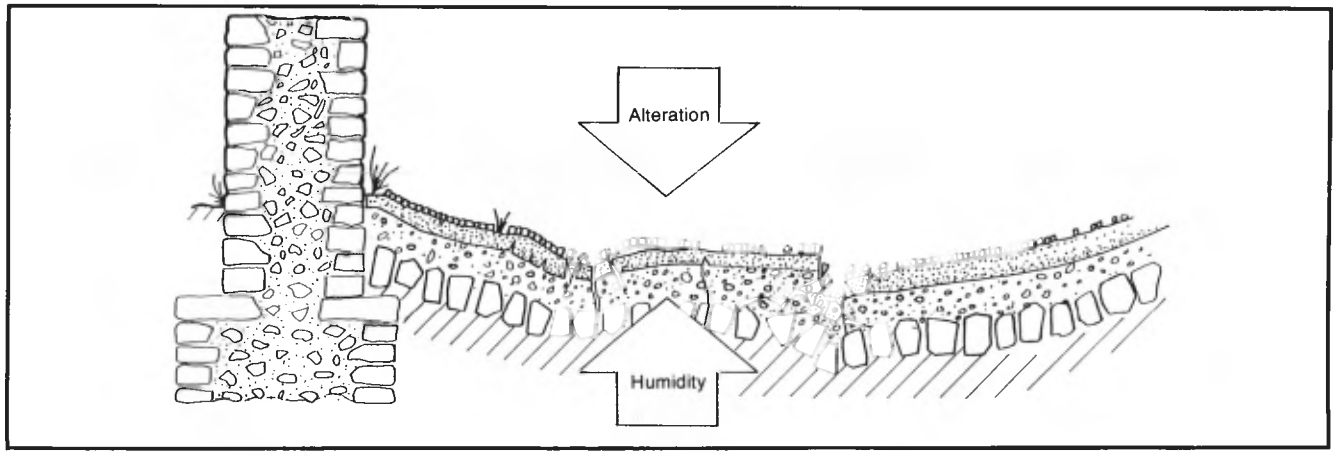


Fig. 1: Agents producing alterations in an unprotected mosaic.

(*) In order to make these recommendations more readable and understandable, we have occasionally repeated certain passages rather than refer to sections or paragraphs. This is meant to be a practical handbook, not a collection of theories. Forthcoming numbers in this series on mosaics will investigate more completely the problems posed by specific cases and processes which we can only touch on rapidly in this text.

I. FIRST MEASURES

Under the guidance of an archaeologist:

I.1 Protect the site against inclement weather and dig runnels to collect and drain off rainwater.

I.2 Clean the pavement with trowels, scrubbing brushes, whisk brooms or paint brushes, depending on how damp or dry it is. Special care should be taken when moisture is present. It may be necessary to build a small bridge so that the surface of a fragile, blistered or detached mosaic will not be damaged by pedestrian traffic. Resistant, calcareous incrustations should be left in place.

I.3 Collect all loose tesserae, level by level, and group them by category and origin.

I.4 Make a photographic record, first in black and white and then in colour, taken vertically or square with the pavement. If possible, include a measuring rod and a colour scale, or take pictures over a frame 1 metre square with lines across forming a 10 cm grid.

I.5 Make measured drawings, with triangulation and showing levels. If the pavement elements are separated by large lacunae, more precise measurements must be taken. Tracings may be taken so that detached portions can be accurately recorded by reference either to grid lines placed across the pavement at 50 cm intervals in both directions or by tracing on polyester sheets, for instance.

I.6 Protect against crumbling at the edges by making temporary reinforcements of clay, plaster or lime mortar (See figs. 2 and 3). NEVER USE CEMENT. Throughout the work process, always try to introduce compatible materials which are similar to the ancient ones - lime in particular.

I.7 **Take or obtain a decision on the mosaic's future destination.** This is the most important stage and no work, other than temporary protective measures, should be undertaken until this decision is made. All operations should be thoroughly documented. Six actions are possible.

- Leave *in situ* without disturbance and re-cover with earth.
- Leave *in situ* without disturbance and leave uncovered.
- Lift in pieces and replace *in situ* on a new fixed support.
- Lift in pieces and transfer onto a new, movable support.
- Remove all in one piece, replace on a support *in situ*.
- Remove all in one piece, replace on a movable support.

There are several lifting techniques, each with its advantages and disadvantages. The choice of the best technique for each case should be based on the nature of the mosaic, the availability of necessary materials, climatic conditions, and the relative competence of the technicians.

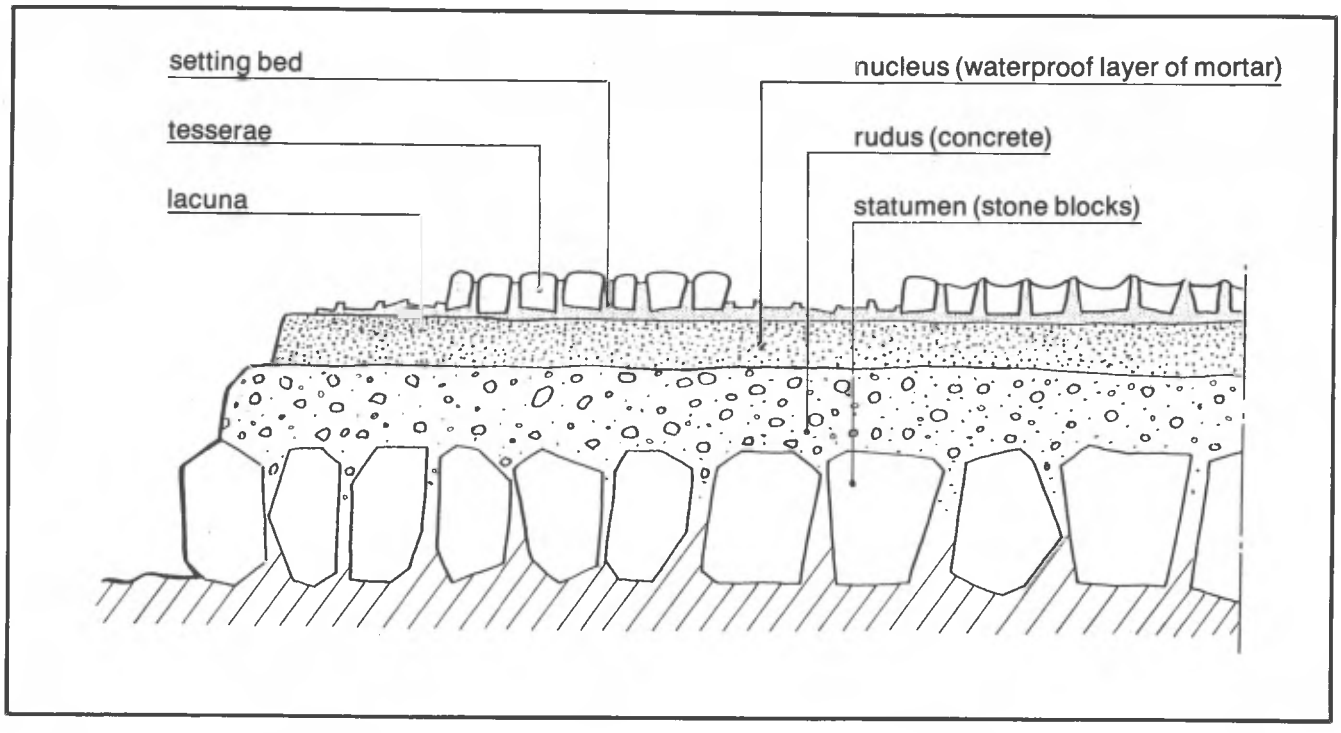


Fig. 2: Condition of a mosaic on discovery.

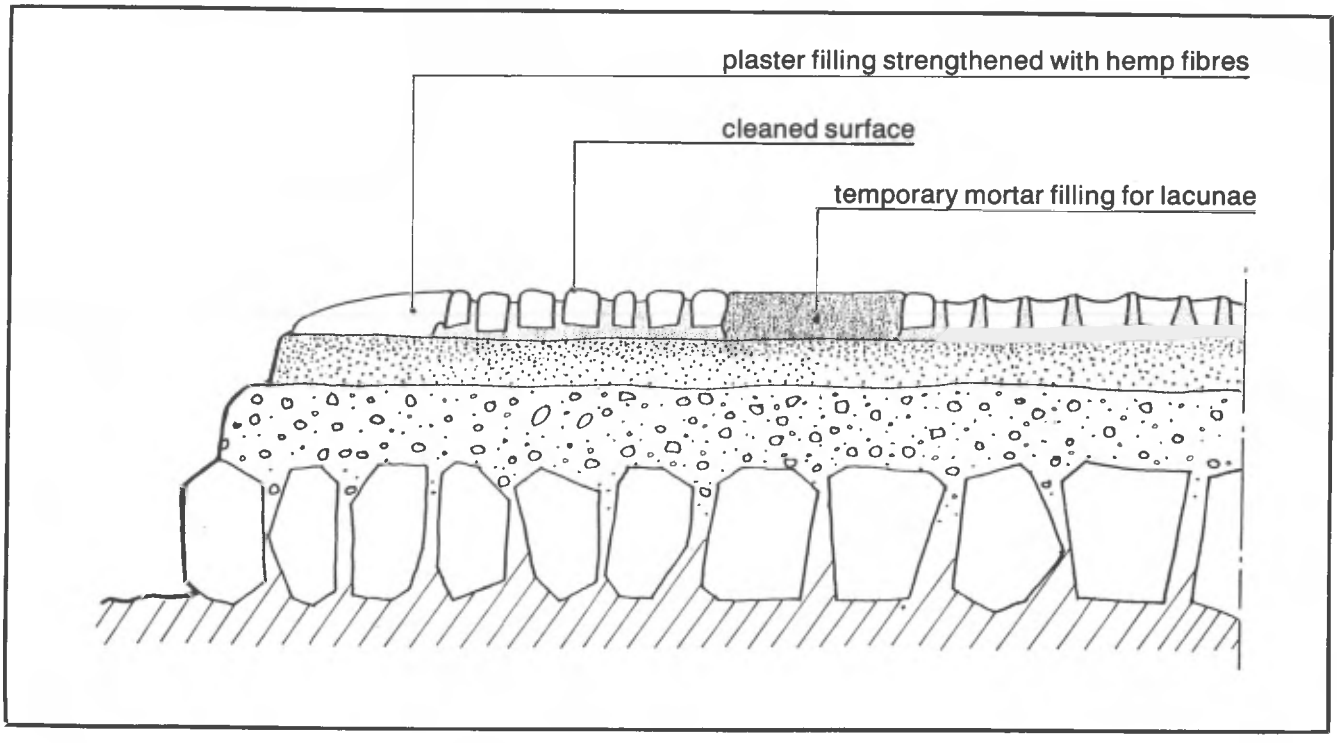


Fig. 3: Application of plaster filling.

II. LEAVING IN SITU AND RE-COVERING WITH EARTH

II.1 Clean thoroughly, removing any calcareous accretions either mechanically or chemically. Considerable dexterity is needed in both cases. When chemical means are used, first build a small wall of clay or other suitable material around the accretion. Water poured into this receptacle will soften the accretion. NEVER use strong acid — nitric, hydrochloric or sulphuric — even when it is diluted.

II.2 Make another series of photographs for archives and publications.

II.3 For some months in winter, the mosaic can be covered with a polythene sheet, plus 20 cm of washed sand, pozzolana, volcanic earth, or a similar, well-sifted material. However, it is extremely dangerous to keep an impermeable film on the mosaic for more than a year. This "protection", in time, increases the likelihood of the mosaic's destruction by earthworms, rats, roots, salts or condensation.

(See *Mosaics No 1*, 1978, p. 72, figs. 12-17).

II.4 For longer periods, the mosaic is covered with a first layer of washed sand, pozzolana or expanded clay granules, then with well-sifted earth which has been mixed with a hormonal-type herbicide. A covering 30 cm deep should be used for short periods, 1 m deep for long periods. Straw, sawdust and, in general, any organic materials must be avoided entirely.

II.5 The mosaic's position is then marked in relation to fixed and well-established reference points.

II.6 Herbicide applications and/or weeding must be repeated yearly, at least, and more often if vegetation develops.

III. LEAVING IN SITU WITHOUT RE-COVERING WITH EARTH

This solution will inevitably involve destruction of the mosaic within a short time. It should therefore be avoided. If there is no other choice, the area must be enclosed and if possible, protected against the elements by erecting a building over the pavement large enough to permit pedestrian traffic to flow around, not over, the mosaic. The building should be well lit and well ventilated to prevent the development of micro-organisms.

III.1 Protect all edges of the pavement by making permanent rims in lime mortar with washed sand, or with pieces of slate, marble, or brick, or by resetting the last two or three rows of tesserae. NEVER USE CEMENT OR SEA SAND.

III.2 Fill in lacunae with a mortar of lime and coarse washed sand. For aesthetic reasons, avoid an overly smooth surface. Lost tesserae can be used to fill places where only a few are missing, thus avoiding further losses at such points.

III.3 Clean thoroughly, removing any calcareous accretions either mechanically or chemically. Considerable dexterity is needed in both cases. When chemical means are used, first build a small wall of clay or other suitable material around the accretion and fill this receptacle with water to soften the accretion before proceeding further. NEVER use strong acid — nitric, hydrochloric or sulphuric — even when it is diluted.

III.4 Make another series of photographs for archives and publications.

III.5 If the tesserae are disintegrating, and if circumstances permit, reinforce their stability by impregnation with an approved substance.

III.6 Grout the joints with a rich, fluid mortar of lime, fine washed sand, marble or brick powder. Carefully remove the excess, rinse and dry, cleaning away all white deposits.

III.7 Find the most effective way possible to protect the pavement from water from any source.

III.8 Provide suitable materials, such as permanent insulation, to protect against winter frosts. (See fig. 4).

III.9 Check the pavement regularly and keep a progressive photographic record of its state of conservation.

III.10 Provide regular, appropriate maintenance to combat the proliferation of algae, lichens, moss and other plants.

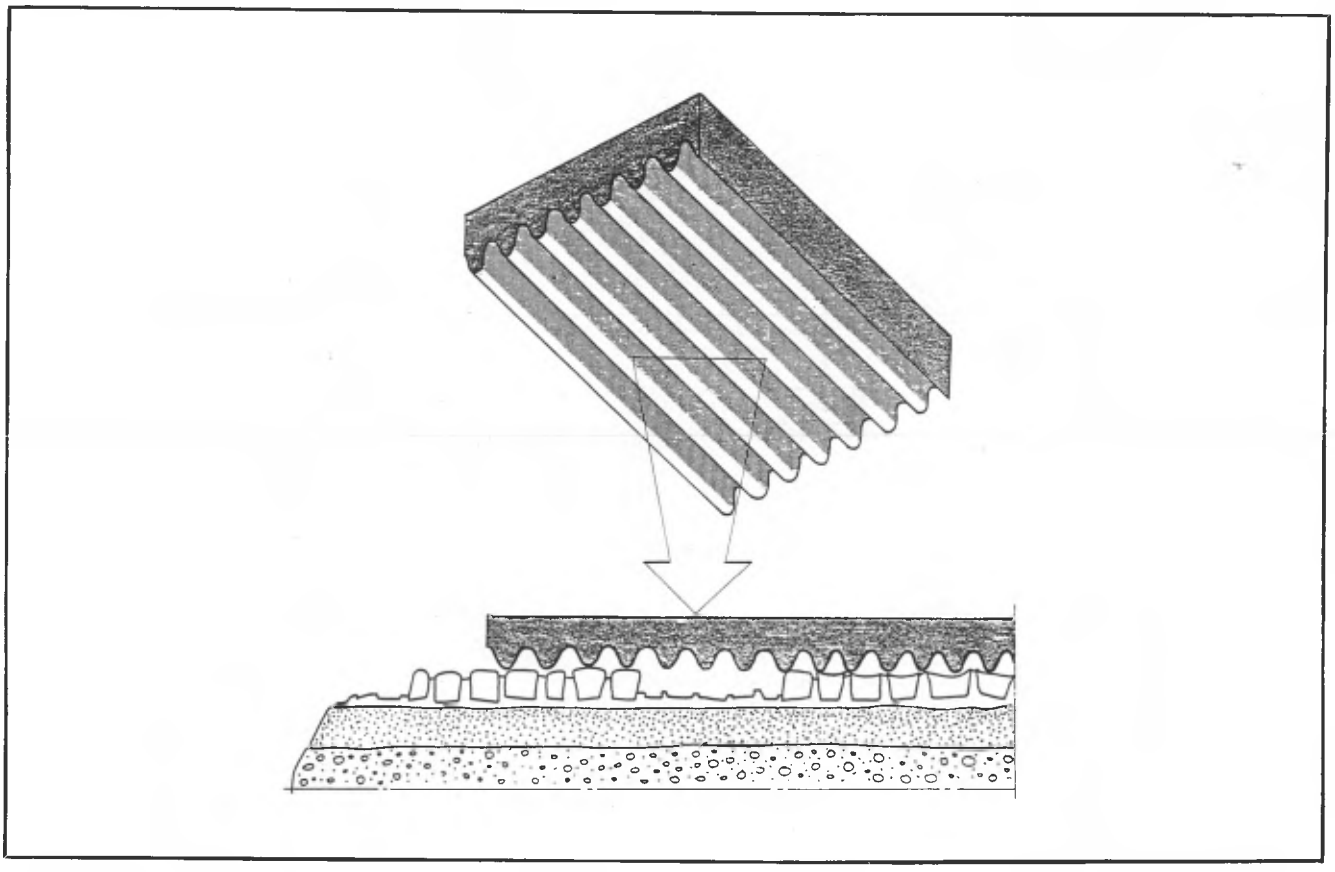


Fig. 4: Panel of corrugated polystyrene for protection against freezing.

IV. LIFTING IN PIECES AND REPLACING IN SITU ON A NEW FIXED SUPPORT

IV.1 TO REMOVE IN PIECES

IV.1.1 Protect the work site against inclement weather and dig runnels to collect and drain off rainwater.

IV.1.2 Thoroughly document each of the subsequent operations.

IV.1.3 Remove any accretions (See II.1, p. 18) that might hinder the adherence of the glue to the tesserae.

IV.1.4 Restructure disintegrating tesserae to improve their adherence during the lifting operation.

IV.1.5 If, for technical (maintenance, storage) or administrative (delays, funding) reasons, the mosaic must be cut into several pieces, a cutting plan must be made. (See fig. 5). This plan should be carefully laid out to take advantage of cracks and lacunae, and perhaps backgrounds, borders, or geometric designs as well as straight black lines. Cuts should not have overly sharp angles. Pieces of the largest possible size should be cut. **A figurative motif must never be cut through.**

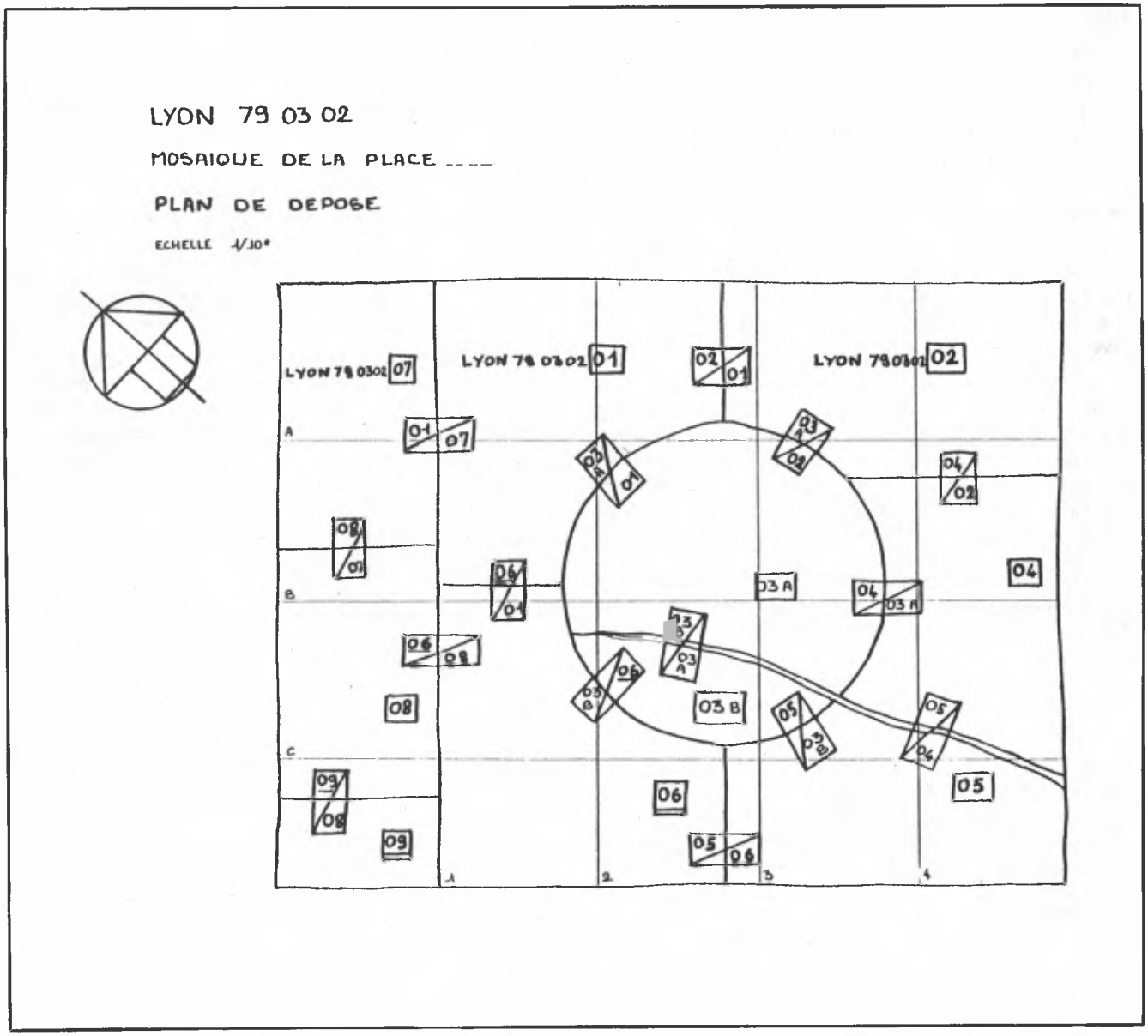


Fig. 5: Plan for lifting a mosaic.

IV.1.6 The condition of the pavement will dictate the method of lifting. In some cases, the bedding mortar is relatively soft, particularly on wet sites. On the other hand, the mosaic, setting bed, nucleus and rudus may adhere very strongly together in a rock-like formation. Sometimes both conditions occur in one pavement, such as those which have undergone earlier repairs and restorations, so different ways of lifting are required.

a) **Lifting when the bedding mortar is relatively soft.**

1. In preparation for moving, fill the lacunae to avoid distortions. The use of a reversible material is recommended.

2. Cover the whole pavement with a layer of unsized cotton gauze using an emulsion adhesive like PVA. The edges of each strip of gauze should overlap the edges of the next. When the emulsion has dried, the mosaic pattern will be visible through the gauze.

3. Mark a grid over the gauze, with lines of one colour going in one direction, those of another colour in the other direction. The distance between parallel lines could be about 50 cm but it can differ if the situation requires it.

4. Prepare a drawing showing the grid lines, the outline and main pattern of the mosaic, all in relation to the grid. If the contour is to be preserved, a drawing should be made showing variations in level at regular intervals.

5. When the mosaic is thoroughly dry, proceed to lift it in sections small enough to be handled by one person. Cutting through the gauze with a sharp pointed knife, along convenient pattern lines, never through a figurative motif, lift each section by inserting thin bladed tools, such as long trowels, under the mosaic through the softened bedding mortar.

When a piece is detached, a thin panel should be slid underneath it so that it can be lifted clear. Another panel should be placed on top of the fragment and the resulting sandwich turned over so that the back can be cleaned. Any semi-detached tesserae should be replaced and loose material put in a bag and labelled.

6. Each piece of mosaic should be numbered, and its shape outlined on the drawing with the number shown. It should then be wrapped in paper and stored in shallow trays with again the number noted on the outside edge of the tray. The trays should be kept in a dry, ventilated, and secure store until required for relaying.

b) **Lifting when the bedding mortar is very hard.** (See fig. 6)

1. In preparation for moving, fill the lacunae to avoid distortions. The use of a reversible material is recommended.

2. In choosing an adhesive, the following factors should be considered:

— availability of the product;
— reversibility of the product;
— condition of the tesserae;
— how firmly the tesserae are attached to the nucleus;
— humidity of the soil;
— humidity of the air;
— temperature of the air;
— the time available.

Unless suitable fungicides are added, gelatin-base animal glues should not be used as they can be quickly attacked by biological agents. Birdlime should not be used either, especially when the transfer to a new support does not follow immediately upon lifting the mosaic. Neoprene glue should not be used because it is not easily reversible.

Suitable fungicidal agents must, without fail, be added to vinyl emulsions.

3. Unsized, frayed, cotton gauze without selvedge should be used for the first reinforcing layer of the temporary consolidation system, whatever the type of adhesive used.

4. For the second layer of the temporary consolidation, use strong cotton cloth, kraft paper or, in difficult cases, depending on the situation, fibreglass.

5. If conservation of the relief is desired, or if the nucleus is particularly hard, the second reinforcing layer can be made of wood or honeycomb.

6. Following the lifting plan, cut through the facing with an appropriate tool, like a scalpel, cutter, knife or pavior's chisel. In some cases (extremely urgent operations, very thick support, close adherence of tessellatum to nucleus, presence of cement from previous restorations, for instance), one will be forced to cut the tessellated layer and the nucleus with chisels or saws. However, this operation should be avoided if at all possible.

7. Sometimes the whole mosaic must be hammered with a suitably hard or soft mallet. This apparently simple operation calls for some skill, or disaster may ensue. This operation is always done from the edges toward the centre.

8. Detach the sections of tessellatum from the ground by gradually incising underneath and introducing steel blades parallel to the tessellatum plane. This should preferably be done between the rudus and the nucleus. Work as deep down as possible and never directly beneath the tessellatum. Insert the first blades in the centre of the side chosen as the point of attack, then move outward, toward the right or left.

9. Slide a rigid panel under the piece of tessellatum that has been detached. Block it from sliding off the panel by nailing wooden wedges around the edge of the tessellatum or by framing it with a rim of plaster reinforced with jute fibres.

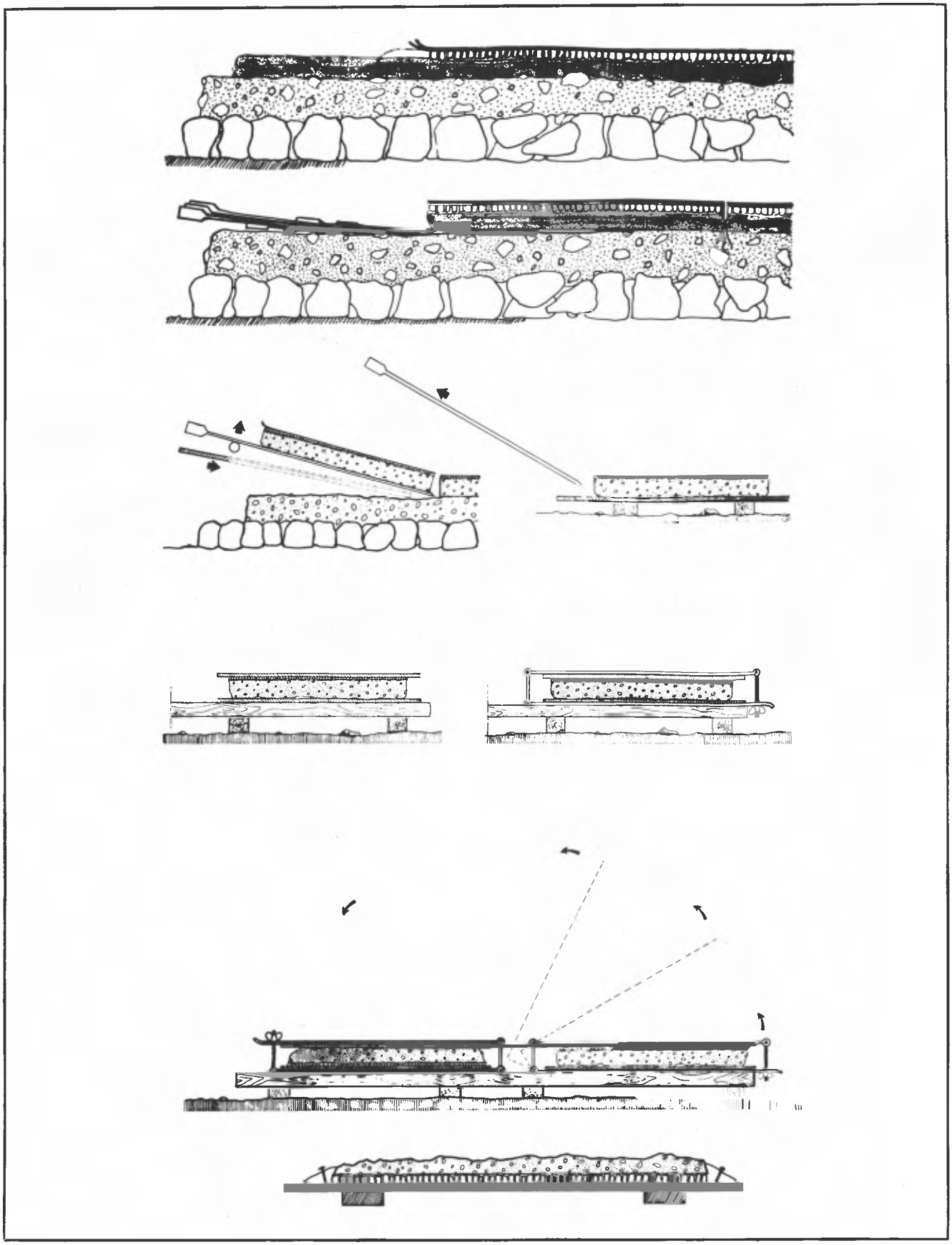


Fig. 6: Lifting when bedding mortar is very hard.

10. On the cloth-covered side of the piece, apply another rigid panel which has been treated with fungicides in preparation for long storage. Make sure the whole sandwich stays together — lower panel, tessellatum section, upper panel — by using clamps, for example. Above all, avoid slippage when the whole unit is turned over.

11. Turn over the whole unit and mark the upper edge of the panel that is now supporting the tessellatum with the reference number of the cutting plan so that the pieces can be easily identified after long storage. Marking should be indelible and standardized.

12. Important: **Let the pieces dry out** before storage.

IV.2 STORAGE

IV.2.1 If not already done, surround the entire perimeter of the piece with rims of plaster reinforced with jute fibre.

IV.2.2 Remove the remnants of the rudus, nucleus and setting bed with a chisel, saw or grinder.

IV.2.3 Keep the old joints if they are in good condition. If they are not, remove the vestiges of old jointing and apply new jointing, of appropriate colour and grain size, on the back side. Fill lacunae with reversible mortar.

IV.2.4 If some tesserae or insertions are much thicker than the rest of the pavement, it may be necessary to level their back surface but this should preferably be avoided.

IV.2.5 Use well kept storerooms, having a constant humidity level, protected against theft and fire, and easily maintained.

IV.2.6 Stack the pieces of tessellatum on their temporary support panels no more than 1 m high. If possible, they should rest on a palette so that they can be moved with a fork lift. Identify the whole group.

IV.3 MAKING A NEW SUPPORT AND TRANSFERRING THE TESSELLATUM SECTION

IV.3.1 Make the new support. The most suitable ones are a fixed floor of cement concrete with an intervening bed, or a fixed floor of lime mortar in contact with the tesserae.

More details are given in pages 35-39.

IV.3.2 Transfer the tessellatum sections onto this support.

IV.3.3 Remove the temporary cloth facing by using suitable solvents and/or heat. Adhesives should not be heated above their melting point or their reversibility will be adversely affected.

V. LIFTING IN PIECES AND TRANSFERRING TO A NEW, MOVABLE SUPPORT

V.1 TO REMOVE IN PIECES

V.1.1 Protect the work site against inclement weather and dig runnels to collect and drain off rainwater.

V.1.2 Thoroughly document each of the subsequent operations.

V.1.3 Remove any accretions (See II.1, p. 18) that might hinder the adherence of the glue to the tesserae.

V.1.4 Restructure disintegrating tesserae to improve their adherence during the lifting operation.

V.1.5 If, for technical (maintenance, storage) or administrative (delays, funding) reasons, the mosaic must be cut into several pieces, a cutting plan must be made. (See fig. 5). This plan should be carefully laid out to take advantage of cracks and lacunae, and perhaps backgrounds, borders, geometric designs as well as straight black lines. Cuts should not have overly sharp angles. Pieces of the largest possible size should be cut. **A figurative motif must never be cut through.**

V.1.6 The condition of the pavement will dictate the method of lifting. In some cases, the bedding mortar is relatively soft, particularly on wet sites. On the other hand, the mosaic, setting bed, nucleus and rudus may adhere very strongly together in a rock-like formation. Sometimes both conditions occur in one pavement, such as those which have undergone earlier repairs and restorations, and different ways of lifting are required. In that case, the two methods described below should be combined and used.

a) **Lifting when the bedding mortar is relatively soft:**

1. In preparation for moving, fill the lacunae to avoid distortions. The use of a reversible material is recommended.

2. Cover the whole pavement with a layer of unsized cotton gauze using an emulsion adhesive like PVA. The edges of each strip of gauze should overlap the edges of the next. When the emulsion has dried, the mosaic pattern will be visible through the gauze.

3. Mark a grid over the gauze, with lines of one colour going in one direction, those of another colour in the other direction. The distance between parallel lines could be about 50 cm but it can differ if the situation requires it.

4. Prepare a drawing showing the grid lines, the outline and main pattern of the mosaic, all in relation to the grid. If the contour is to be preserved, a drawing should be made showing variations in level at regular intervals.

5. When the mosaic is thoroughly dry, proceed to lift it in sections small enough to be handled by one person. Cutting through the gauze with a sharp pointed knife, along convenient pattern lines, never through a figurative motif, lift each section by inserting thin bladed tools, such as long trowels, under the mosaic through the softened bedding mortar.

When a piece is detached, a thin panel should be slid underneath it so that it can be lifted clear. Another panel should be placed on top of the fragment and the resulting sandwich turned over so that the back can be cleaned. Any semi-detached tesserae should be replaced and loose material put in a bag and labelled.

6. Each piece of mosaic should be numbered, and its shape outlined on the drawing with the number shown. It should then be wrapped in paper and stored in shallow trays with again the number noted on the outside edge of the tray. The trays should be kept in a dry, ventilated, and secure store until required for relaying.

b) **Lifting when the bedding mortar is very hard:**

1. In preparation for moving, fill the lacunae to avoid distortions. The use of a reversible material is recommended.

2. In choosing an adhesive, the following factors should be considered:
- — availability of the product;
- — reversibility of the product;
- — condition of the tesserae;
- — how firmly the tesserae are attached to the nucleus;
- — humidity of the soil;
- — humidity of the air;
- — temperature of the air;
- — the time available.

Unless suitable fungicides are added, gelatin-base animal glues should not be used as they can be quickly attacked by biological agents. Birdlime should not be used either, especially when the transfer to a new support does not follow immediately upon lifting the mosaic. Neoprene glue should not be used because it is not easily reversible.

Suitable fungicidal agents must, without fail, be added to vinyl emulsions.

3. Unsized, frayed, cotton gauze without selvedge should be used for the first reinforcing layer of the temporary consolidation system, whatever the type of adhesive used.

4. For the second layer of the temporary consolidation, use strong cotton cloth, kraft paper or, in difficult cases, depending on the situation, fibreglass.

5. If conservation of the relief is desired, or if the nucleus is particularly hard, the second reinforcing layer can be made of wood or honeycomb.

6. Following the lifting plan, cut through the facing with an appropriate tool, like a scalpel, cutter, knife or pavior's chisel. In some cases (extremely urgent operations, very thick support, close adherence of tessellatum to nucleus, presence of cement from previous restorations, for instance), one will be forced to cut the tessellated layer and the nucleus with chisels or saws. However, this operation should be avoided if at all possible.

7. Sometimes the whole mosaic must be hammered with a suitably hard or soft mallet. This apparently simple operation calls for some skill, or disaster may ensue. This operation is always done from the edges toward the centre.

8. Detach the sections of tessellatum from the ground by gradually incising underneath and introducing steel blades parallel to the tessellatum plane. This should preferably be done between the rudus and the nucleus. Work as deep down as possible and never directly beneath the tessellatum. Insert the first blades in the centre of the side chosen as the point of attack, then move outward, toward the right or left.

9. Slide a rigid panel under the piece of tessellatum which has been detached. Block it from sliding off the panel by nailing wooden wedges around the edge of the tessellatum or by framing it with a rim of plaster reinforced with jute fibres.

10. On the cloth-covered reverse side of the piece, apply another rigid panel which has been treated with fungicides in preparation for long storage. Make sure the whole sandwich stays together — lower panel, tessellatum section, upper panel — by using clamps, for example. Above all, avoid slippage when the whole unit is turned over.

11. Turn over the whole unit and mark the upper edge of the panel that is now supporting the tessellatum with the reference number of the cutting plan so that the pieces can be easily identified after long storage. Marking should be indelible and standardized.

12. Important: **Let the pieces dry out** before storage.

V.2 STORAGE

V.2.1 If not already done, surround the entire perimeter of the piece with rims of plaster reinforced with jute fibre.

V.2.2 Remove the remnants of the rudus, nucleus and setting bed with a chisel, saw or grinder.

V.2.3 Keep the old joints if they are in good condition. If they are not, remove the vestiges of old jointing and apply new jointing, of appropriate colour and grain size, on the back side. Fill lacunae with reversible mortar.

V.2.4 If necessary, flatten the back side.

V.2.5 Use well kept storerooms, having a constant humidity level, protected against theft and fire, and easily maintained.

V.2.6 Stack the pieces of tessellatum on their temporary support panels no more than 1 m high. If possible, they should rest on a palette so that they can be moved with a fork lift. Identify the whole group.

V.3 MAKING A NEW SUPPORT AND TRANSFERRING THE TESSELLATUM SECTION

The most suitable supports are described in sections 5 through 11 in Part II of this publication, pp. 42-55.

Never set tesserae directly into a support of cement concrete.

VI. LIFTING ALL IN ONE PIECE AND REPLACING IN SITU ON A NEW FIXED SUPPORT

VI.1 Mosaics can be lifted in one piece only if they are almost flat. If a mosaic is mainly flat, large and predominantly figurative, it is most desirable to lift it in this way.

VI.2 Several techniques can be used to lift a mosaic in one piece. Among them are:

— a roller alone;
— a frame alone;
— a lifting beam system, pulley, gantry. (See figs. 7a, 7b and 8).

These extremely delicate techniques can only be performed by highly qualified technicians. Due to their complexity, they are beyond the scope of this publication and cannot be described here.

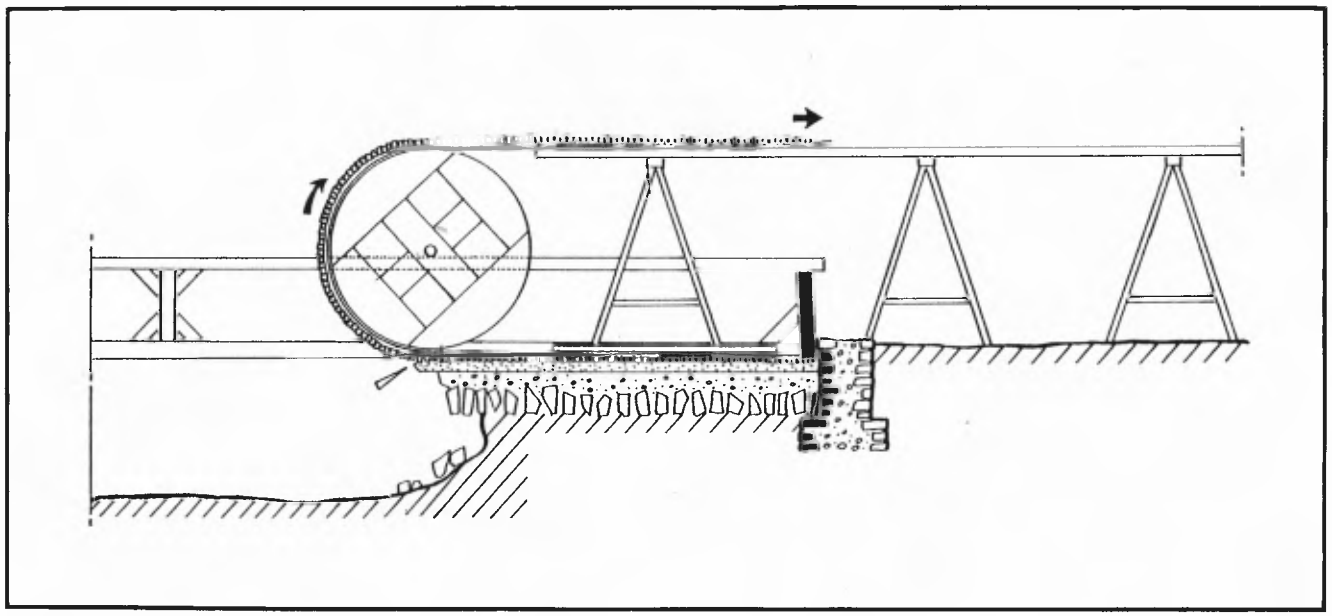


Fig. 7 (a): Lifting big pieces with a roller.

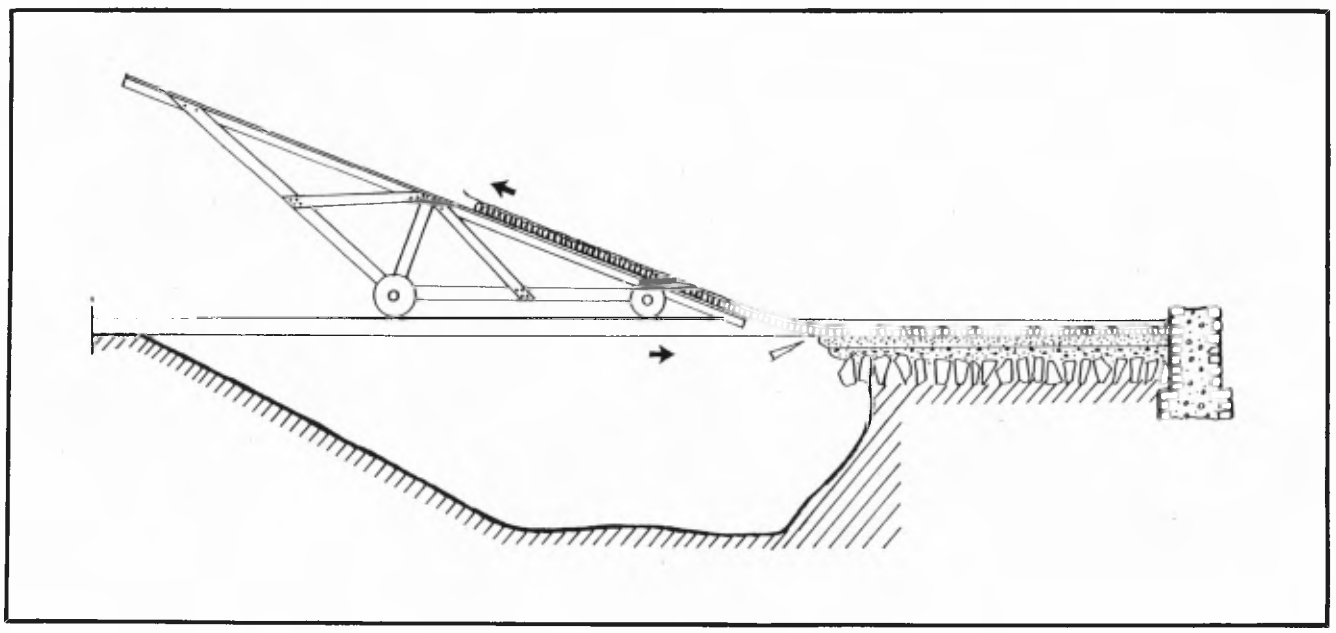


Fig. 7 (b): Lifting big pieces with a frame.

VII. LIFTING ALL IN ONE PIECE AND TRANSFERRING TO A NEW MOVABLE SUPPORT

The remarks in VI.1 and VI.2 also apply here.

Remember that the transportation and fixing of large size panels is difficult, and that doorways are not always large enough to allow them to pass through.

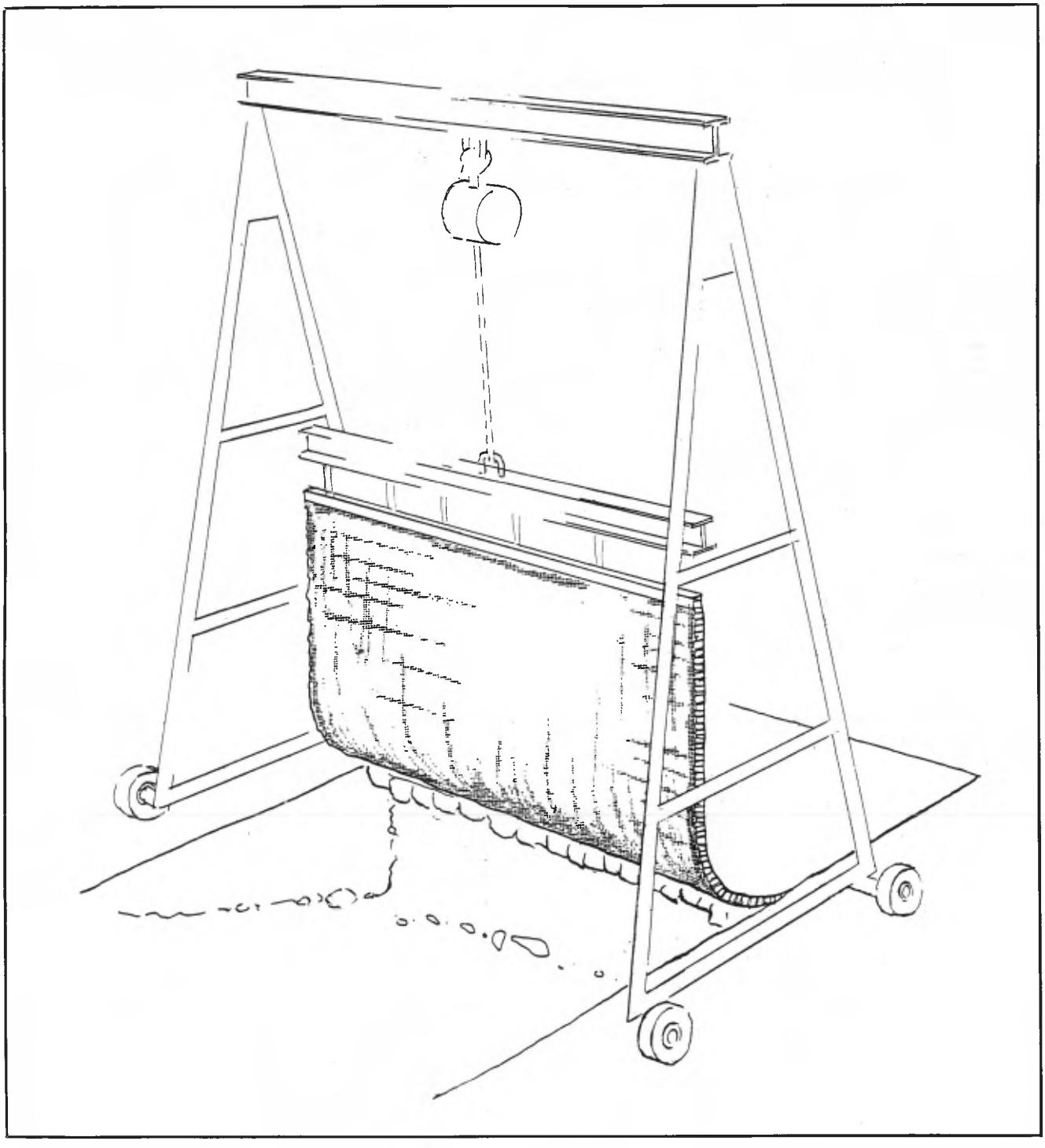


Fig. 8: Lifting big pieces with a lifting beam and gantry.

VIII. TREATING LACUNAE AND EXHIBITING THE MOSAIC

VIII.1 LACUNAE

Original lacunae and joints are a special problem both because they weaken the structure and for aesthetic reasons.

First remove any reversible mortar which was applied to the lacunae to ensure mechanical cohesion during preceding operations.

The lacuna can be restored or not, depending on the following factors:

— its location;
— its size in respect to the total mosaic surface;
— existence of clear evidence of the missing pattern.

VIII.1.1 **Lacunae that can be restored**

First, the missing parts must be thoroughly documented. Then the lacunae can be recomposed with material similar to, or different from, the old material. In any case, it must be possible to distinguish the remade portion from the original by close examination.

VIII.1.2 **Lacunae that cannot be restored**

These lacunae are either too large or their recomposition would involve too much guesswork. They must receive special treatment, depending on whether or not people will be allowed to walk on the pavement.

When walking on the pavement is permitted. The primary aim of filling lacunae must be to protect the original mosaic from destruction. The filling should be slightly below the face of the tesserae and resemble the surface and colour of the original.

When walking on the pavement is prohibited. The primary aim of filling lacunae in this case is to enhance the original mosaic and minimize the losses. The filling can be slightly lower than the tesserae, level with the setting bed, or even level with the nucleus. Flat, uniform surfaces should be avoided, and material that harmonizes with the original should be found. Several kinds of solution have been proposed, depending on the type of mosaic: rough setting beds, crushed brick, various sizes of gravel, setting beds with the imprints of lost tesserae, etc.

VIII.1.3. Particular attention must be given to lacunae in mosaics which are to be laid horizontally.

The imprint of missing tesserae often remains in the original setting bed. Saving the interesting part of the original setting bed is strongly advised. It can be reinserted in the tessellatum when that has been placed on its new support.

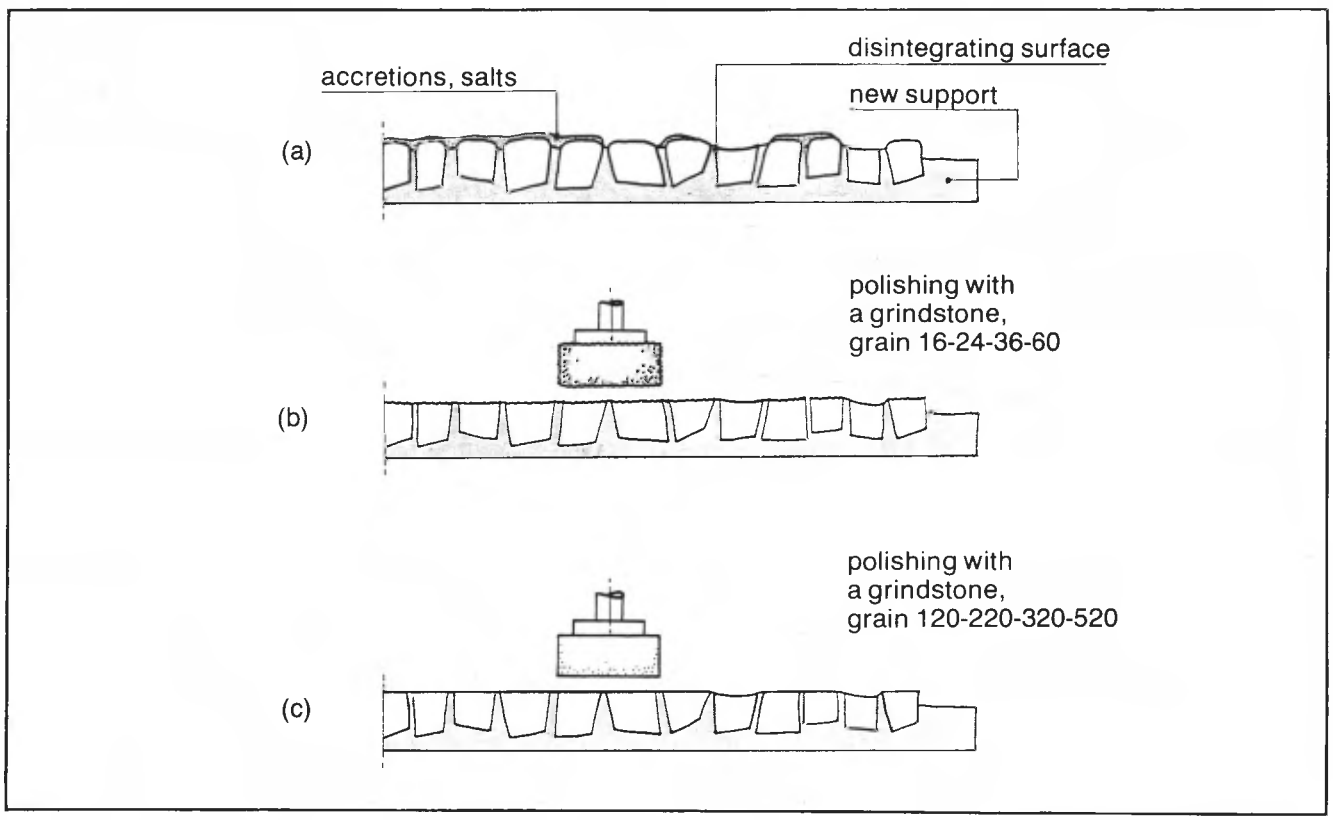


Fig. 9: Treating the surface — restoring the original polish. Use this method only when it is impossible to apply any other.

VIII.2 SURFACE TREATMENT

Depending on the surface condition, the tesserae may be deteriorating, cracked, irregular or obscured by deposits. Such conditions can be approached in several ways:

— leaving the situation as it is;

— treating with chemicals, if necessary. After testing first, the correct materials and methods for cleaning and strengthening the mosaic should be used;

— cleaning mechanically by hand with a stone to bring back the original sheen. This is done when the tesserae are very deteriorated but it should be avoided because it destroys the mosaic surface (See fig. 9);

— cleaning mechanically (by pouncing or sand-blasting) to remove the calcareous incrustations which obstruct legibility, without damaging the mosaic surface (See fig. 10 a);

— in some cases, felt pads and polishing paste can be used (See fig. 10b).

VIII.3 PRESENTATION

Except for mosaics specifically designed for fountains or ponds, mosaics should never be displayed under water. Water does make the colours more lively but it also accelerates deterioration.

Adequate walkways around a pavement should be provided at a level somewhat higher than the pavement itself.

If the lacunae are very large, the public should not be allowed to walk on the mosaic. A properly lifted and relaid mosaic in a museum will not be visibly damaged by walking over with light shoes.

VIII.4 EXHIBITING THE MOSAIC

Depending on the type of support chosen, the surface of the mosaic piece, and the space available, the mosaic can be shown horizontally, upright, or at an angle to the wall. Floor mosaics should be displayed flat on the ground.

For didactic purposes, fragments can be exhibited on the wall. Mosaics with themes of particular aesthetic or historical interest can be exhibited in suitable museum rooms. Standard geometrical mosaics can be kept in rooms for specialists.

In no case should a mosaic, large or small, be displayed in a frame as if it were a painting. This is an historical contradiction.

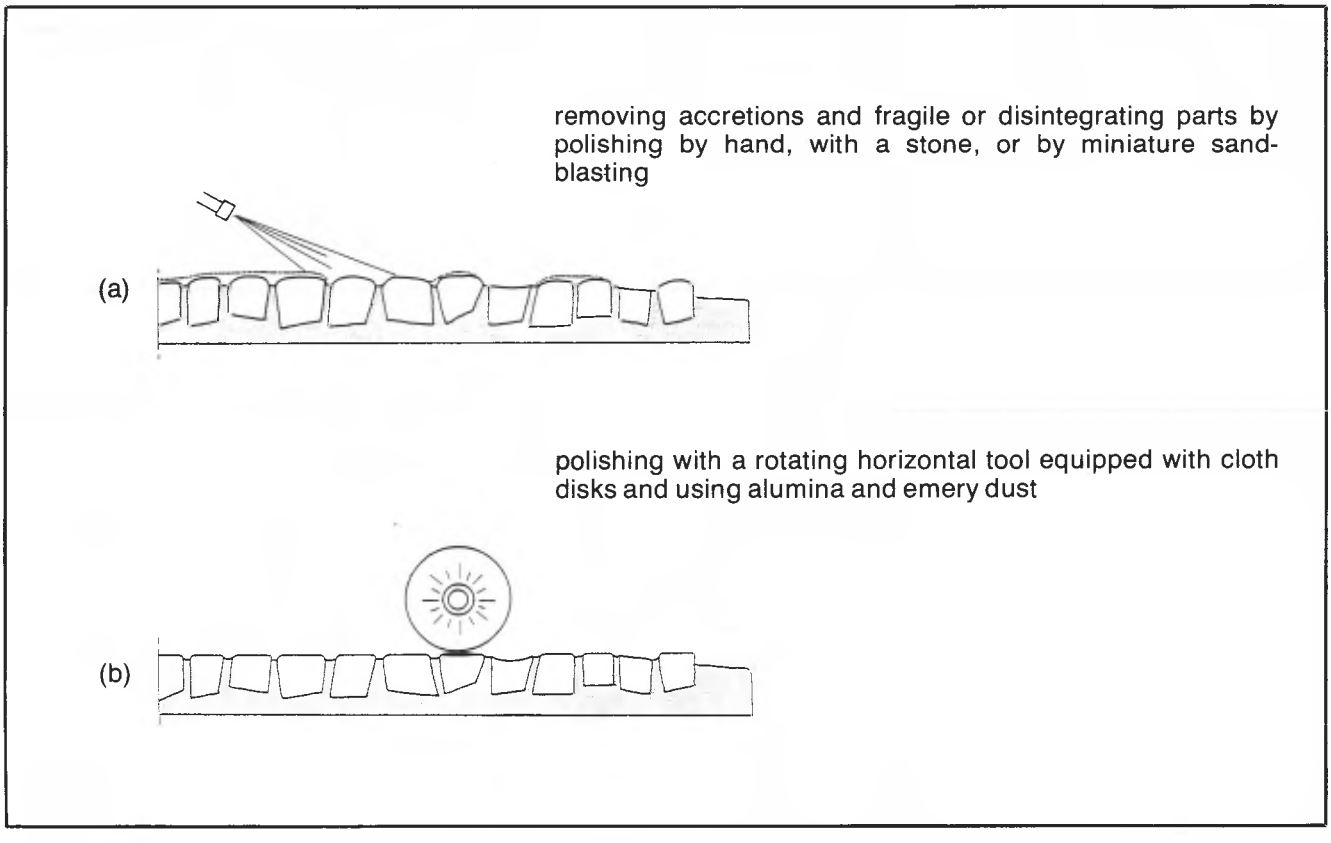


Fig. 10: Treating the surface - preserving the contour changes.

PART II

MOSAIC SUPPORTS
A COMPARATIVE STUDY OF THE PRINCIPAL MATERIALS AND METHODS

INTRODUCTION

A detached mosaic should receive a primary treatment in preparation for its transfer to a new support of whatever type. This treatment, essential to prepare the mosaic for transfer, is described in section I.

The choice of new supports will depend on:
— the nature of the pavement;
— the financial means available;
— the technical means available;
— the size of the mosaic;
— the mosaic's final destination.

The new support can be on either a solid or a movable base.

Solid base:

— fixed floor of reinforced cement concrete with an intervening bed (section II);
— fixed floor in lime mortar (section III);

Movable base:

— slab of cement concrete in direct contact with the tesserae (section IV) (to be completely rejected);
— slab of reinforced cement concrete with an intervening bed (section V);
— slab of lime mortar in contact with the tesserae (section VI);
— wood (section VII);
— plaster (section VIII);
— stratified, reinforced resins (section IX);
— sandwich specially built on the reverse of the mosaic (section X);
— industrial honeycomb sandwich (section XI).

We shall study the fabrication, characteristics, advantages and disadvantages of each type of support and make some specific observations.

Whatever the type of support chosen, mosaic elements must be prepared in advance for transfer to it.

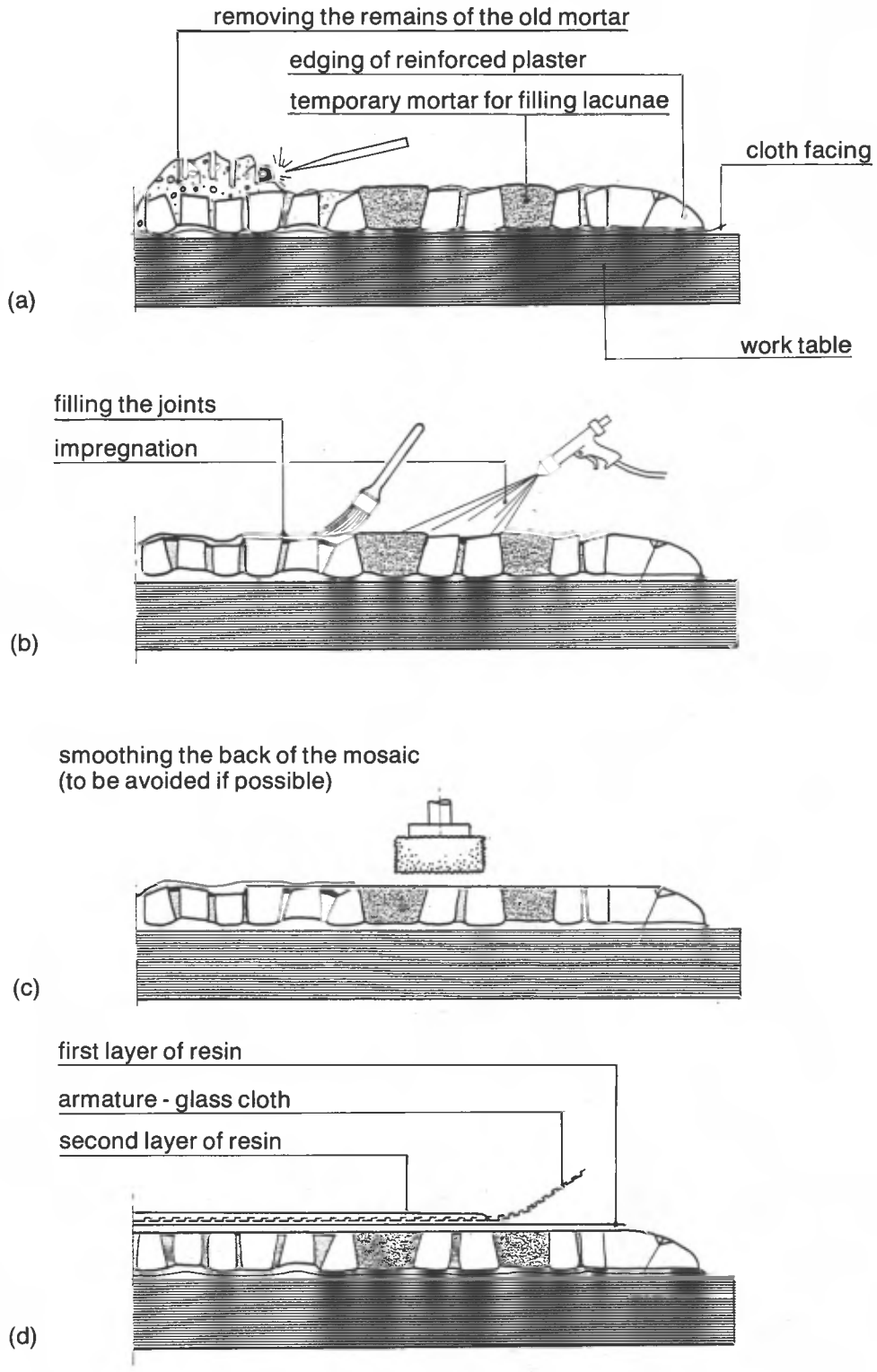


Fig. 11: A lifted mosaic being treated in a workshop. It is placed upside down on the work table. When using the indirect method of transferral, a stratum of reinforced resin is first placed on the back of the tesserae.

I.1 PREPARING THE TESSELLATUM

With the mosaic section lying face down, begin work on the back, removing any remains of the old support. If there are lacunae, fill them with a reversible mortar. If some tesserae or insertions are much thicker than the rest of the pavement, it may be necessary to level their back surface but this should preferably be avoided. (See fig. 11).

I.2 PREPARING THE INTERVENING BED

The insertion of an intervening layer between the tesselatum and the new support is strongly advised. This layer, called the intervening bed, should be of an easily reversible material so that future interventions, if needed, can be made without the risk of damaging the tessellatum.

Depending on the technology and the finances available, the intervening bed can consist of any of the following:

a) lime + crushed brick, with or without additives;
b) lime + pozzolana, with or without additives;
c) lime + sand, for small surfaces only;
d) lime + resin + filler;
e) resin + filler + additives;
f) lime + cement + sand + fillers.

Mixtures a) and b) are particularly recommended because they are very similar to an ancient nucleus.

I.3 TRANSFER

Two methods may be used.

The direct method is faster, cheaper, but more dangerous. (See figs. 11 a) b) c) and 12).

— Apply the material for the intervening bed to the top surface of the slab and to the back of the tessellatum.

— Take care that the mortar of the intervening bed is not too fluid or it might seep through to the face of the tessellatum. Should it seep through, it would be very difficult to clean the surface of the mosaic after the temporary cloth has been removed.

— Immediately place the tessellatum bottom down on the supporting slab, or, in reverse, place the slab face-down on the back of the tessellatum.

— This operation is particularly delicate because the inclusion of air between the mosaic and the slab must be avoided.

— Solidify the slab and the tessellatum by beating them with a wooden block, a rubber mallet, or some appropriate tool. (See fig. 12).

— If several panels need to be placed together to form the mosaic, make sure that they are level where they abut.

— Detach the cloth from the surface of the tessellatum and remove all traces of adhesives.

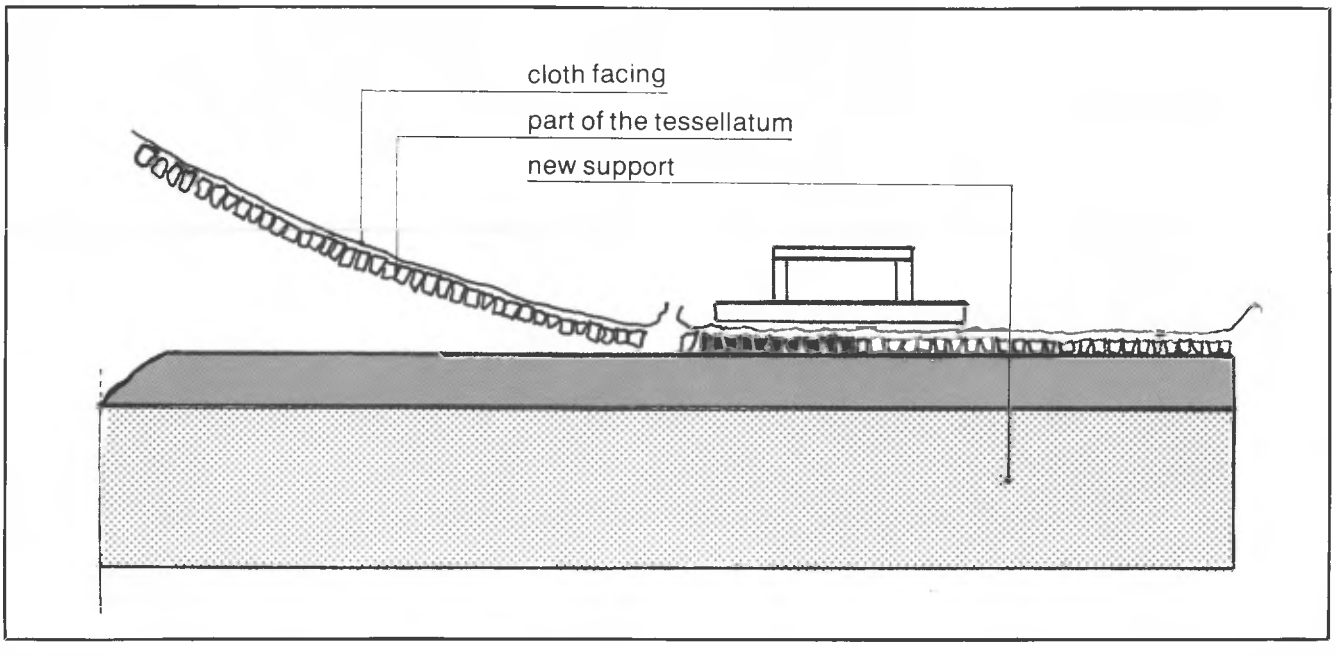


Fig. 12: Direct transfer to a new support.

The indirect method is slower, more expensive, but safer. (See figs. 11 and 13).

— On the bottom side of the tessellatum, apply a first layer of the mortar for the intervening bed. This should be strengthened with jute fibre, burlap or glass cloth.

— Take care that the mortar does not run between the tesserae and does not seep to the surface of the tessellatum.

— Make everything perfectly level. Let it dry.

— Remove the cloth from the surface of the tessellatum.

— For the remainder of the operation, follow the direct method.

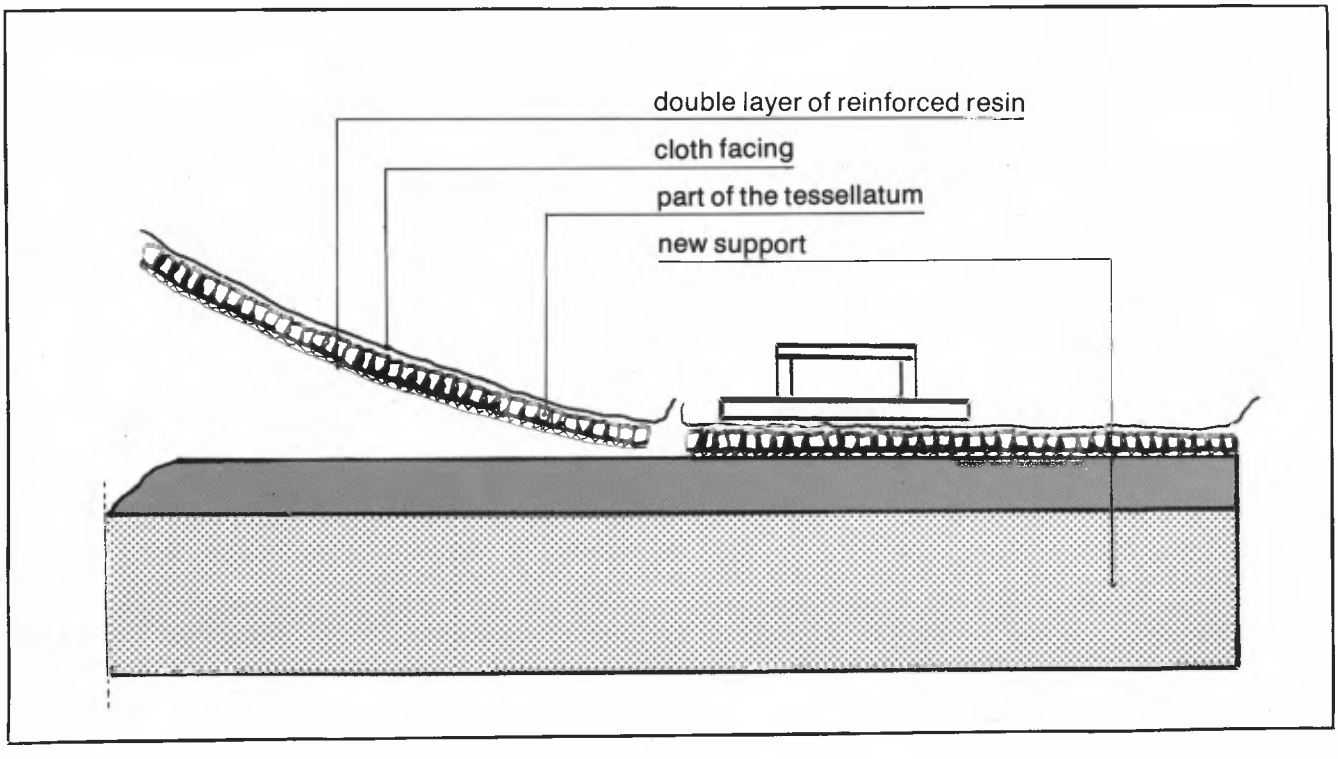


Fig. 13: Indirect transfer to a new support.

II. FIXED FLOOR OF REINFORCED CEMENT CONCRETE WITH INTERVENING BED

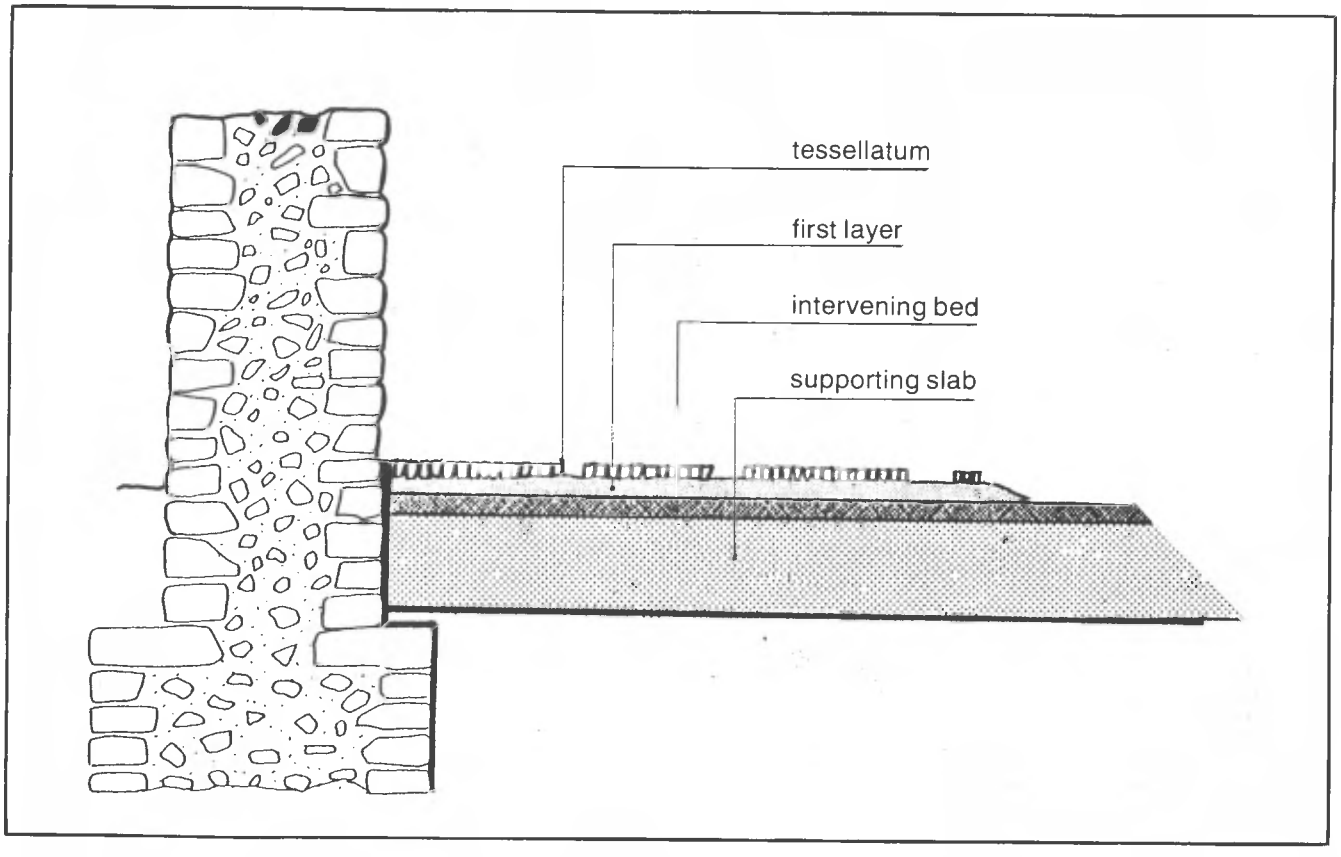


Fig. 14 (a): Mosaic transferred to a floor of reinforced cement concrete with an intervening bed.

II.1 FABRICATION

II.1.1 **Archaeological excavation**

After the mosaic has been lifted, make a complete archaeological excavation of the site down to virgin soil.

II.1.2 **The floor**

II.1.2.1 Construct a floor after having taken into account the level of the original floor, and the thicknesses of the setting bed, the intervening bed, and the tessellatum. Place this new flooring over a hollow underfloor or on a gravel bed, depending on the circumstances. It must be protected against rising damp and have the necessary mechanical characteristics.

II.1.2.2 The floor slab should be designed by an architect or engineer who will specify the mix of the concrete and the detailed reinforcement necessary to provide a stable base over the site capable of supporting the future loading to be anticipated.

If the services of an architect or engineer are not available, it is essential to keep in mind the following recommendations:

— do not put in too much cement;
— use only washed aggregates;
— when mixing the cement and aggregate, use only the amount of water strictly necessary. Do not use salt water;
— the diameter of the iron rods, the position of the reinforcement within the slab, and the network of the reinforcement depend on the dimensions of the slab. But in every case, the reinforcement should be completely covered with cement and should be at least 40 mm from the surface of the slab;
— mosaic elements should be transferred to a slab of reinforced concrete with an intervening bed.

II.1.2.3 If the mosaic was lifted by the method described in section IV.1.6a, p. 21 of Part I, and if the variance in surface level is to be kept as found, the different height can be indicated by pegs. (See fig. 15).

II.1.2.4 To provide for future removal of the mosaic, place kraft paper or a polythene sheet on the floor. When this is done, the thickness of the setting bed should be increased up to 40 mm to facilitate future work.

All mosaics can be treated this way, however they were lifted.

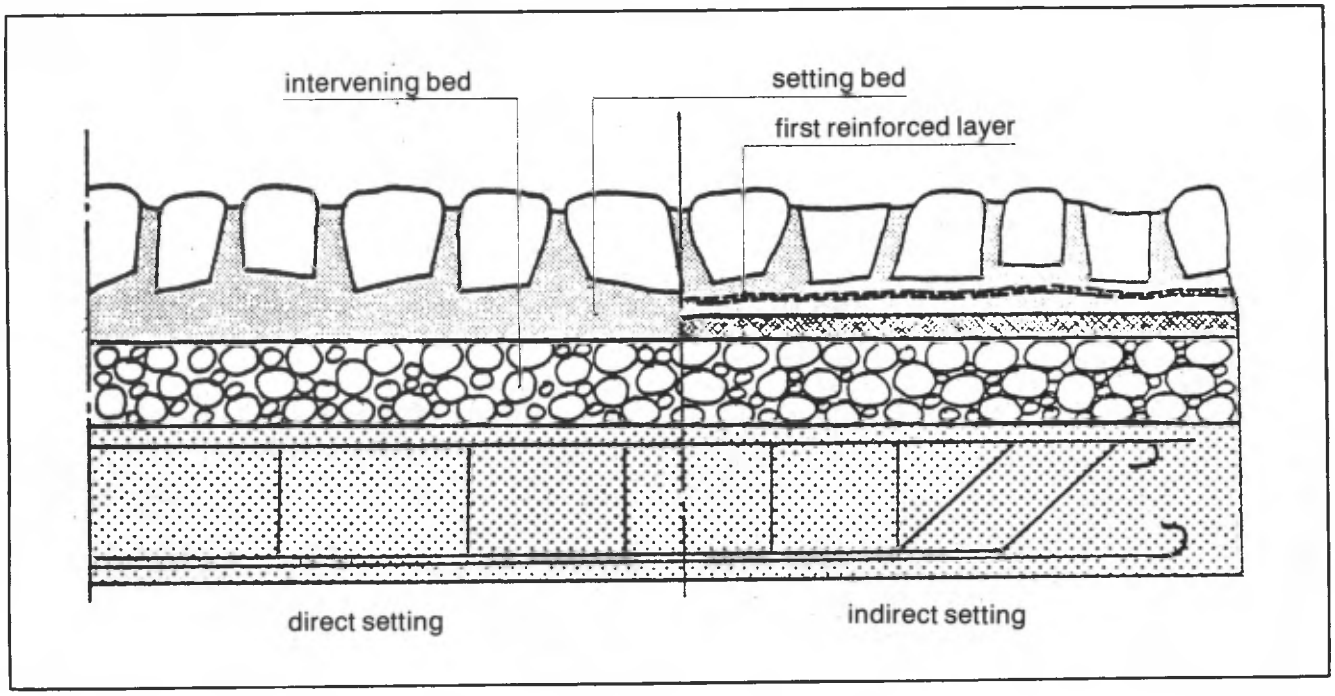


Fig. 14 (b): Details of direct setting and indirect setting.

II.1.3 **The tessellatum** (See Part II, p. 33, section 1, Preparation for transfer).

II.1.4 **Replacing the tessellatum**

II.1.4.1 Never place the mosaic pieces directly into cement concrete. This will bring about a more or less rapid loss of the mosaic. An intervening bed must always be placed between the tessellatum and the concrete.

II.1.4.2 The method of replacing the tessellatum depends on the method used when it was lifted.

a) **In case the lifting was done when the bedding mortar was relatively soft.** (See Part I, section IV.1.6a, p. 21).

1) Replace by the conventional mosaic method, the sections being set into a lime mortar fixing bed and lightly beaten flat.

2) Work should begin from the centre line. The exact position and direction of each piece can be determined by reference to the grid lines marked on the gauze facing and the numbered drawing.

3) When the mosaic has been replaced and when the lime mortar is hard enough, remove the gauze covering and all traces of adhesive. If the mosaic was lifted using animal glues — which nowadays should be avoided — the glue must be carefully removed by continued washings in warm water. Unfortunately, this treatment will not preclude the possibility of micro-organisms' developing, above all if the mosaic is exposed to humidity.

4) Restore the small lacunae.

5) Repoint the mosaic with a lime mortar similar to the original. It could contain marble powder, crushed brick, or sand.

b) **In case the lifting was made from a hard mortar.** (See Part I, section IV.1.6b, p. 21).

1) If the mosaic was sawn out in pieces, carefully replace the pieces according to the lifting plan. Drive the pieces into the setting bed with a mallet.

2) Remove the temporary strengthening layers from the mosaic surface with appropriate solvents and/or heat. The adhesives should not be heated beyond their melting point for fear of affecting their reversibility. Avoid heat when working on tesserae made of glass paste.

3) Remove all traces of reversible mortar used for strengthening the mosaic during the preceding work.

4) Put back in place all tesserae detached during the preceding operations, particularly those along the borders. Joints between pieces of the mosaic should be refilled. Lacunae should be treated as indicated in Part I, section VIII.1. Repoint the mosaic with a rich mortar similar to the original.

II.2 CHARACTERISTICS

No limitations on size.

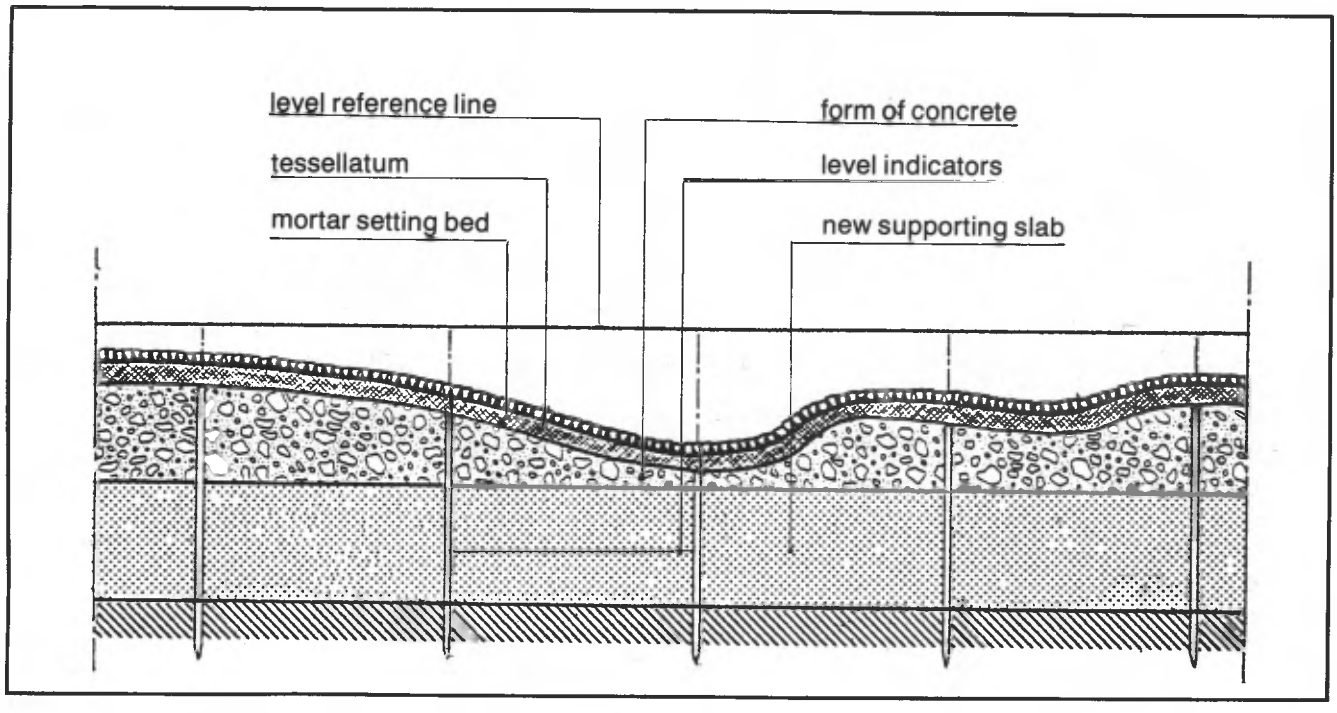


Fig. 15: Transfer preserving deformations of the pavement (W.E. Novis' method).

II.3 ADVANTAGES

— the work remains *in situ*;
— requires a minimum of expertise;
— low cost (not including the floor);
— fairly easy to reverse;
— can be laid over a membrane to facilitate easy removal and to give additional protection against moisture;
— protects against direct physical and chemical reactions of cement;
— easy to establish a consistency of level among pieces;
— good stability over the course of time if sufficiently protected.

II.4 DISADVANTAGES

— people are likely to walk on it;
— if the cutting up of the mosaic has involved the loss of one or more tesserae, any subsequent completion of the lacunae will be conspicuous and unsightly.

II.5 OBSERVATIONS

THE TESSELLATUM AND THE SUPPORT MUST BE PROTECTED AGAINST VARIATIONS IN HUMIDITY AND TEMPERATURE WHICH CAN BRING ABOUT PHYSICAL, CHEMICAL AND BIOLOGICAL PROCESSES OF DETERIORATION.

III. FIXED FLOOR IN LIME MORTAR

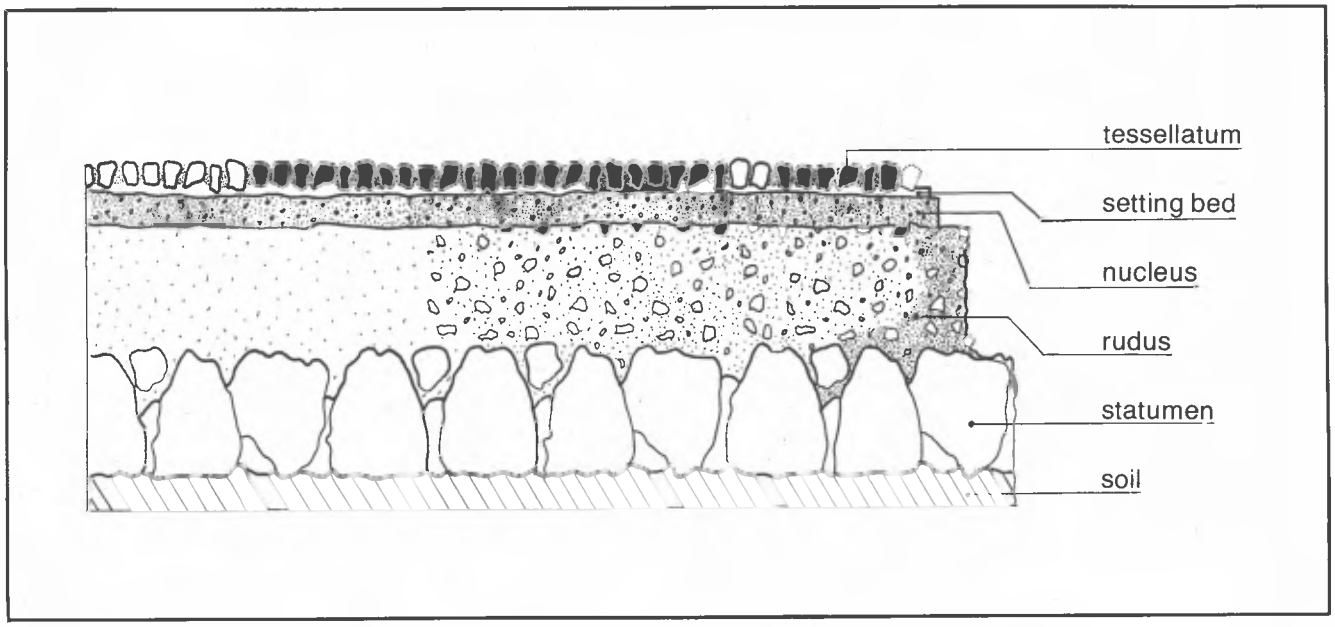


Fig. 16: Mosaic transferred to a fixed floor of lime mortar.

III.1 FABRICATION

III.1.1 **Archaeological excavation**

After the mosaic has been lifted, make a complete archaeological excavation of the site down to virgin soil.

III.1.2 **The floor**

III.1.2.1 On a reconstituted rudus, or on a perfectly waterproof fill, lay a nucleus of lime, pozzolana and sand or of lime and crushed bricks.

III.1.2.2 If the mosaic was lifted by the method described in section IV.1.6a, p. 21 of Part I, and if the variance in surface level is to be kept as found, mark the different heights with pegs. (See fig. 15).

III.1.2.3 To provide for future removal of the mosaic, place kraft paper or a polythene sheet on the floor. When this is done, the thickness of the setting bed should be increased up to 40 mm to facilitate future work.

All mosaics can be treated this way, however they were lifted.

III.1.3 **The tessellatum** (See Part II, section 1, Preparation for transfer)

III.1.4 **Replacing the tessellatum**

III.1.4.1 Never place the mosaic pieces directly into cement concrete. This will bring about a more or less rapid loss of the mosaic. An intervening bed must always be placed between the tessellatum and the cement.

III.1.4.2 The method of replacing the tessellatum depends on the method used when it was lifted.

a) **In case the lifting was done when the bedding mortar was relatively soft.** (See Part I, section IV.1.6a, p. 21).

1) Replace by the conventional mosaic method, the sections being set into a lime mortar fixing bed and lightly beaten flat.

2) Work should begin from the centre line. The exact position and direction of each piece can be determined by reference to the grid lines marked on the gauze facing and the numbered drawing.

3) When the mosaic has been replaced and when the lime mortar is hard enough, remove the gauze covering and all traces of adhesive. If the mosaic was lifted using animal glues — which nowadays should be avoided — the glue must be carefully removed by continued washings in warm water. Unfortunately, this treatment will not preclude the possibility of micro-organisms' developing, above all if the mosaic is exposed to humidity.

4) Restore the small lacunae.

5) Repoint the mosaic with a lime mortar similar to the original. It could contain marble powder, crushed brick, or sand.

b) **In case the lifting was made from a hard mortar.** (See Part I, section IV.1.6b, p. 21).

1) For mosaics with gaps caused by the cutting operation, carefully replace the pieces according to the lifting plan. Drive the pieces into the setting bed with a mallet.

2) Remove the temporary strengthening layers from the mosaic surface with appropriate solvents and/or heat. The adhesives should not be heated beyond their melting point for fear of affecting their reversibility. Avoid heat when working on tesserae made of glass paste.

3) Remove all traces of reversible mortar used for strengthening the mosaic during the preceding work.

4) Put back in place all tesserae detached during the preceding operations, particularly those along the borders. Joints between pieces of the mosaic should be refilled. Lacunae should be treated as indicated in Part I, section VIII.1, p. 28. Repoint the mosaic with a rich mortar similar to the original.

III.2 CHARACTERISTICS

No limitations of size.

III.3 ADVANTAGES

— the technique is identical with that used in antiquity;

— very lasting.

III.4 DISADVANTAGES

— in certain countries it is difficult to find good quality lime.

III.5 OBSERVATIONS

A MUCH RECOMMENDED METHOD BECAUSE IT HAS PROVEN ITSELF IN THE PAST. BUT THE REINSTALLATION OF THE MOSAIC MUST BE THOROUGHLY PLANNED BEFOREHAND.

IV. MOVABLE SLAB OF CEMENT CONCRETE IN DIRECT CONTACT WITH THE TESSERAE

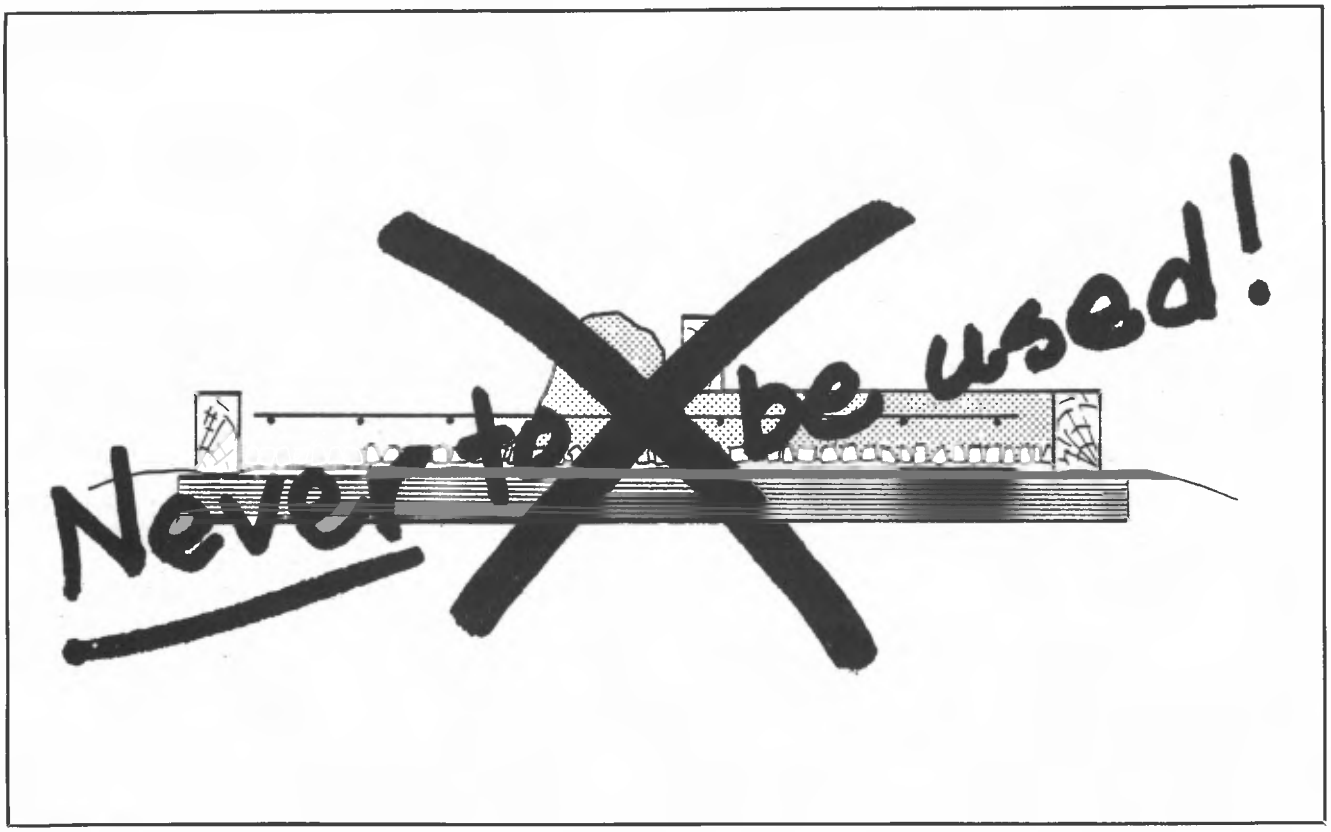


Fig. 17: Fabrication of a slab of reinforced cement concrete directly on the back of the tesserae - to be absolutely rejected.

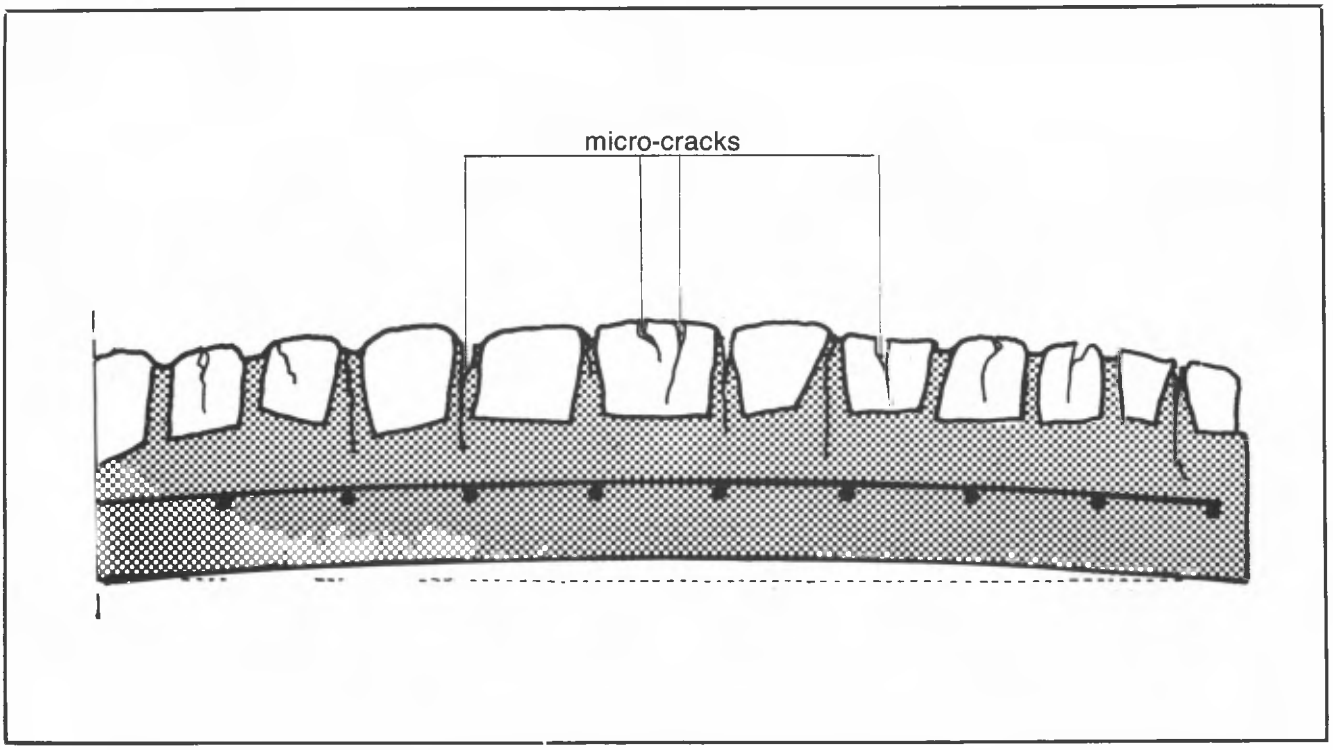


Fig. 18: Buckling of reinforced cement concrete slab.

IV.1 FABRICATION

This method must be completely rejected. It is described here only because it has been used in the past.

Work is done on a mosaic piece which has already been detached, reversed, and cleared of the remnants of its old support.

For a museum installation:

— place a wooden framework around the perimeter of the piece;

— wet the back surface, then apply a cement grout;

— set up reinforcement at a distance of more than 15 mm from each surface of the slab;

— pour cement mortar into the form. (See fig. 17).

For return to its original site:

— place the mosaic, which has been previously dampened, bottom down in fresh cement concrete;

— seal them together by beating with a mallet and block or pressing with a roller.

IV.2 CHARACTERISTICS

When the slabs are meant to be movable, their dimensions are limited by their weight.

Dimensions are unlimited when *in situ.*

A slab of reinforced concrete 35 mm thick, the thinnest practicable, weighs 85 kg/m^2.

IV.3 ADVANTAGES

— easily fabricated under ordinary conditions;

— very low total cost;

— immediately apparent results;

— the mosaic can be walked on.

IV.4 DISADVANTAGES

— difficulties in setting, aligning and levelling several panels;

— almost irreversible;

— great difficulty in reworking previous restorations;

— very serious damage in case of accident;

— very heavy material, making it difficult to move panels larger than 1.50 m x 2.00 m. When the cement sets, the slab can arch slightly and cause small cracks (fig. 18);

— affected by humidity which oxidises the reinforcement, causing the cement to crack;

— affected by temperature variations which cause the reinforcement to expand;

— migration of soluble salts, affecting the colour of the tesserae and causing some to come loose.

IV.5 OBSERVATIONS

FOR ALL THE REASONS DESCRIBED, CONCRETE SHOULD NEVER COME IN DIRECT CONTACT WITH THE TESSERAE. THIS METHOD SHOULD, THEREFORE, NEVER BE USED.

V. MOVABLE SLAB OF REINFORCED CEMENT CONCRETE WITH INTERVENING BED

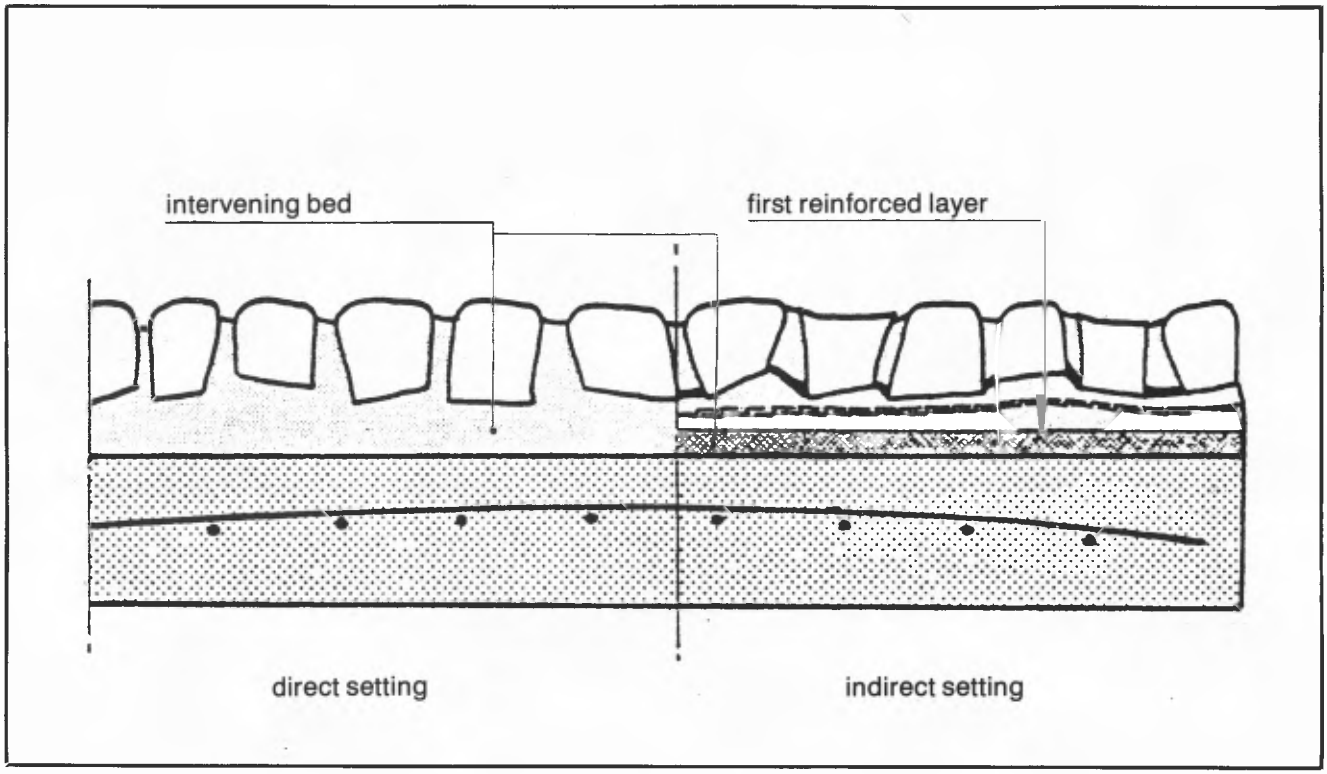


Fig. 19: Mosaic transferred to a slab of reinforced cement concrete with an intervening bed.

V.1 FABRICATION

V.1.1 **The slab**

The floor slab should be designed by an architect or engineer who will specify the mix of the concrete and the detailed reinforcement necessary to provide a stable base over the site capable of supporting the future loading to be anticipated.

If the services of an architect or engineer are not available, it is essential to keep in mind the following recommendations:

— do not put in too much cement;

— use only washed aggregates;

— when mixing the cement and aggregate, use only the amount of water strictly necessary, without excess. Do not use salt water;

— the diameter of the iron rod, the position of the reinforcement within the slab, and the network of the reinforcement depend on the dimensions of the slab. But in every case, the reinforcement should be completely covered with cement and should be at least 40 mm from the surface of the slab;

— never use galvanized iron reinforcements;

— pour the concrete over the armature within the form;

— vibrate the mixture to avoid the inclusion of air pockets;

— prevent evaporation while the concrete is hardening;

— when the slab is poured, wait until the cement has hardened before using it (generally this takes 3 months);

— if, after hardening, the slab has buckled, it must be ground flat before applying the tessellatum. (See fig. 20).

V.1.2 **The tessellatum** (See Part II, section I, p. 33, Preparation for transfer)

V.1.3 **Replacing the tessellatum** (See Part II, section II.1.4, p. 36)

V.2 CHARACTERISTICS

Usual maximum dimensions are 3 m^2 but some thin slabs have attained 12 m^2.

Weight, with the mosaic, of a 35 mm slab made by a technician, from 1 to 3 m^2 - 90 to 100 kg/m^2.

Weight, with the mosaic, of an often oversize slab, from 1 to 3 m^2 - 200 kg/m^2 and more, without any improvement of mechanical characteristics.

The cost, by m^2, of a slab of cement is very low.

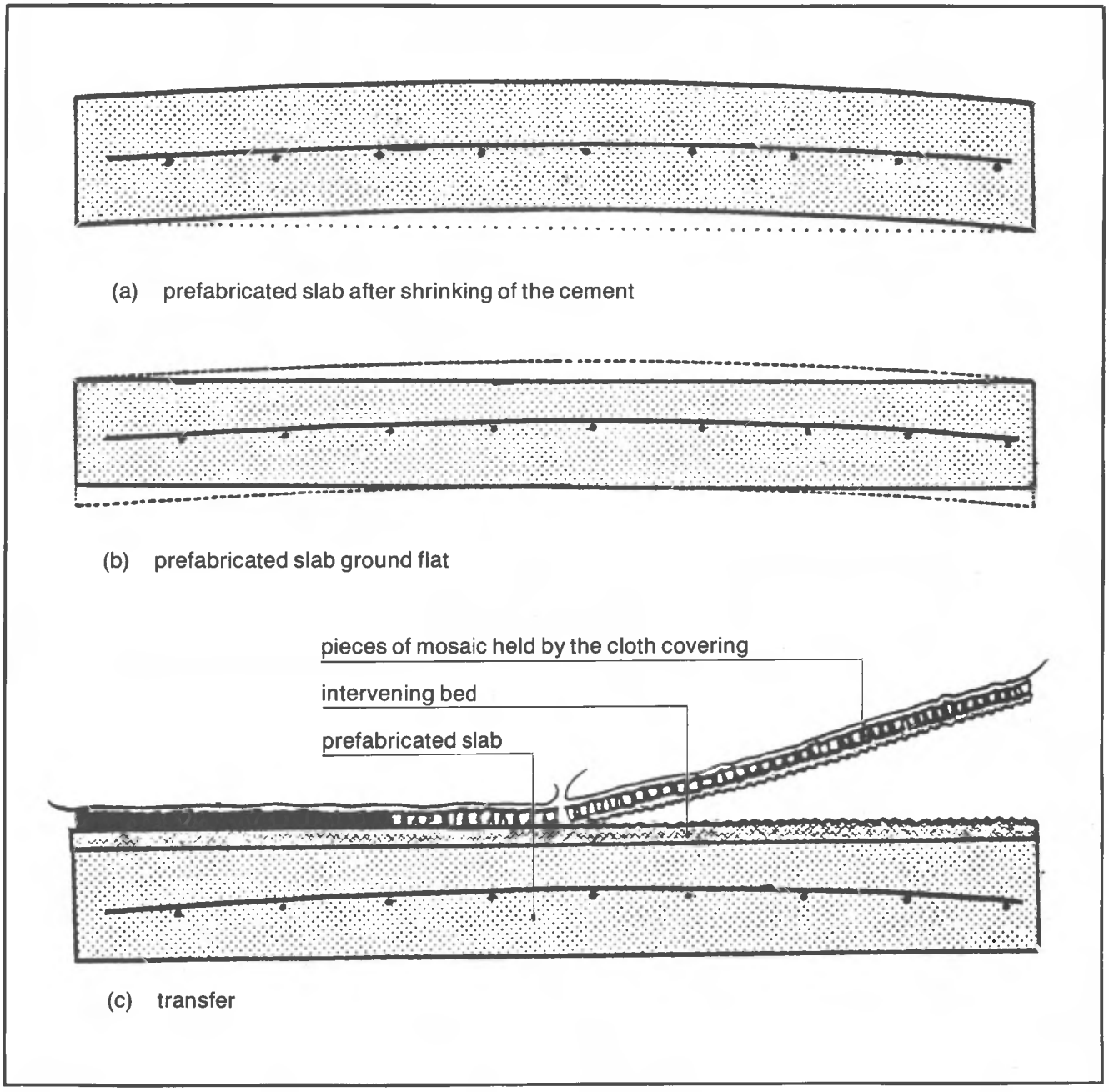


Fig. 20: Transfer to a prefabricated slab of reinforced cement concrete with an intervening bed.

V.3 ADVANTAGES

— can be done with a minimum of technical expertise;
— relatively low cost;
— gives protection against direct physical and chemical reactions of cement.

V.4 DISADVANTAGES

— people are likely to walk on it;
— heaviness, the weight can cause accidents during maintenance;
— hard and brittle, risk of tessellatum coming loose during maintenance;
— cutting required for works of large dimensions.

V.5 OBSERVATIONS

REQUIRES PROTECTION AGAINST VARIATIONS IN HUMIDITY AND TEMPERATURE WHICH CAN CAUSE PHYSICAL AND CHEMICAL DETERIORATION IN THE SUPPORT AND THE TESSELLATUM.

VI. MOVABLE SLAB OF LIME MORTAR IN CONTACT WITH THE TESSERAE

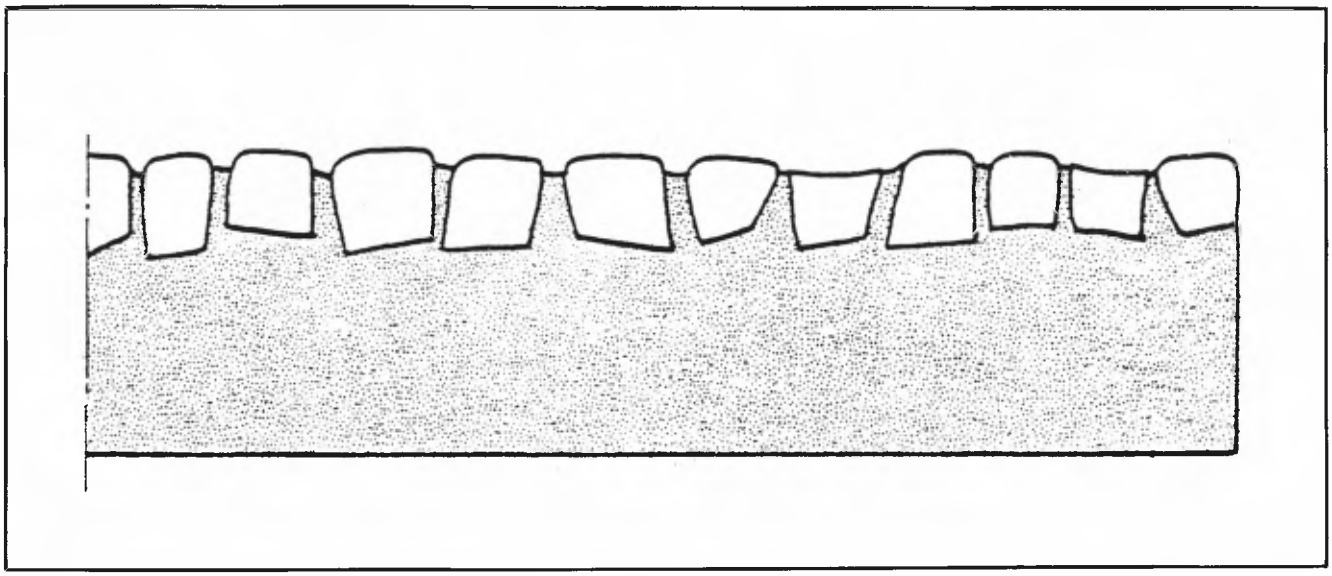


Fig. 21: Mosaic transferred directly to a movable slab of lime mortar.

VI.1 FABRICATION

Work on a mosaic piece which has already been detached, turned over, and cleaned of all vestiges of its old support.

Fill the lacunae with reversible mortar.

Place a wooden framework around the perimeter of the piece.

Wet the back surface of the tesserae and apply a lime grout.

Spread on lime mortar. (See fig. 22).

Let it harden, making sure that it remains damp during the whole process.

Turn over, remove the cloth used for strengthening during the lifting.

Remove all traces of adhesives.

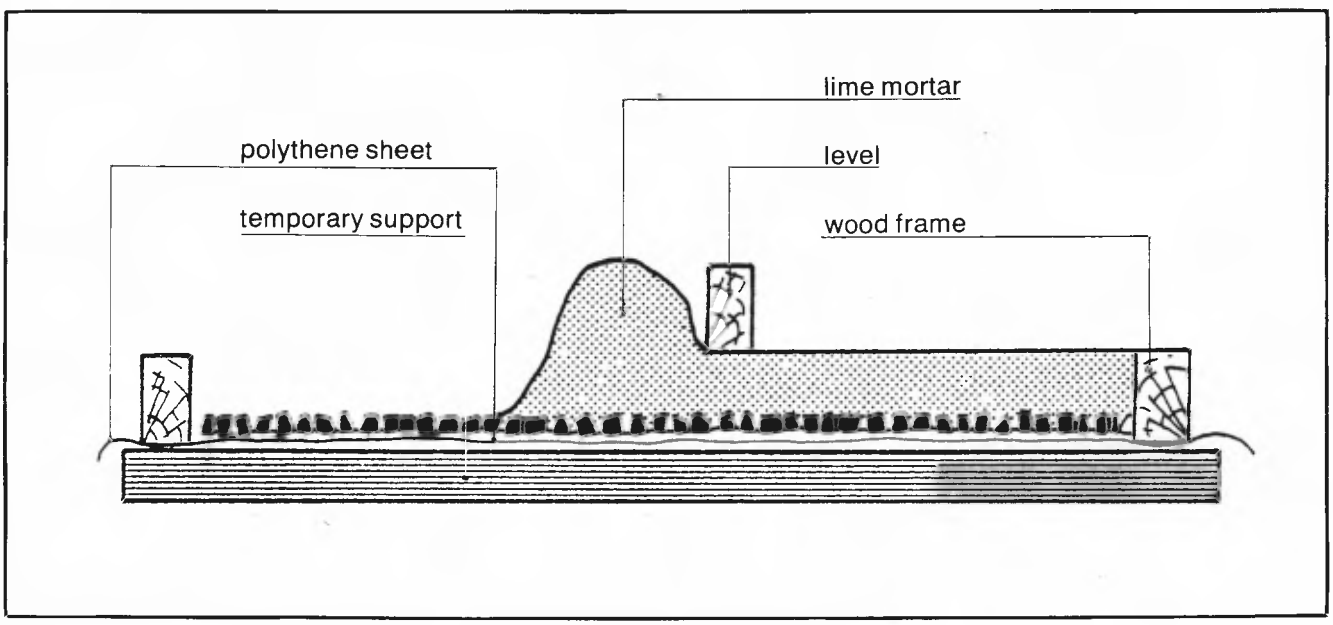


Fig. 22: Fabrication of a slab of lime mortar directly on the back side of the tesserae.

VI.2 CHARACTERISTICS

Maximum dimension: 0.70 m x 0.70 m.
Thickness: at least 10 cm.
Weight varies according to the thickness and the quality of the mortar.

VI.3 ADVANTAGES

— excellent conservation;
— the traditional technique and also the cheapest system.

VI.4 DISADVANTAGES

— impossibility of working in big dimensions;
— must be protected.

VI.5 OBSERVATIONS

THIS IS USEFUL ONLY FOR MOSAICS OF SMALL SIZE. IT WOULD BE VERY DIFFICULT TO USE FOR A MURAL.

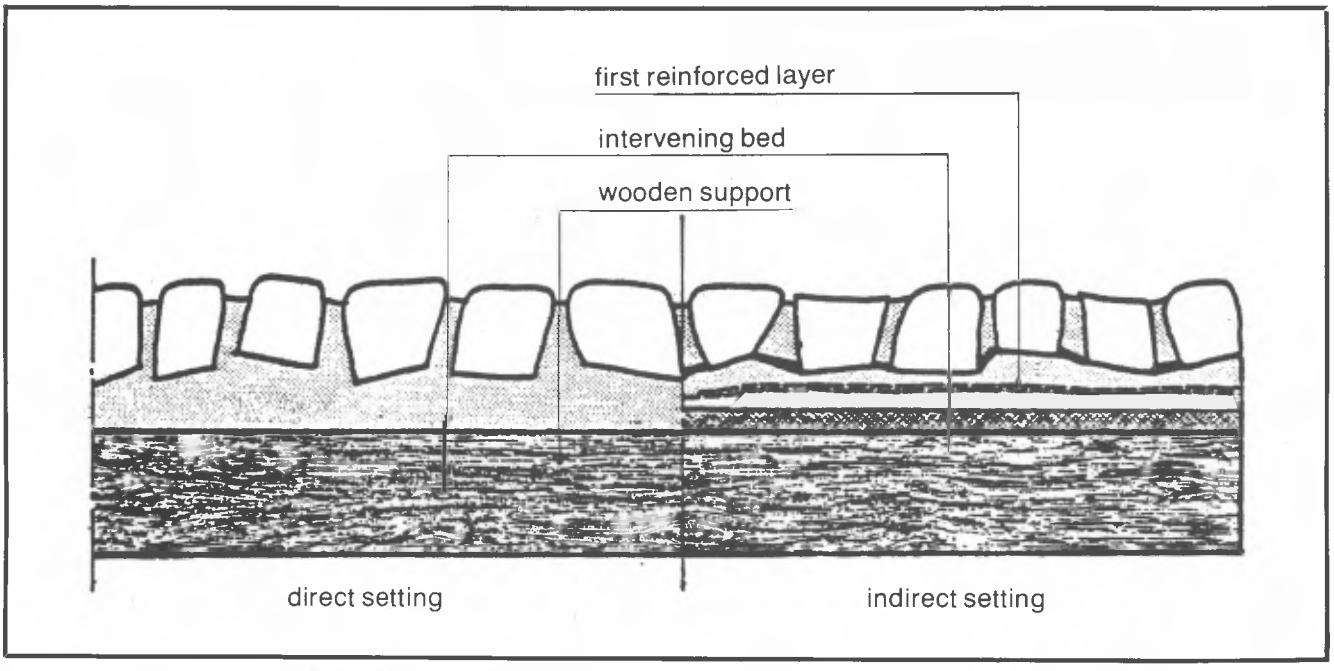


Fig. 23: Mosaic transferred to a portable wooden support.

VII.1 FABRICATION

VII.1.1 **The support**

— Never use wooden boards.
— In descending order of preference, the materials to use are blockboard, marine plywood, or sandwiches with chipboard centres (always in special materials which resist humidity).
— A protective coating must be applied to the edges of the wooden support and strips put around them to protect them.
— Surfaces must be impregnated with, for example, dilute marine varnish, to reduce humidity exchange between the support and the atmosphere.

VII.1.2 **The tessellatum**

With the mosaic section lying face down, begin work on the back, removing any remains of the old support. If there are lacunae, fill them with a reversible mortar. If some tesserae or insertions are much thicker than the rest of the pavement, it may be necessary to level their back surface but this should preferably be avoided.

VII.1.3 **The bonding layer**

This can be made of a large variety of materials, depending on what is available:
a) plaster and bone glue (should be avoided);
b) plaster and emulsion of synthetic resins, such as vinylic styrene-butadiene;
c) mortar:
— sand + marble powder + PVC emulsion;
— sand + lime + PVC or acrylic resin emulsion;
— sand + epoxy resin + additives.

To strengthen the adherence of the mortar to the wood panel, use a mesh reinforcement anchored to the panel but make sure it is compatible with the materials making up the bonding layer.

VII.1.4 **Transfer**

Direct method: quicker and cheaper to use for small panels.
— Apply the bonding layer to the underside of the tessellatum.
— On the wooden support, apply a bonding layer identical to that used on the tessellatum.
— Turn the tessellatum face up and put it in place in the bonding layer.
— Check and adjust for adhesion.
— Remove the cloth from the tessellatum surface which had been attached before lifting.

Indirect method: slower, more expensive, good for large panels of one piece.
— On the reverse side of the tessellatum, first apply the mortar of the intervening bed, preferably reinforced with jute fibres or fibreglass. Level perfectly and let dry or harden.
— Then follow the direct method.

VII.2 CHARACTERISTICS

Maximum dimensions: 1.50 m^2 for a thickness of 12 mm; 3 m^2 for a thickness of 19 mm, more with a thicker sandwich or special supports.

Weight of support: at 12 mm, about 10 to 12 kg per m^2, without framework; at 19 mm, about 20 kg per m^2, without framework.

Inexpensive.

VII.3 ADVANTAGES

— support is easy to build, present and assemble;
— support is light, tidy;
— good ratio between mechanical characteristics and weight;
— recommended for vertical use;
— standard flush doors can be used for temporary exhibitions.

VII.4 DISADVANTAGES

— susceptible to humidity and insects;
— combustible;
— a framework is needed on large surfaces;
— danger of warping;
— can only be used indoors.

VII.5 OBSERVATIONS

MAY BE USED FOR SMALL SURFACES DISPLAYED INDOORS, WITHOUT EXCESSIVE VARIATIONS IN HUMIDITY.

VIII. PLASTER

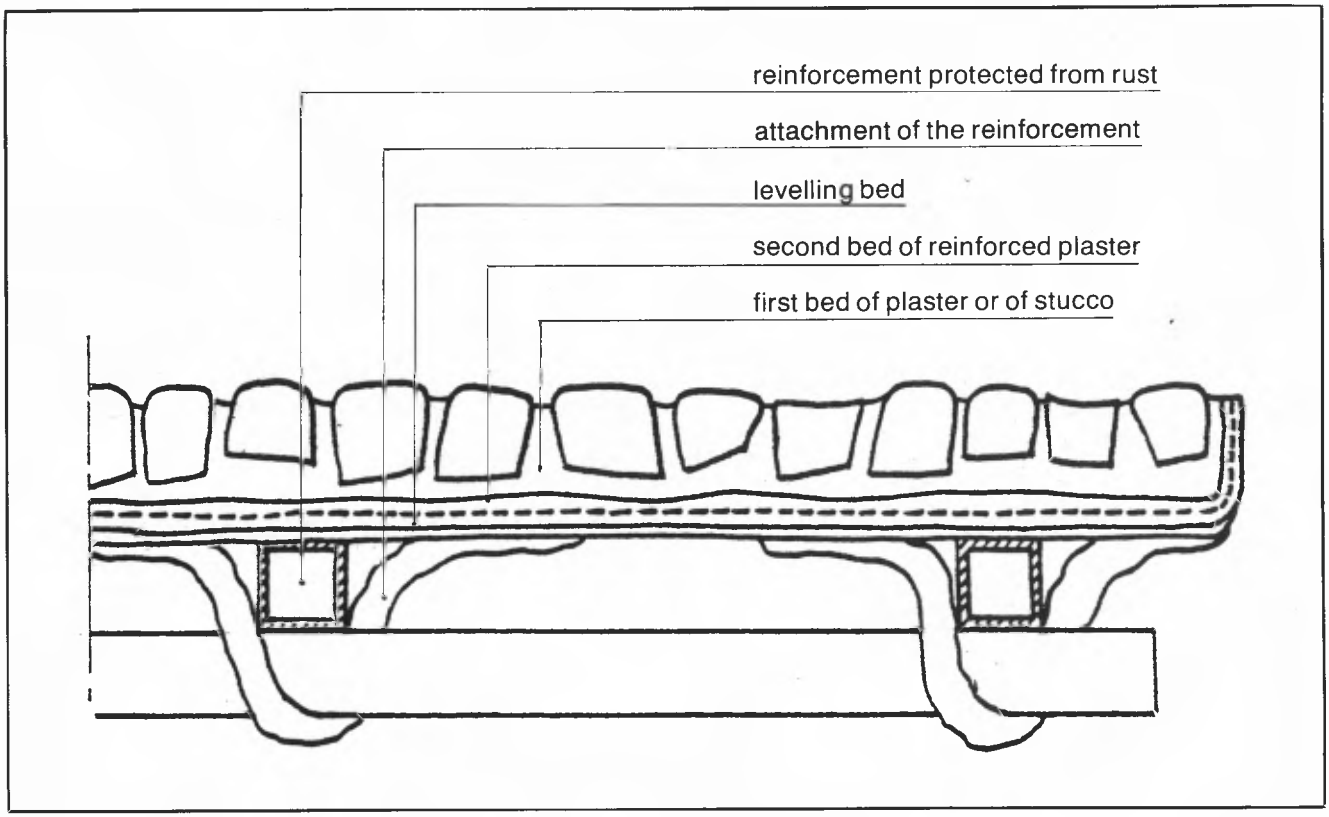


Fig. 24: Mosaic transferred to a plaster support.

VIII.1 FABRICATION

Work on a mosaic piece which has already been lifted, turned over, and cleaned of all vestiges of its old support.

Fill the lacunae with reversible mortar.

Use fine grain plaster, such as plaster of Paris, but never building plaster.

The back of the tessellatum should be set in a layer of pure plaster.

The next underlying layer, the second, should also be plaster but reinforced with jute fibres or burlap.

The performance of the plaster is improved by adding synthetic organic glues, by painting over it or by impregnation.

Wood or metal ribs, running across the back of the mosaic and firmly attached to it, will provide further strength.

These reinforcing ribs should be painted to preserve them from humidity and corrosion.

If a framework is needed, it must be designed to be an integral part of the whole piece.

The plaster should dry in the shade over a long period, as slowly as possible. Fifteen days are sometimes necessary.

Turn over and remove the cloth used during lifting. Remove all trace of adhesives.

VIII.2 CHARACTERISTICS

Dimensions: 2 m x 3 m sections can be constructed without difficulty, and specialists can make even larger panels.

Weight of support, without reinforcement: A square metre of panel 1 mm thick weighs 1.6 kg. As an example, a panel which is 2 m x 3 m and 12 mm thick will weigh about 120 kg.

Very low cost.

VIII.3 ADVANTAGES

— one of the oldest methods used in restoration;

— good for quick, temporary first-aid treatment;

— easily reversible;

— work can be conducted over a previous intervention;

— in case of mechanical accident, the damage is striking but intervention is easier than it would be on a cement support;

— relatively light in weight;

— very low cost of basic materials;

— materials easy to obtain and use.

VIII.4 DISADVANTAGES

— susceptible to fractures;
— susceptible to humidity;
— can only be used in a closed, dry environment, never outdoors;
— when exposed to humidity (liquid or vapour), the plaster partially dissolves; this causes a white deposit to form on the mosaic surface, and also the tesserae to become loose;
— susceptible to dryness, which will loosen the tesserae;
— wood reinforcements can be attacked by insects, micro-organisms and fire;
— metal reinforcements can rust and expand;
— limited life span.

VIII.5 OBSERVATIONS

THIS MUST BE USED ONLY INDOORS IN DRY CONDITIONS. THERE ARE BETTER, ALTHOUGH MORE EXPENSIVE, METHODS AVAILABLE. ALLOWS MOSAICS TO BE RESCUED AT LOW COST WITH RELATIVELY LITTLE RISK.

IX. STRATIFIED, REINFORCED RESINS

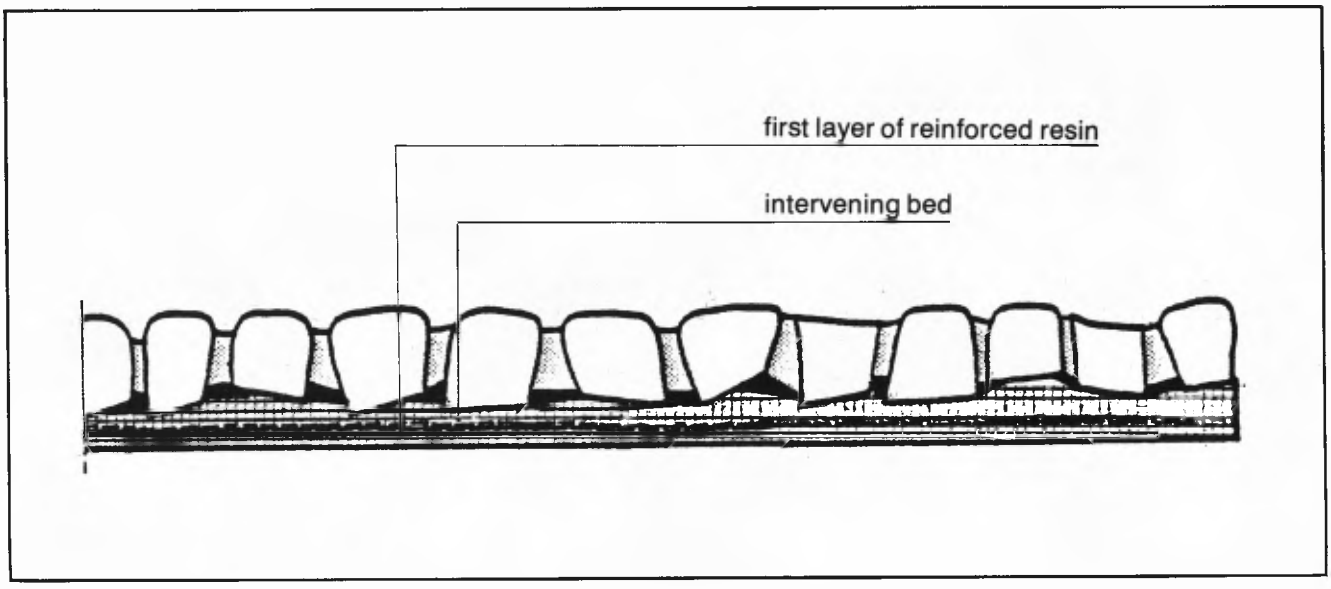


Fig. 25: Mosaic transferred to a layer of reinforced resin.

IX.1 FABRICATION

IX.1.1 **Resins**

Use only resins from the so-called "thermosetting" series, with good mechanical characteristics, like polyester, polyurethane epoxides.

Scrupulously follow the health and safety rules relating to the use of these materials. Whenever necessary, use masks, gloves, skin protection creams and special soaps.

Follow the manufacturer's directions.

Note: The same product can be manufactured by two different firms under different names. A manufacturer may also furnish several types of products under the same brand name. A resin is therefore defined by:

— the name of the manufacturer;
— the brand name;
— the product name;
— the exact, full code number of the product.

If necessary, include additives and fillers to promote ease of use, viscosity, adhesion, thixotropy, fire resistance and to inhibit shrinkage after hardening.

On a special form, register the date, the user's name, the resins, hardeners, additives, quantities used, and conditions of use, such as temperature and humidity.

IX.1.2 **Fibreglass**

Fibreglass is the most frequently used type of reinforcement. Use a kind of fibreglass whose components are compatible with the type of resin employed.

IX.1.3 **Stratification**

IX.1.3.1 Prepare the mosaic sections.

IX.1.3.2 Adopt the indirect method of working if possible. On the back of an already prepared mosaic section, apply a layer of resin, then a layer of glass fibre or fibre tissue, followed by a second layer of resin. Let it dry.

IX.1.3.3 Remove the cloth used during the lifting, and any trace of adhesive.

IX.2 CHARACTERISTICS

The resin and fibreglass stratum can serve as the mosaic's support as well.

Practical dimension: about 1 m^2.

Unlimited dimensions when stratum supported by framework.

As a temporary support, 2 mm thick, dimensions may reach 6 m^2, on condition that maintenance rules are followed.

IX.3 ADVANTAGES

— very high mechanical resistance to traction and compression;
— flexible;
— resists humidity;
— high chemical and biological resistance;
— light in weight;
— excellent resistance to ageing.

IX.4 DISADVANTAGES

— can be constructed only by experienced technicians;

— danger of resin penetration on face if the precautions described in section IX.1.3, p. 50 are not taken;

— relatively high cost;

— possible creeping of the resin above 100°C;

— chemical reversibility can only be carried out by highly qualified specialists;

— mechanical reversibility extremely difficult;

— physical reversibility possible with some resins;

— physiological dangers to workers when sawing or polishing (burning produces a noxious gas);

— some resins are highly inflammable without the addition of flame-proof agents;

— thin panels must always be supported when handled.

IX.5 OBSERVATIONS

USE WITH CARE, ONLY AFTER TESTING BY EXPERIENCED TECHNICIANS. CAN BE USED AS THE FIRST STAGE OF CONSERVATION OF A MOSAIC WHICH CAN LATER BE MOUNTED IN VARIOUS WAYS. CARE MUST BE TAKEN TO MAKE JOINTS UNOBTRUSIVE.

X. SANDWICH SPECIALLY BUILT ON THE REVERSE OF THE MOSAIC

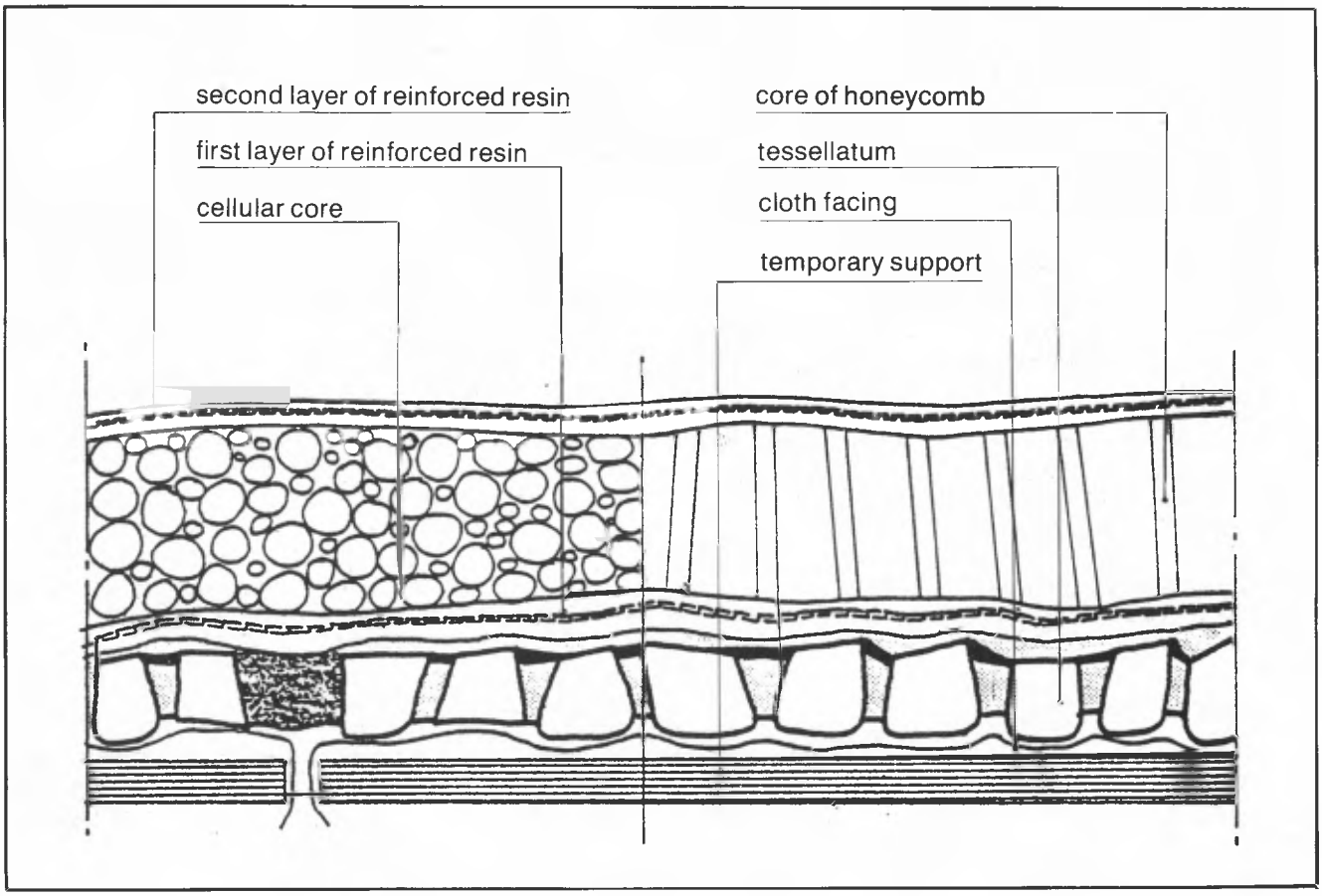


Fig. 26: Sandwich built onto the back of a mosaic.

X.1 FABRICATION

X.1.1 **The tessellatum**

With the mosaic piece lying face down, work on the back, removing any remains of the old support. If there are lacunae, fill them with a reversible mortar. If some tesserae or insertions are much thicker than the rest of the pavement, it may be necessary to level their back surface but this should preferably be avoided.

X.1.2 **The sandwich**

A sandwich must include:
— a reinforced stratum;
— a centre layer composed of light cellular material;
— another reinforced stratum.

If the lower and upper strata are not reinforced, the sandwich will be extremely fragile, with no mechanical resistance.

X.1.3 **Resins**

Use only resins from the so-called "thermosetting" series, with good mechanical characteristics, like polyester, polyurethane, epoxides.

Scrupulously follow the health and safety rules relating to the use of these materials. Whenever necessary, use masks, gloves, skin protection creams and special soaps.

Follow the manufacturer's directions.

Note: The same product can be manufactured by two different firms under different names. A manufacturer may furnish several types of products under the same brand name. A resin is therefore defined by:
— the name of the manufacturer;
— the brand name;
— the product name;
— the exact, full code number of the product.

If necessary, include additives and fillers to promote ease of use, viscosity, adhesion, thixotropy, fire resistance and to inhibit shrinkage after hardening.

On a special form, register the date, the user's name, the resins, hardeners, additives, quantities used, and conditions of use, such as temperature and humidity.

X.1.4 **Transfer**

On the back surface of the mosaic, which has already been prepared for indirect transfer and provided with a stratum of resin reinforced with fibreglass, attach a sandwich which will be built in the following way *in situ:*

— application of a second layer of resin (stratification paste) to the back of the mosaic;

— immediate attachment of the centre filling, which may be of cellular foam, honeycomb, or of a mortar of resin and vermiculite well glued to the preceding layer. **Attention: a stratified sandwich is designed according to mechanical laws and formulae and the resistance of materials. Not every light material can be used to fill the centre of a sandwich:**

— immediate application of the last layer, impregnated with resin mortar, so that it becomes firmly attached to the centre filling;

— finish the edges and affix attachments before or after the sandwich is finished;

— harden under the required conditions;

— remove the cloth and adhesives that were used for the lifting.

X.2 CHARACTERISTICS

Characteristics vary according to the materials used and the techniques adopted. Panels of 15 m^2 are not unusual.

X.3 ADVANTAGES

— can be used for complicated shapes without reducing its resistance;

— great mechanical strength;

— some flexibility;

— resistance to humidity and to chemical and biological attack;

— lightness in weight;

— resistance to ageing.

X.4 DISADVANTAGES

— irreversibility;

— danger of resin penetration on face;

— can be constructed only by experienced technicians;

— high cost;

— edges need protection;

— direct exposure to sunlight and to temperature variations must be avoided because of a high coefficient of expansion under such circumstances.

X.5 OBSERVATIONS

VERY INTERESTING IN THE CASE OF MOSAICS WHICH ARE NOT FLAT. SHOULD ONLY BE CARRIED OUT BY EXPERIENCED TECHNICIANS.

XI. INDUSTRIAL SANDWICH

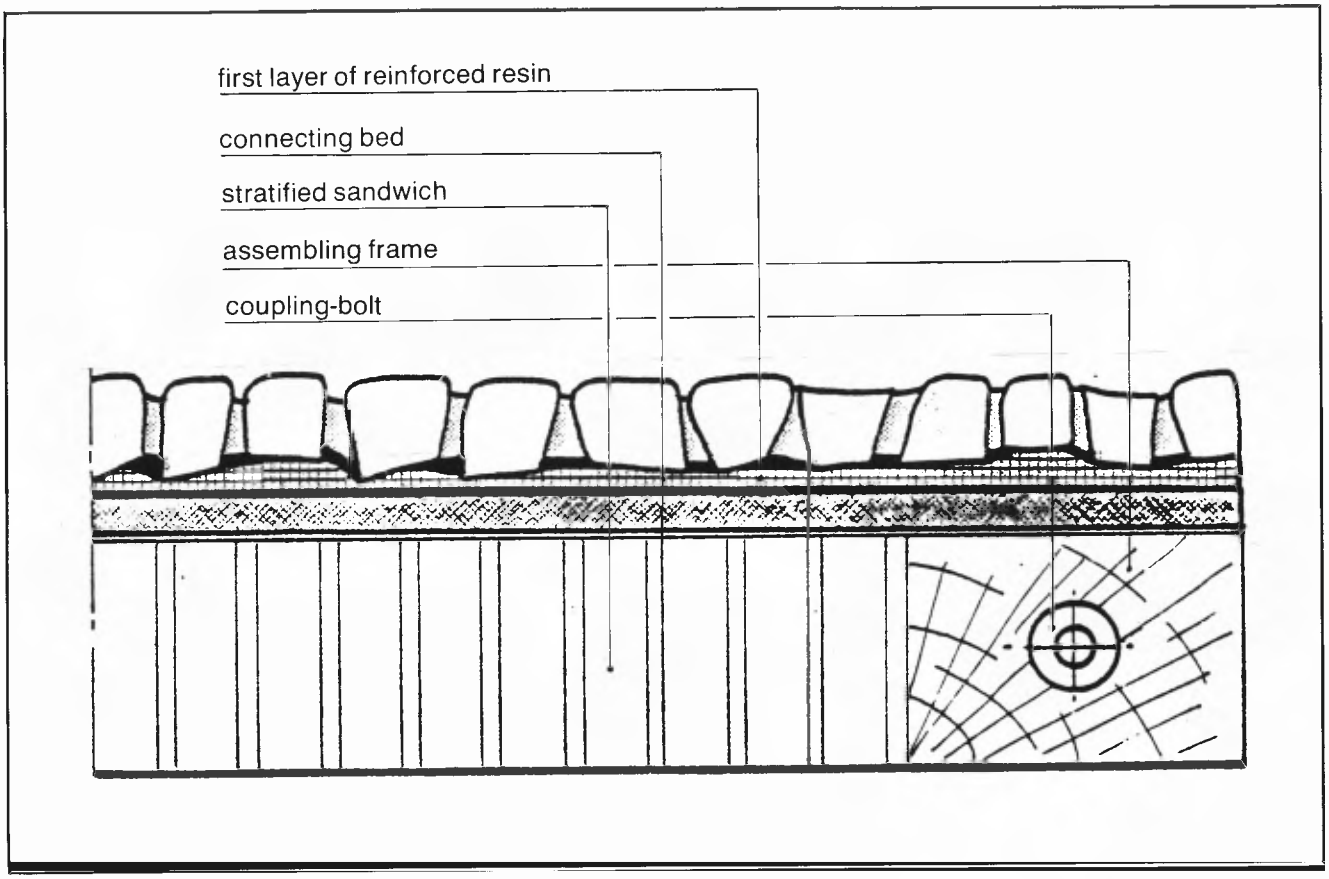


Fig. 27: Mosaic transferred to an industrial sandwich.

XI.1 FABRICATION

Use a mosaic which already has a first backing of reinforced resin (See IX p. 50).

XI.1.2 **Resins**

Use only resins from the so-called "thermo-setting" series, with good mechanical characteristics, like polyester, polyurethane, epoxides.

Scrupulously follow the health and safety rules relating to the use of these materials. Whenever necessary, use masks, gloves, skin protection creams and special soaps.

Follow the manufacturer's directions.

Note: The same product can be manufactured by two different firms under different names. A manufacturer may also furnish several types of products under the same brand name. A resin is therefore defined by:

— the name of the manufacturer;
— the brand name;
— the product name;
— the exact, full code number of the product.

If necessary, include additives and fillers to promote ease of use, viscosity, adhesion, thixotropy, fire resistance and to inhibit shrinkage after hardening.

On a special form, register the date, the user's name, the resins, hardeners, additives, quantities used, and conditions of use, such as temperature and humidity.

XI.1.3 **Transfer**

— Place a layer of resin on an industrial panel. The tessellatum piece, already prepared for indirect transfer, will be placed on this.
— Build the sides of the sandwich.
— Strengthen the corners.
— Let it harden in the required conditions.
— Remove the cloth and adhesive that were used for lifting.

XI.2 CHARACTERISTICS

Supports of up to 100 m^2 can be constructed with this method if careful calculations are made. Panels of 15 m^2 are easily accomplished. Supports can also be either flexible or rigid.

XI.3 ADVANTAGES

— considerable mechanical resistance;
— resistance to humidity and to chemical and biological attacks;
— good resistance to ageing;
— very much lighter than any of the other supports.

XI.4 DISADVANTAGES

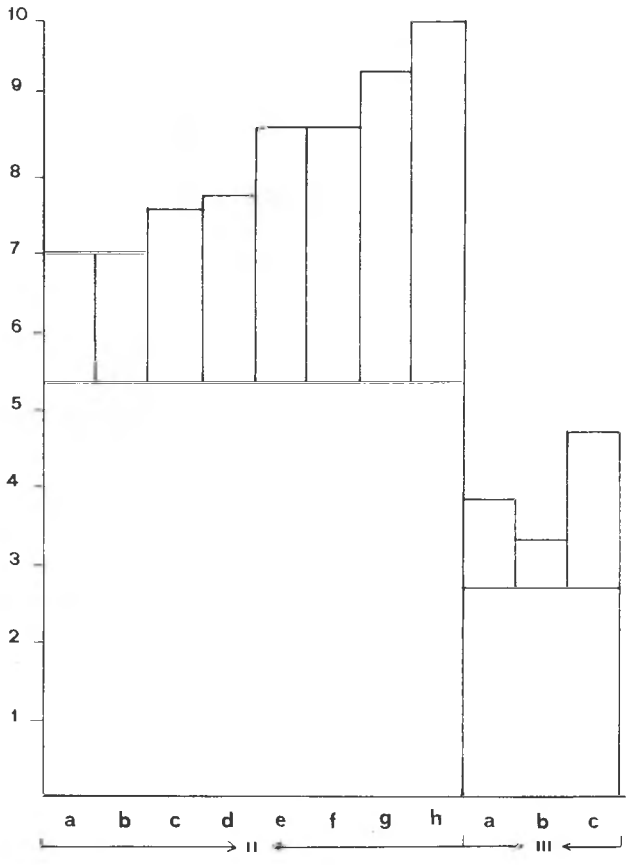
— irreversibility;
— can be constructed only by experienced technicians;
— high cost;
— without special protection, edges and corners are fragile;
— direct exposure to sunlight and to temperature fluctuations should be avoided because of its high expansion coefficient;
— can be used only for mosaics that are relatively flat.

XI.5 OBSERVATIONS

PARTICULARLY SUITABLE FOR BIG MOSAICS WHICH CAN THEN BE EASILY MOVED.

Appendix 1

COMPARATIVE COST OF MATERIALS FOR 1 m² OF A SOLID FOUNDATION FOR A FIXED SUPPORT OF 30 m²



The methods, for which the estimated cost is given here, involve either techniques described fully in this book or a combination of these techniques.

In this diagram, the numbered units do not represent absolute values.

The two main types of solidly fixed new supports are the following:

On a floor of reinforced concrete, waterproofed, or built over a hollow underfloor (II)

a) The parts of the mosaic are placed in a setting bed of lime mortar by either the direct or indirect method.

b) The parts of the mosaic are placed in a setting bed of cement mortar — a method to reject absolutely.

c) The mosaic pieces are first set together in plaster and then the whole composite is placed in a setting bed of plaster or of resin emulsion.

d) The mosaic pieces are placed on a first layer of resin emulsion mortar, according to either the direct or indirect method.

e) The mosaic pieces, already set in resin emulsion, are placed by the indirect method in a setting bed of resin emulsion over a sub-layer of broken bricks.

f) The mosaic pieces are first transferred to a stratum of resin emulsion. Then, using the indirect method, the resulting elements are placed on an intervening bed made of expanded clay.

g) Mosaic pieces transferred to a first layer of resin and hardener are set, by the indirect method, in an intervening bed made of resin and hardener.

h) Mosaic pieces are transferred to a first layer of resin and hardener. Then the whole piece is put into a setting bed of resin emulsion, above an intervening bed, which in turn rests on bricks, concrete or expanded clay.

On a bed composed of stone blocks, a framework, and a waterproof kerbing (III)

a) The mosaic pieces are placed, by the indirect method, in a setting bed of lime.

b) The mosaic pieces are placed, by the direct method, in a setting bed of lime.

c) The mosaic pieces are placed first in a layer of resin emulsion. Then the whole composite is set, by the indirect method, in a setting bed of lime mortar and resin emulsion.

Appendix 2

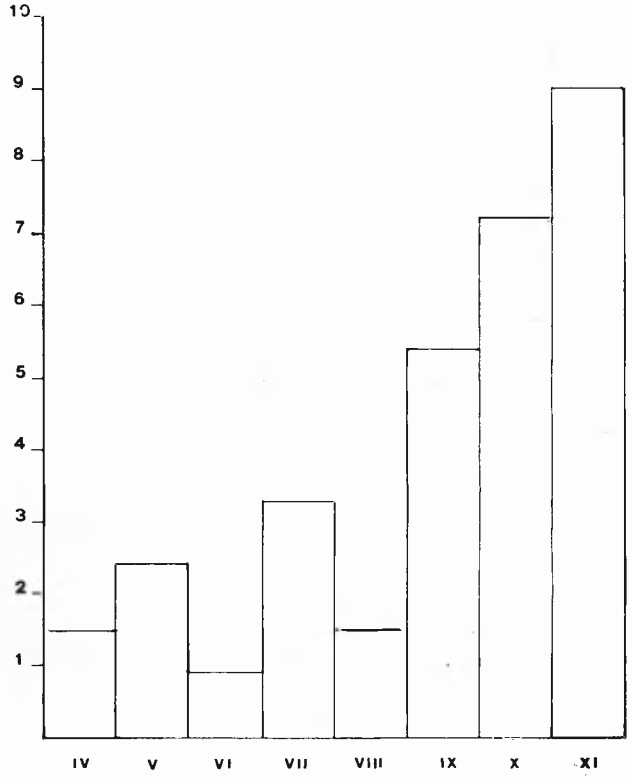
COMPARITIVE COST AND CHARACTERISTICS OF MATERIALS NEEDED TO BUILD 1 m² OF A NEW MOVABLE SUPPORT

The following diagrams are meant to compare:

— the working time needed to build the various supports;
— the cost of materials needed;
— their reversibility;
— their adhesive qualities;
— their resistance to tension;
— their resistance to compression;
— their degree of elasticity.

In these diagrams, the Arabic numbers do not represent absolute values. The new support systems are indicated by the vertical columns. The Roman numerals at their base in all diagrams correspond to the following systems:

— support in cement concrete in direct contact with the tesserae — to be rejected (IV);
— support in reinforced cement concrete with an intervening bed (V);
— support in lime mortar (VI);
— support of wood resistant to humidity (VII);
— support in plaster or stucco (VIII);
— first stratum of resin and hardener reinforced with fibreglass or glass cloth (IX);
— sandwich specially built directly on the reverse of the mosaic (X);
— industrial sandwich (XI).



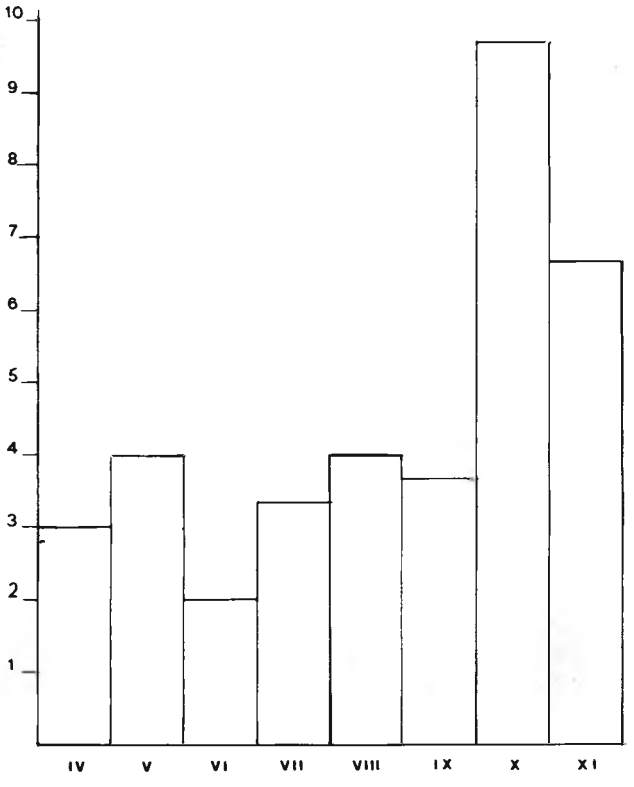
Working time needed for 1 m² of a movable support

Cost of materials

This graph shows the cost per 1 m^2 of the support for a piece of mosaic under 3 m^2 in size, and without including the foundation.

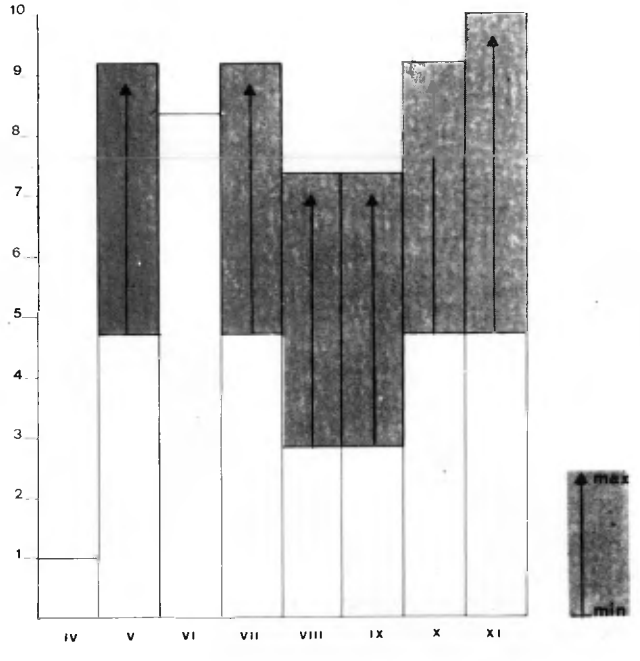
It is important to note that the price of a movable support is inversely proportional to weight. The lighter and more resistant a support is, the more it costs.

The price of materials increases with the size of the system. The size must be decided by mechanical limitations, the weight of the system itself, the weight it must bear, its rigidity and similar factors.



Reversibility

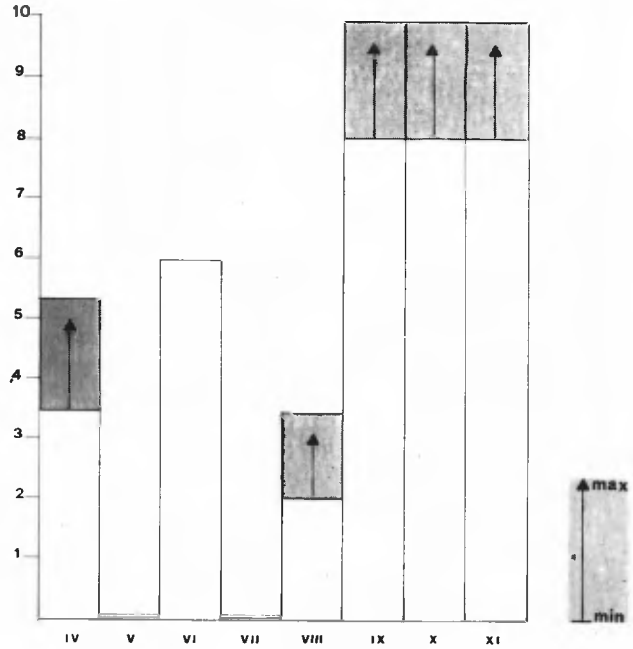
Reversibility in most systems ranges between minor and major levels of difficulty. Cement is the most difficult to reverse.



Adhesion

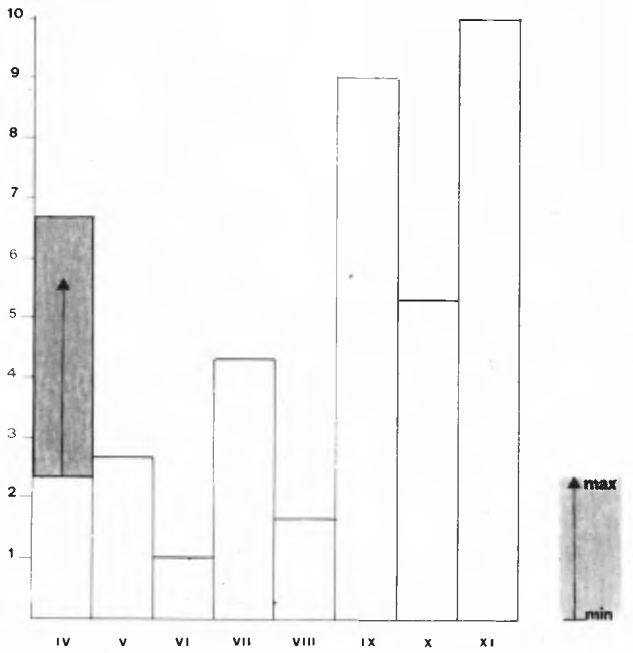
Plasticized intervention beds are the most adhesive. Plaster is the least adhesive material, unless resins have been added.

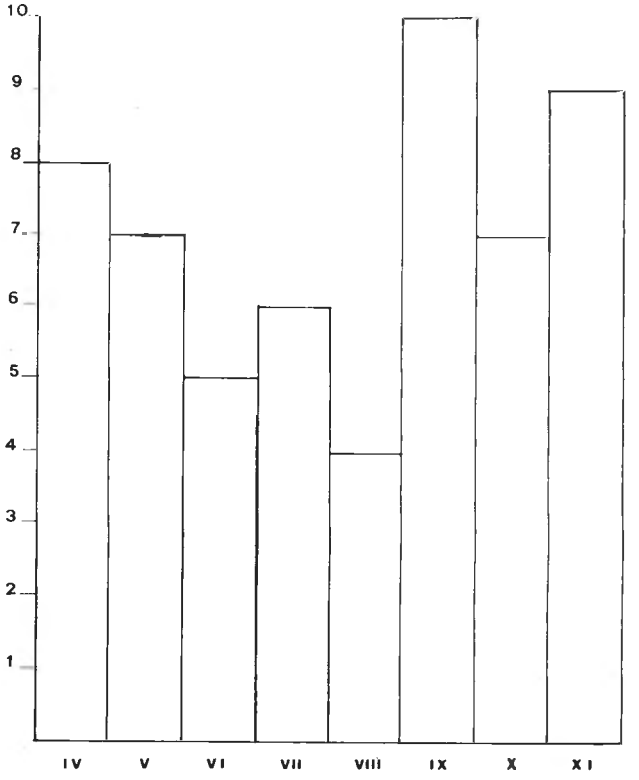
The type of resin chosen may be decided by the degree of adhesion desired.



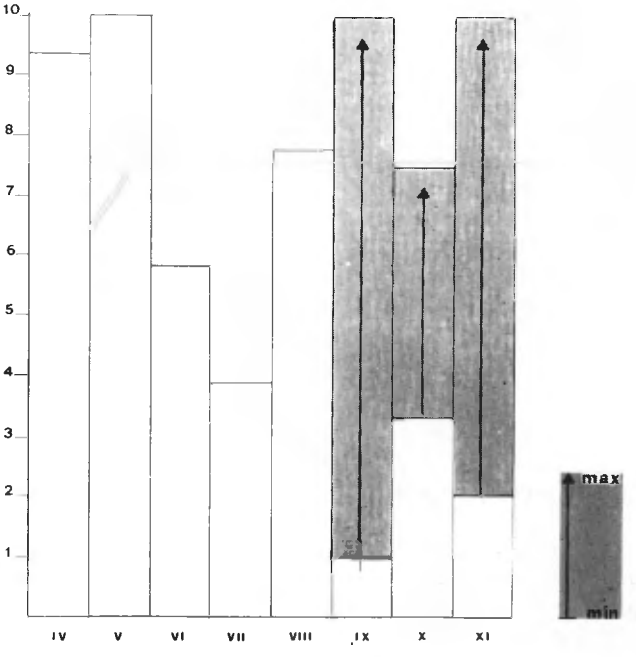
Resistance to tension

Most supports resist compression well. On the other hand, only resins with hardeners added, and sandwiches built with a base of these resins, can withstand tension.





Resistance to compression



Elasticity

Understanding the various degrees of elasticity is very important to the construction of large supports.

Only resins, or sandwiches built of resins, allow a choice of elasticity according to the needs of the support chosen.

Lime, plaster and cement are rigid and therefore more fragile.

GLOSSARY

ADDITIVE: Any material which is added to modify the natural characteristics of stucco, mortar or mastic.

AGGREGATE: A non-homogeneous assemblage of different substances forming a whole. In masonry, this term applies to any material which, mixed with a binder and essential additives, is used to make mortar or concrete. It can be composed of sand or of various sizes of gravel: fine, medium, coarse, rolled or crushed, of uniform size or not. Sometimes a distinction is made between sand and aggregates (gravel and stone).

CEMENT: Prepared at high temperature by reactions between calcareous stone and clay. The final product is ground into a powder which will form, with water, a hydraulic binder capable of solidifying, with or without fillers, into a very hard mass.

CONCRETE: An artificial conglomerate of pebbles, gravel and sand, held together with a binder which is generally hydraulic.

CONCRETE, CEMENT: Concrete in which the hydraulic binder is natural or artificial cement.

CONCRETE, LIGHT: A conglomerate of light aggregates artificially held together with a binder which is generally hydraulic.

CONCRETE, REINFORCED: Concrete which has been strengthened by having metal bars, gratings or wire imbedded in it.

ELEMENT: One of the many individual parts which together compose a whole. In the case of a mosaic, an element is each part that has been separated from the whole composition.

FILLER: A substance, either inert or active, which is added to a binder to give it body.

GROUTING: A mixture of water, cement and sometimes additives which is fluid enough to pour freely into the joints and cavities of masonry.

INTERVENING BED: A setting bed placed between the tessellatum and its support. Easily destroyed or reversed, it permits the tessellatum to be detached at a later time, if necessary, without risk.

KERBING OR KERB: A waterproof layer of mortar or concrete applied to a floor, a vault or to similar places, to prevent the infiltration of water, to raise the level, or to finish the surface of the area.

LIME, SLAKED: When calcium oxide is combined with water it forms calcium hydroxide — slaked lime — which then hardens when exposed to the carbon dioxide present in the air to become calcium carbonate.

MASTIC: A dense, pasty mixture made with a filler and a binder, used to fill joints and to bind together diverse materials.

MORTAR, HYDRAULIC: Artificial conglomerate of grains of sand bonded by the hydration of its components (lime, cement); used to bind the elements of a structure or construction.

MORTAR, SYNTHETIC: A conglomerate of natural and artificial materials (marble powder, tiny glass beads) bonded with a synthetic resin of one or two components.

MORTAR, CEMENT: Mortar in which the binder is cement.

MORTAR, LIME: Mortar in which the binder is lime.

MORTAR, RESIN: Mortar in which the binder is a synthetic resin.

SLAB: A flat piece of marble, stone, glass, concrete or reinforced concrete used as a support for other layers placed over it, as floor paving, or as a facing for walls.

STRATIFICATION PASTE: A mixture of synthetic resin, fine sand and additives which can be used to lay tesserae or elements of mosaics.