

Indigenous Treatment Methods and Construction Techniques for Increasing the Durability of Traditional Houses in Bangladesh

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ABSTRACT: Bangladesh is a disaster prone Country. The geographical setting of Bangladesh makes the country vulnerable to different natural calamities like floods, nor-wester, cyclones. The climate of the country is characterized by high temperature, heavy rainfall and often excessive humidity. Bangladesh is a rural based country. The rural populace uses the indigenous materials, methods and design techniques to construct their houses not only because of their availability and low cost, but also because of their familiarity and acceptability. But the country's climatic behaviours are quite favourable to decrease the durability of house materials, moreover almost every year natural disasters destroy a considerable number of village houses leading to housing problems and financial burden of reconstructing the houses for poor villagers. With available materials and local methods it is very difficult to build their houses totally immune to those unfavourable climatic conditions and natural disasters. Although from a long time rural people have been trying to develop different treatment methods of house materials and construction techniques for increasing the durability of houses and some of them are very effective. This paper reviews the traditional treatment methods and local construction techniques that are used by rural people to increase the durability of the traditional houses in Bangladesh.

Key words: traditional house, construction materials, local treatment methods, construction techniques, durability.

1. INTRODUCTION

Bangladesh is among the most densely populated countries in the world and has a high poverty rate, 85% of her population living in the villages. Since the poverty is concentrated mainly in rural areas rural people are not able to build their houses by using permanent and costly materials like concrete, steel, sand, stone, cement, brick etc. Traditional houses in Bangladesh are constructed mostly with the use of most

readily available materials and indigenous construction techniques. Rural houses are mainly made of indigenous materials such as, straw, grass, jute stick, *Golpata* [*Golpata*] (*Nipa fruticans*), *Son* [*Shon*] grass (*Imperata arundinacea*), bamboo, mud, wood and CI sheets [1]. Different combinations of them make the main type. There are different causes like heavy rain fall, high humidity especially natural disasters for which the longevity of the houses is reduced. The geographical

location of Bangladesh makes the country vulnerable to those natural disasters [2]. Natural calamities, such as floods, cyclones, tornadoes etc. affect the country yearly. Natural calamities cannot be prevented, but the damage can be mitigated with adequate planning and adaptation. Rural people accepted the fact that natural calamities would take their occasional toll and they would have to rebuild from the bits and pieces left over after the calamities. However, from a long time ago rural people have developed their own techniques and ways to increase the life-span of housing materials as well as the durability of their houses. Those techniques have been developed by the local people based on their needs from their long experience using local resources. This paper mainly reviews and abstracts the treatment methods of the house materials and construction techniques that are being used traditionally to increase the longevity of the construction materials and the traditional houses.

2. TYPES AND CONSTRUCTION OF TRADITIONAL RURAL HOUSES IN BANGLADESH

Traditional houses in rural areas can be classified into three broad categories depending on the type of construction [3].

2.1 Kutcha House

The term “Kutcha” means something temporary or not sufficiently strengthened.

- Foundation: Earthen plinth with bamboo (sometimes timber) posts.
- Walls: Organic materials like jute stick, catkin grass, straw, bamboo mats, etc. Split bamboo framing. Earthen walls in some areas.
- Roof: Thatch-rice or wheat or maize straw, catkin grass, etc with split bamboo framing or sometimes reed stalk framing.

2.2 Semi-Pucca House

Part of the house is constructed of permanent materials like sand, cement etc.

- Foundation: Earthen plinth; Brick perimeter wall with earth infill; Brick and concrete are also use.
- Walls: Bamboo mats, CI sheet, Timber (sometimes split bamboo) framing. Earthen walls in some areas. Sometimes part or full are brick.
- Roof: CI sheet with timber framing (sometimes split bamboo).

2.3 Pucca house

The word “pucca” means permanent or strong. Pucca construction is totally constructed of permanent materials. Pucca construction is rare in village.

- Foundation: Brick and concrete.
- Walls: Brick.
- Roof: Reinforced concrete (RC).

80.16% of the houses in the rural areas are of kutcha construction, 17% is semi pucca and 2.33% are pucca or permanent. [4]

3. CAUSES OF SHORT DURABILITY OF CONSTRUCTION MATERIALS AND HOUSES

There are different causes that reduce the longevity of the construction materials and the houses. Some important causes of those are given below-

3.1 Rainfall and Floods

It is a well-known fact that Bangladesh is a highly flood-prone country. During the monsoon season there is very heavy rainfall and some places are prone to floods. As the result of annual floods, significant numbers of houses in the countryside even in urban areas are being destroyed annually. Direct flood hazard is associated with other types of secondary hazards such as high winds or storms, lightning, slope instability, ground settlement etc.

3.2 Cyclones, Nor'westers and Tornadoes

These natural disasters destroy a considerable number of village houses,

leading to an increased risk and injury, housing problems and -last not least- to the considerable financial burden of maintaining and reconstructing the houses.

3.3 Humidity

Humidity has an effect on structure itself. High humidity causes the unwanted growth of plant life on the house itself. Moss and lichen grow on the walls and encourages the breeding and growth of certain insects associated with them.

3.4 Insects, rodent and vermin Infestation

Various insects, including worms, termites and ants, and also rodents and birds tend to burrow into earthen walls and establish their habitats. This can weaken earthen plinths and walls substantially.

The above mentioned causes result the weakening and damage of house materials and structure, decay and rotting of organic materials (e.g. jutestick, catkin grass, bamboo mats, wood etc.), washed off of the earthen foundation and walls, development of crack and losing alignment of different parts of house, corrosion of CI sheets and ultimately reduce the lifespan of the house.

4. LOCAL TREATMENT METHODS OF TRADITIONAL HOUSE MATERIALS

4.1 Treatment of bamboo

The natural durability of bamboo is very low and depends on species, climatic conditions and type of use. In contact with atmosphere and soil untreated bamboo may last 1-3 years. Under cover, this may last 4-6 years. However lifespan of treated bamboo can be extended up to 15-20 years even if in contact with humid atmosphere and soil [3].

Short lifespan of bamboo occurs when it remains in contact with water or moisture, including flood. Bamboos are particularly weakened if exposed to alternating wet and drying periods such as in flood. Durability also becomes shortened when it is attacked or weakened by insects, primarily borers and

termites and when it rots due to fungal or bacterial action.

Traditionally following bamboo treatments are done in rural areas without special equipment [3].

a) Soaking in water (“Pynot”): This treatment is most commonly practiced in rural areas. The culms are placed in water for around two weeks, and then they are to be dried for a week (in the shade). By leaching, this process eliminates the nutrients (starch) sought after by bamboo borers. This treatment does not retard termite infestation.

b) Clump curing: Cut bamboos are stacked vertically for a few weeks after felling, with branches and leaves intact. Such bamboo continues to live off its reserves and hence reduces starch content and thereby insect attack.

c) Seasoning: Bamboo seasoning is done by drying bamboo in the open, under cover, with as much air movement as possible. It can take a couple of months.

d) Dip diffusion treatment: Simple chemical preservatives treatment methods for increasing the longevity of organic materials have been developed a long time ago. A typical preservative can be prepared to be mixed in the tank (brick or concrete made) or container (e.g. oil drum) or excavated ground lined with polythene sheet in the proportions of Copper Sulphate 4%, Sodium Dichromate 4%, Boric Acid 2%, Water 90% = TOTAL 100% . The materials are preferably freshly harvested, but dry ones can also be treated. Bamboo battens and mats are to be first soaked in water for at least 24 hours and then dried. They are then to be immersed completely in the chemical preservative solution for 24 hours. After soaking, the materials are to be raised above the tank and supported on bamboo poles or timber battens so that

excess chemicals can drip back into the tank and can be re-used.

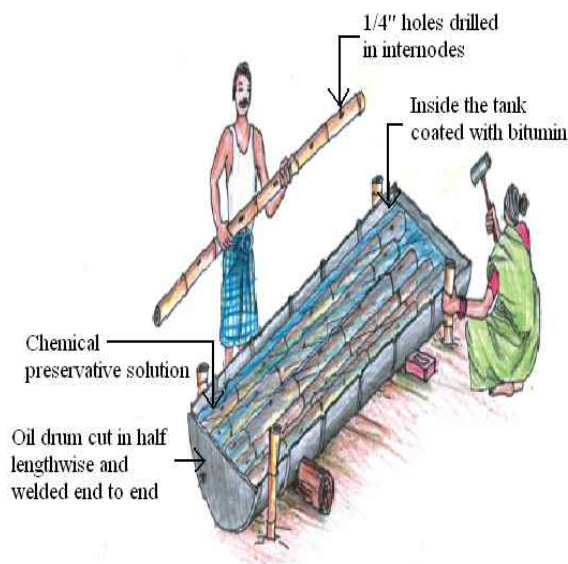


Figure 1: Bamboo treatment by soaking in chemical preservatives [3].

Then they are to be dried in an open shaded space for 1-2 days and then in sunshine for 3-4 days. People also use mobil, sump oil, diesel, kerosene, creosote (bitumen/tar oil) independently or in combined form as the preservative.

f) Hot-and-cold method: Bamboo to be treated is submerged in tank or oil drum of preservative that is directly heated by fire. After a period of maintaining constant temperature, the container should be allowed to cool, when the preservative is drawn into the bamboo. 10% boron solution or creosote + kerosene/Mobil/sump oil/diesel are used as preservative. This method are also used for green or dry culms.

e) Internodal Injection Method: It is a simple method requiring little equipment. First, 6 mm hole are drilled in each internodes of a whole bamboo culm and 20-50 ml creosote (tar oil/molten bitumen) combined with kerosene/sump oil/ Mobil/ diesel are injected with a large syringe. Paraffin wax (or putty, if available) are used to plug the holes. The culms are rolled 2-3

times a day for 7-10 days to distribute the preservative and complete the treatment.

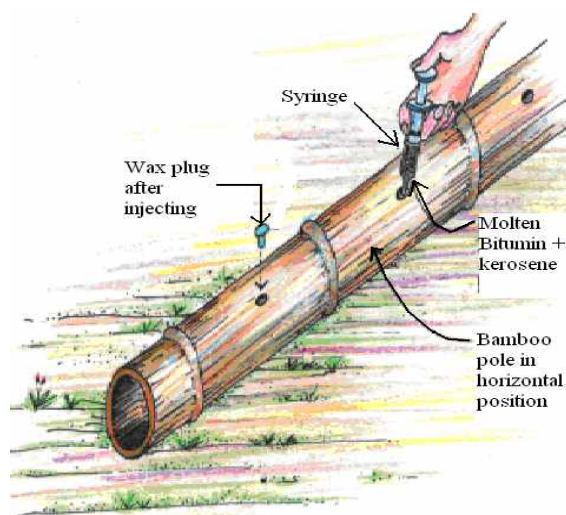


Figure 2: Internodal injection method for treatment of whole bamboo culm [3].

g) Painting or coating lower end: It is the cheapest method and known by most villagers for protecting from dampness bamboo mat walls and lower end of bamboo/timber posts typically embedded into the ground. Generally molten bitumen, mobil or sump oil, or combinations of these are used as painting agent.

4.2 Timber treatment

Timber is mostly used only as framing elements, such as roof structural frame, posts and framing for CI sheet walls. Generally following treatment and protection techniques are traditionally used in rural areas:

a) Dip diffusion method: For smaller sections of less thickness (maximum 1½ inch), the dip diffusion method as for bamboo treatment are followed.

b) Air-seasoning: This method involves natural air and temperature by putting the timbers in the open or under shade for a long time. It is a traditional method and requires at least one year including one winter season for the round and sawn timbers thicker than

25 mm in climatic conditions of Bangladesh [5].

c) Water Seasoning: By this process the green timber or bamboo is kept in water for several weeks to months and then air-dried or kiln-dried for use or for preservative treatment. As a result of water treatment some reserve food materials are removed or decomposed; consequently wood becomes less attractive to insects and becomes more porous for quick drying. [5]

d) Surface treatment: Surface treatment such as painting with creosote or bitumen can serve as water proofing.

4.3 Treatment of thatch

Chemical treatment of thatch is similar to dip diffusion treatment of bamboo mats and battens that has been described in the section 4.1 (d). Fibrous thatching materials, such as catkin grass, rice straw, palm fronds, wheat, maize or sugarcane leaves needs to be soaked in preservative solution for only 12 hours (bamboo mats and battens 24 hours) [3].

4.4 Treatment of earth

Whenever mud is used for wall construction it is first prepared by mixing with certain additives like lime stone chips, rice husks etc to improve its quality or give it more strength [4]. Mixing a small amount of ordinary Portland cement to earth greatly increases its resistance to water. This process is known as stabilization. It is now widely available in most areas.

5. STRUCTURAL FEATURES, DESIGN AND CONSTRUCTION TECHNIQUES

Materials alone do not make houses resistant against natural disaster rather, it is the manner in which these are used. This section present the structural techniques used in traditional houses built with bamboo, wood and mud house.

5.1 House Plan

The best plan shape is a square or a rectangle for wind resistance. The traditional houses are mostly rectangular with length and width ratio within 2:1. Length to width ratio up to 3:1 is recommended for cyclone resistant houses [6].

5.2 Foundation and Plinth

Traditional houses are built on raised homestead with slightly sloping ground for drainage. There kept a small gap (around 1 inch) between wall bottom and floor. It also allows prevention of termite infestation.

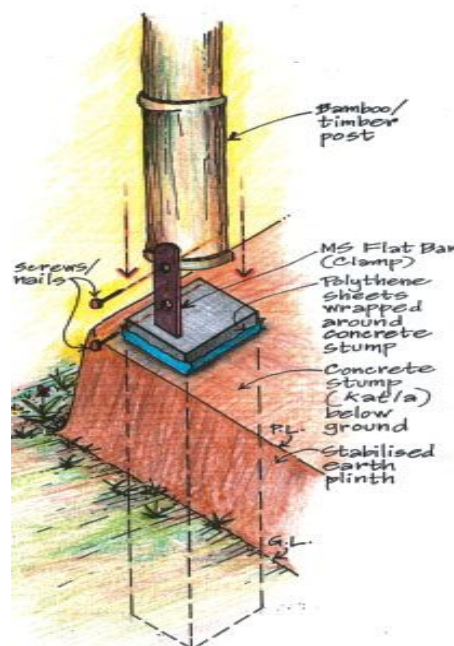


Figure 3: Details of hollow kaatla [3].

The base of bamboo/timber posts are protected by supporting on concrete stumps embedded into the plinth of ground and connecting them by mild steel clamps. It is locally known as kaatla or shiri. Termite shield made of polythene or metal are sometimes used in the space between bottom of post and above kaatla top. Stabilization of the typical earthen plinth is carried out with a mixture of earth and cement. People sometimes make a brick perimeter (locally known as “dowa-posta”) wall around the typical earthen plinth resists erosion from the sides.

5.3 Walls

a) Diagonal or Cross-Bracing

To increase stability and wind resistance of the structural frame of bamboo-framed houses, diagonal or cross bracing with split bamboo sections are done. Diagonal bracing strengthens the walls and reduce the chances of corner failures; due to unequal pressure on two side walls during cyclones. If a house becomes weakened at its base due to natural calamities like flood, it helps to keep the structure stable. The wind is resisted by woven bamboo or timber board sheathing and vertical support

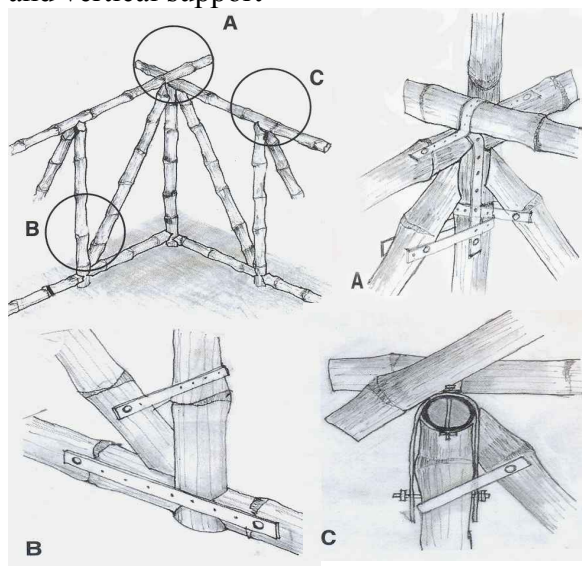


Figure 4: Diagonal bracing with corner details in woven bamboo sheathing walls [6].

b) Internal structure frame

In flood-prone areas, instead of building monolithic earthen walls people incorporate an internal framework of bamboo, timber or similar materials which is plastered with earth. In the case of flood or rain which may damage the earth plaster, the framework prevents the house from collapsing and it can be plastered later and repaired. Plaster of typical bamboo, jute stick or rushes walls with mud is common in many areas [3]. Improved and stronger variation of internal frame work is used in many areas where earth is packed in between two retaining frameworks (i.e. double layer framework with earth infill).



Figure 5: wattle-and-daub construction [3].

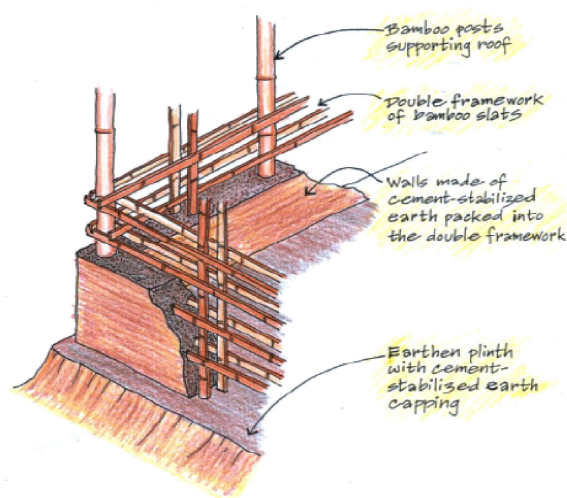


Figure 6: Construction of wall with double layer framework and earth infill [3].

Sometimes earth used for plastering is stabilized with cement. Small brick chips and/or gravel are also included into earth mixture. Instead of jute or coconut coir rope, good quality galvanized wire or nylon rope are used for tying together the elements of the framework.

5.4 Roofs

For protection against wind-hazard roof pitches are constructed around at 30°-40°

angle to reduce effects of suction and uplift by wind [3]. The traditional houses have hip roof over the “ghar” (main dwelling unit) and a very low roof over the “pashchati” (veranda) which is separated from the hip roof.

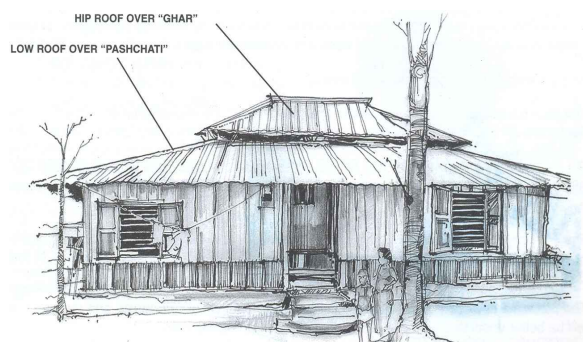


Figure 7: Roof shape of traditional house [6].

Experiences have shown that houses with hip roofs have the best record of resistance and traditional builders keep a minimum roof overhang in most houses, and maintain a separation between roof over the “pashchati” and the main roof of the “ghar” to protect the roof from pry away from walls and vertical support [6].

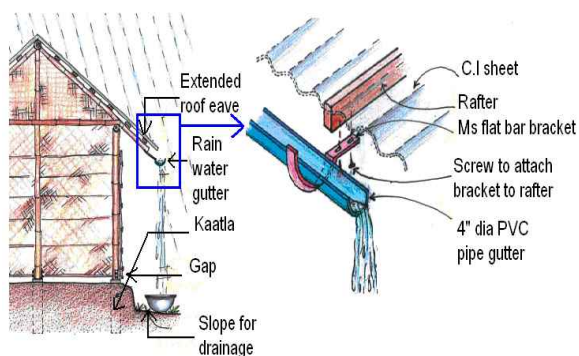


Figure 8: Rainwater gutter

Extended roof eaves (overhangs) are used to prevent direct wetting of walls during rain. Rainwater gutters are set up to discharge water away from the house. In the thatch roof, the local builders use lattice bamboo slats having gaps of 200mm to 250mm between two slats. The latticed slats are fixed to purlins to protect the thatch roof from uplift due to cyclone. In case of mud

house roofs are supported on posts instead of earthen walls.

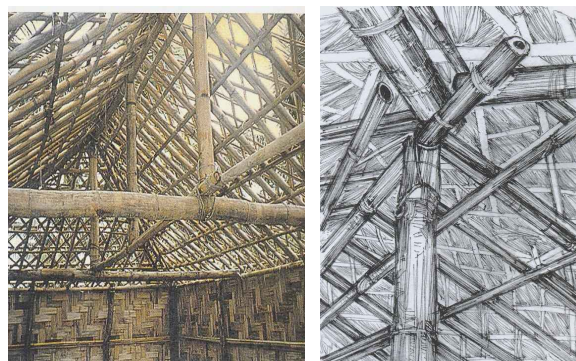


Figure 9: Bamboo roof structure and corner details of ridge [6].

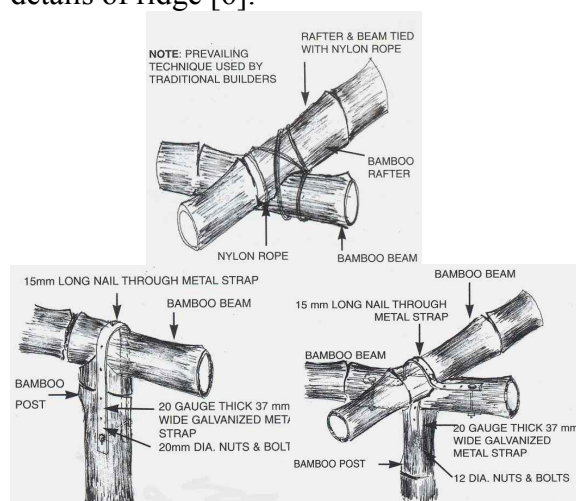


Figure 10: Fixing details between post, beam and rafter. [6].

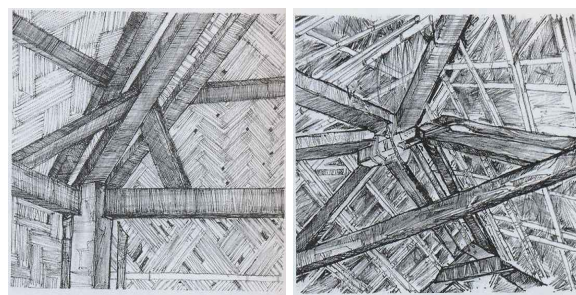


Figure 11: Corner and ridge details of wood structure [6]

Building materials like pre-cast concrete post nylon ropes, steel angle and steel sections for fixing and tying of different structural members are used for house construction.

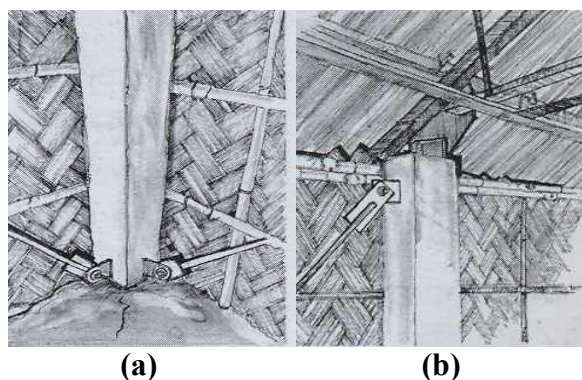


Figure 12: (a) Bottom details of pre-cast concrete post. (b) Top details of the pre-cast concrete post [6].

The local technology for connection details between beam and rafter is done by tying the rafter firmly to the beam by nylon rope after cutting a notch in the rafter and in a better constructed structure the notch in the rafter is securely fitted to the beam maintaining the required slope at the same time. The existing construction technique of roof cladding is well though out and in most cases built well [6].

6. CONCLUSION

The treatment methods of house materials, structural features and construction techniques have been developed in response to the harsh climate, topography and availability of the materials. The anonymous local builders show an admirable talent of blending their houses with the natural surroundings. The competence of local builders is evident in their understanding and ability to identify certain structural features which are particularly susceptible to damages. There are several invented construction techniques by rural people are rather appropriate and sound especially for rural areas which give a permanent hence durable structure and healthy atmosphere with lower cost. If we can identify effective indigenous techniques of strengthening of houses, and combine them with the findings of modern architectural technology, we

might actually be able to contribute towards a mitigation of the destruction of houses and of injuries and casualties due to collapsing of houses. The innovative construction techniques by rural people is rather appropriate and sound especially for rural areas which give a permanent hence durable structure and healthy atmosphere with lower cost.

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