**D4 – Roman tile roofing**

**Country:** Tunisia

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**PRESENTATION**

**Geographical Influence**

**Definition**

*Roman tile roofing*

Roof with slope from 25% to 35% covered with two layers of tiles (bottom and covering), sometimes laid in mortar.

The terracotta clay tiles, truncated shape, cylindrical or curved shape, are commonly 30cm to 50cm long, and an average tail width of 15 cm (small end) to 25 cm at the head (larger end).

The extrados of the curve of the bottom layer tiles is laid on the bottom to allow rain water run-off, the extrados of the tiles of cover is laid on the top, to ensure tight covering.

The roofing generally rests on a wooden frame, and sometimes on one or more cross or barrel vaults.

This old technique is still in use, except in Tunisia; crafted roman tiles were replaced by industrial roman tiles, the supports and the techniques of laying changed in most cases.

**Environment**

In the MEDA area, sloped roofings with roman tiles are generally present in urban and rural environment, seaside, plain or mountain, except in Egypt, in Morocco and in Tunisia where they are mainly in urban environment. This type of roofing is common, except in Egypt where its presence is limited to urban sea side environments, and in Tunisia where its presence only concerns coastal or plain urban environments.

In Tunisia, this type of roofing is rare; only present in coastal and plain urban environments.

**Illustrations**

- General view:
- Detail close-up:
CONSTRUCTION PRINCIPLE

Nature and Availability (in what form)
The roofing consists of an assembly of Roman tiles made with clay, sometimes mixed with sand, straw or organic elements. Clay deposits are extremely common and plentiful; they are located near the places where the Roman tile is used. After mixing, pressing, moulding or shaping and drying the clay, the tiles are fired at a temperature from 800°C to 1200°C. The colour of the tiles depends on the oxide contained in the clay, and the temperature of firing, which was formerly irregular (flamed aspect of the old tiles).

In Tunisia, the traditional tiles of Testour are manufactured with a reddish clay (tourba) extracted at nearby Jebel Kharoub. Sieved clay is mixed with animal excrements (routh) at a dose ratio of two volumes of clay for a volume of excrement. This mixture is poured in a large water container or pool to ferment for two to three days; the paste obtained is mixed and kneaded, till full disappearing of any solids, and reaching a plastic mixture. For a long time, organic material was believed to contribute to the mechanical resistance of the tiles. Actually, when firing the tiles, the organic particles are completely consumed, it is the air pockets left which improve the thermal insulation properties of the material.

Modules, Dimensions, Thickness, Dosages
Roman tiles, truncated in shape, cylindrical or curved (moulded, pressed or shaped), are a length varying from 18 cm to 60 cm and a width varying from 10 cm at the tail (small end) to 25 cm at the head (larger end); the common dimensions are between 30 cm and 50 cm in length, and 15 cm (small end) to 25 cm (larger end). The height of the tile is approximately between 5 cm and 10 cm. The thickness varies from 6 mm to 25 mm, the most recent tiles being generally thinner. The total thickness of the tiles and their support, making up the roofing varies from 6 cm to 40 cm, the most common thickness is between 10 cm and 20 cm. The weight of a unit is between 1.5 kg and 3 kg, which means a weight of 35 kg to 65 kg per 2 m².

In Tunisia, Roman tiles are approximately 37cm long, for a width varying from 13cm (small end) to 26cm (larger end). The tiles, built with plaster on small vaults which rest on juniper beams, (‘rear ar’) form a roofing whose total thickness varies from 35cm to 40cm.

Type of laying

Type of laying
Roman tiles are laid according to two reversed layers: the tiles on the bottom layer or drainage (extrados on the bottom) are laid with heads (larger end) close and tight on the higher part, and tails (small end) spaced spaced on the lower part. The tiles on the bottom layer are covered a third or a quarter on the higher part (gauge on two thirds or three quarters of the length) by the covering tiles (extrados on top), with heads (larger end) close and tight on the lower part, and tails (small end) spaced on the higher part.

In Tunisia, Roman tiles are laid on a mixture of ash and broken tiles, spread over a 5cm to 6cm layer of plaster and tile fragments making up the slope, which rests in a 5cm to 6cm layer of plaster and broken brick, making up small vaults.

Associated framework
Roman tile roofing generally rests on a wooden frame, stacked or sometimes assembled, or sometimes on one or more cross or barrel vaults.

In Tunisia, the roofing rests on small vaults with formworks using a bag filled with straw (ch’ will kâra), elliptic shape, (35cm X 25cm); these small vaults are supported by beams of juniper trunk (‘rear ar’) 12cm in diameter and 2,5m to 3m span, spaced approximately 35cm.

Drainage

Adapted slope (%)
The slope varies from 15% to 76%; the slope ranges between 25% and 35%. Wind exposure is lessened when the slope is weak; weak slope, the slower flow of water can cause infiltrations.

In Tunisia, the slope ranges between 20% and 30%.

Water collecting and drainage
Rainwater is more and more often collected by gutters, in particular in urban environment. They are generally drawn away from façades by overhanging eaves (projecting roof).

In Tunisia, there is no particular system of drainage, aside from the slope of the roof; sometimes, a decorative lambrequin is laid as roof run-off, makes it possible to draw away rainwater from the façade.
CONSTRUCTION PRINCIPLE (CONTINUED)

Drainage (next)

Processing of specific points (bargeboards, runoff, neck gutters, ridge sheathing...)
With the exception of eaves and chimneys, the majority of specific points are processed with Roman tiles cut or laid in a specific way, to solve problems of waterproofing and tearing due to wind, which can appear in various spots (bargeboards, ridge sheathing, sewer).

Ridge sheathing (and hip rafters)
Horizontal row of tiles (identical size or larger module) sealed with tight lime mortar, covering direction is opposite dominant winds.

Side bargeboards
Edges covered with two side rows of covering tiles, a side row of bottom tiles making up a gutter, a side row of covering tiles on a bed of brick or terracotta tiles (mallons), or on pitch Genoese roofing; when the bank is not perpendicular to the ridge sheathing (trapezoidal face of roof), the tiles are cut one by one to finish the slope on the bargeboard row.

Eaves
A – Jutting out of rafter roof (end sometimes a corbel piece) under wooden battens.
B – Genoese roofing (XVII’s – XIX’s) consisted of one to four rows (according to height of the façade to be protected) of heads (larger end) of Roman tiles (hollow or generally filled) laid (generally in a quincunx) as covering (more rarely for the bottom layer), sometimes pressed with terracotta tiles: the Genoese roofing is continuous between the masonry of the wall and the roofing, and ensures a better protection against wind and rain than the jutting out of battens on rafters; on some beautiful residences, Genoese roofing turns round towards the roofing or is prolonged in a façade curve, making up a triangular pediment.
C – Solid cornice carried out in cut stone (ashlar) or from a masonry rendered shape, or made up of tiles or rectangular brick, semicircular profile or in quarter of a circle, allowing an infinite variety of mouldings.
D – Hollow cornice formed by a formwork in wooden lathing with plaster rendering.

Neck gutters
A lime mortar ensures the waterproofing of neck gutters, whose tiles are cut to take the shape of the faces of roofing; neck gutters are not very frequent in Mediterranean architecture.

Chimneys
Stocks carried out with Roman tiles or masonry, brick or stone, laid and rendered with mortar. Stocks are sometimes covered with a duct in terracotta, or terracotta tiles or sloped tiles resting one against the other.
In Tunisia, certain roofs in Testour have a decorated sewer with a brick and tile frieze, making it possible to draw away rain run-off from the façade.
CONSTRUCTION PRINCIPLE (CONTINUED)

Tools

Moulds are often used for hand crafted tiles. Sometimes, the preparation of the roofing support requires the use of specific tools.

Trades

Trade, Number of people necessary

According to cases, Roman tile roofing is implemented by a mason, a carpenter or a roofer. Two to three people are generally required, aside from Spain where only one person can carry out this work, and Morocco, where at least four people are necessary.

In Tunisia, Roman tile roofing is carried out by a mason, helped by one or two workmen. Three people at least are necessary.

Performances

Waterproofing, Protection against bad weather

The resistance of Roman tile roofing is generally rather good, against rain, snow and wind. An imperfectly fired terracotta tile can crack, and undergo water infiltration. Old tiles, sometimes porous, are frost exposed; terracotta is not very resistant to shocks (allen branches...). Often cracked after a few decades, these tiles do not ensure the waterproofing of the roof any more. Laid dry or sometimes loosened with time, tiles can be blown away by violent wind; in the most exposed areas, tiles are held by stones laid mainly in the periphery of the roof (bargeboards, ridge sheathing, sewer). Resistance to tearing off depends on the finishing of the laying and the quality of the sealing mortar.

Thermal insulation

Although terracotta clay is a good thermal insulator, the thermal performance of Roman tile roofing depends mainly on the quality of its support. The laying of dry tiles allows a good ventilation of the roof.

In Tunisia, traditional tiles like those of Testour, offer a good level of thermal insulation, thanks to air pockets, resulting from the combustion of organic particles.

Ageing pathology

Linked to materials and climatic conditions:

The weight of the tiles generates an ageing of the frame, sometimes causing sag or rupture, deformation of the roof and water infiltration. The mechanical resistance of tiles is conditioned by the quality of manufacturing (raw material and firing). The rough texture of tiles facilitates wind erosion, and causes the fixing of lichens and various organic elements, which can prevent good water run-off. The limestone contained in clay produces whitish efflorescence on the tiles, by carbonation. Old tiles are often cracked after a few decades (low impact resistance, frost), and no longer ensure the waterproofing of the roof.

Linked to the technique:

Too weak a slope or insufficient covering of tiles can cause infiltration by water capilarity. Dry laying or low sealing mortar strength ease tearing of the tiles due to wind. To prevent or repair this, in the most exposed areas, stones are sometimes laid on the roof, in particular on the lower part, and along bargeboards. The disintegration of joints and laying mortar, or the accumulation of dust and earth deposited by the wind, favors the growth of parasitic vegetation, which can cause the tiles to crack, and then water infiltration.
CONSTRUCTION PRINCIPLE (CONTINUED)

REALIZATION DESCRIPTION

In Tunisia:

Conditions of realization:

The works must be carried out in dry weather; to avoid rainwater infiltration; no particular protection is necessary. In Tunisia, the favourable period is the dry season.

Preliminary works:

The support and roof overhang (eaves, cornice, Genoese roofing ...), as well as the system to collect water (gutters), are implemented before the roofing. Before laying, the condition of each tile must be checked: the tile is cracked if it does not make a clear sound; a tile must withstand the weight of a man without breaking.

In Tunisia, traditional tiles, like those of Testour, are manufactured with reddish clay (dug peat) sieved, and mixed with animal organic materials (routh). This mixture, poured into a large water basin for fermentation, for two or three days, is then mixed and kneaded, up to disappearing of solid elements. After drying of the paste and shaping, the tiles are fired; the consumed animal dung leaves air pockets, which reduce the density of the tiles.

Realization:

The laying is carried out from the sewer to the ridge sheathing, each slope after the other. A first row of tiles (the bottom layer), aligned with a string, is sealed with a thin mortar in the masonry of the run-off wall (in the case of an overhanging cornice or Genoese roofing), on wooden battens (in the case of an overhang of battens on rafters), or wedged on the "litéaux". The heads (larger end) are close and tight on the higher part, the tails (small end) are spaced on the lower part.

The covering of the tiles is carried out on the top third or quarter (gauge on two thirds or three quarters of the length), by sealing with mortar in successive slope rows. Covering by sealing with mortar of the bottom layer is carried out by rows of tiles: the heads (larger end) are close and tight on the lower part, the tails (small end) are spaced on the higher part. In the case of a laying with mortar, the tiles can be wedged laterally with stones or broken tiles.

The connections between tiles of the bottom layer and covering can be shifted by the laying, on the sewer, of a row of tiles, shortened by one third. In the case of a trapezoidal or irregular face of roof, the tiles are cut out as bargeboards, to blend with the shape of the roof, the parallel slope rows are generally perpendicular to the ridge sheathing. When the slopes of the roof are covered, the ridge tiles are sealed with mortar on all the arrises.

Significant details:

The slabs of stone must be cut in their natural bed direction. The laying mortar must be relatively thin to avoid strain and be compatible with terracotta, and be sufficiently resistant not to disaggregate with time. The cutting of the tiles on the level of the chimney stocks or lanterns must be relatively accurate, to avoid too broad mortar joints. The ridge tiles must be covered opposite dominant winds.

Means of verification:

One can check the waterproofing of the roofing by sprinkling water, in order to detect possible water infiltration.
USE, EVOLUTION AND TRANSFORMATION

Use

Types of buildings
Roman tile roofing is on all types of buildings throughout the MEDA area.
In Tunisia, Roman tile roofing is used for dwelling houses, as well as service annexes.

Period when the technique first appeared / Period of use of the technique - contemporary or disappeared.
Roman tile roofing was inherited from Roman Antiquity where similar shape tiles (imbrex and tegula) appeared. Roman tiles in their current shape appeared in the Middle Ages in Algeria, in Spain, in France, in Morocco and in Turkey; they appeared at the Renaissance in Greece and Portugal, and XVIIIth century in Tunisia. Finally, most recent use go back only to the end of XIXth century in Cyprus, and beginning of XXth century in Egypt. This technique is still used, except in Tunisia.
In Tunisia, Roman tile roofing was introduced in first half of the XVIIth century by the Andalusians, after expulsion from Spain. This technique recently disappeared, in the 1990’s, with the death of the last manufacturer of crafted tiles (called Am Rejab).

Reasons of the disappearing or the modification of the technique
From the middle of the XIXth century onwards, Roman tiles were often replaced by flat mechanical tiles (originating in Marseille), less expensive and easier to lay, on wooden lathing. After the Second World War, curved tiles with shifting, in terracotta or concrete, relatively inexpensive, appeared on the market. In spite of overcost, the manufacturing of Roman tiles continued in an industrial form, to satisfy the market of restoration and new building, except in Algeria and Tunisia, where traditional know-how disappeared. The return a taste for tradition led to the recovery of old patinated tiles for restoration or new building. To compensate for the lack of old tiles, Roman tiles are artificially aged by slip painting of oxides and pigments, more expensive, and appeared on the European market.
The laying of tiles with earth mortar or lime is often replaced by a laying with cement mortar or a fixing with glue. The traditional roofing supports, made up of wooden frames, sometimes covered with mortar, are replaced by concrete slabs. Sometimes, the tiles are fixed on corrugated sheets, laid quickly, which guarantee the waterproofing of the roofing, and sometimes, insulation.

Evolution / Transformation

The materials
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In Tunisia, the technique of Roman tile roofing is no longer used because of the emergence of industrial materials and new, more economic techniques, as well as the evolution of society, which contributed to the disappearing of traditional know-how. Moreover, a stricter forest control policy generated a shortage in branches, used as fuel for the firing of the tiles, which caused the disappearing of artisanal manufacturing of tiles.

The technical aspects
The laying of tiles with earth mortar or lime is often replaced by a laying with cement mortar or a fixing with glue. The traditional roofing supports, made up of wooden frames, sometimes covered with mortar, are replaced by concrete slabs. Sometimes, the tiles are fixed on corrugated sheets, laid quickly, which guarantee the waterproofing of the roofing, and sometimes, insulation.
In Tunisia, concrete slabs, hollow brick or segment sewer blocks, replace traditional roofing supports.

Evaluation of materials and replacement techniques
The laying of industrial Roman tiles is generally satisfactory in restoration, provided their colour and their aspect are in harmony with traditional roofing. The use of corrugated asbestos cement plates is generally satisfactory in restoration, provided that sufficient ventilation of the roofs is assured. With the exception of cement mortar, the new techniques of laying (fixing with glue or cramps...) is regarded as satisfactory.