A Study of the Methods and Materials Used in the Construction of Italian Buildings in Gondar

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Abstract

It is important to carry out research into historical architecture before buildings are lost to demolition or decay, a risk that is particularly great in rapidly growing developing countries. The historic town of Gondar, Ethiopia, has a wealth of historical architecture, including a palace that is registered as a UNESCO World Heritage property, as well as traditional houses and Italian-style buildings constructed during the Italian occupation. These buildings have been examined, but the research has not been thorough enough. In my previous research, I looked at the construction of these buildings, and described details such as the distribution of the buildings, their ownership and uses, their height and current condition and how they are being preserved. Here, I focus on the methods and materials used in the construction of Gondar's Italian-style buildings, and attempt to clarify their features, any damage they have incurred, and the key issues involved in their preservation.

Keywords: Ethiopia; Italian buildings; construction method; construction material; colonial architecture

1. Introduction

1.1 Background

Ethiopia was occupied by the Italian army from 1936 to 1941. Italian town planners dispatched by the central government in Rome designed master plans for major towns such as Gondar, Harar, Jimma and Addis Ababa. During this time, various Italian buildings – homes, business and public service premises, factories etc. – were constructed by the Italians in these towns for Italian soldiers or civilians.

According to my fieldwork, a number of these Italian buildings still exist in these towns. However, since 2002, these towns have been developing drastically, and some of the buildings have already been lost as investment increases in these areas.

The Ethiopian research team of Miyake Studio at Keio University has therefore begun to research Italian buildings, with the cooperation of ARCCCH, and launched a joint project in Gondar in 2003 together with Gondar City Service Office and Addis Ababa University. The aim of this project is to clarify the architectural features of Italian buildings in Gondar and to discuss a preservation policy. We specified the five historical Italian quarters in Gondar and put together building height regulations for these quarters in 2005. In addition, we made a list of all Italian buildings and began to propose guidelines for their maintenance.

1.2 Previous Research on Italian Buildings

I have studied Gondar's Italian buildings continuously since 2003 and have clarified the following: their construction, the concept of the Italian city master plan drawn by Gherardo Bosio, the total number of Italian buildings (352), their distribution, height (in a ratio of storeys), their construction materials, condition and ownership. I also carried out an opinion poll into the preservation of the area's Italian buildings, in which 80 out of the 100 people questioned said they recognized the buildings as historical architecture that should be properly preserved.

Another researcher, Mia Fuller, studied the planning background and design features of Italian buildings in two Italian colonies, Libya and Ethiopia, using documents published by both the Italian government and by private publishers during the occupation. Fuller referred to differences in the design concepts used in the two countries' Italian buildings. She mentioned that most Italian buildings constructed in Ethiopia, designed by Italian architects, had been based on the concept of adaptation to the indigenous environment.

In 1992, an exhibition of Italian colonial architecture, focused on four Italian colonies (Ethiopia, Libya, Eritrea and Somalia), was held in Bologna and a catalogue was compiled that included a general explanation of Italian buildings in colonies along with a number of drawings and photographs. At the same time, another group of scholars published a document introducing designs by several Italian architects who had been dispatched to Ethiopia during the occupation. This latter document mentioned that some architects attempted to copy the design model of colonial residences using local techniques and materials.
The IsIAO\textsuperscript{10} published a similar document in 2005 giving general information of Italian buildings in four colonies.

1.3 Purpose and Method

This paper is a continuation of my last thesis\textsuperscript{11}. My research on Italian buildings in Gondar focuses on structural methods and materials, as clarifying these technical features is necessary for the protection of the Italian buildings through restoration, renovation and other techniques.

I have examined the Italian buildings in Gondar with the following objectives:
1) to classify the types of principal structures used in the Italian buildings and clarify their features;
2) to examine the materials used in the principal structures and clarify their features, including their size and how they are made and used;
3) to clarify the relationships between the principal structures and building uses, and those between the principal structures and their height; and
4) to document the current condition of the principal structures.

This research report is based on fieldwork conducted between October 2003 and December 2005 and on archival research. This paper targets Gondar because it has a wider variety of Italian buildings than other cities.

2. Classification of Principal Structures

Table 1. classifies the principal structures of Italian buildings in Gondar. There are three types of construction method: prefabrication, masonry and reinforced concrete construction. These three methods are subdivided into fourteen types of principal structures. Of the 352 Italian buildings, 67\% were built using the masonry method and 28\% using the prefabrication method.

3. Features of Principal Structures

3.1 Prefabrication Method

Prefabrication has both the advantage of a shorter construction period and an easier way to ensure the quality of the building. In the early 1930s, INCIS\textsuperscript{12} produced prefabricated buildings in Italy under the instruction of AOI\textsuperscript{13} and the Italian army transported the buildings to Ethiopia after the occupation. Four types of prefabrication-method exist in buildings in Gondar: asbestos plate, steel bar, steel bar and asbestos plate, and timber.

The asbestos plate structure involves the construction of a wooden truss roof and a wall made of asbestos plate and plywood (Fig.1.). The advantage of this construction is good thermal insulation. However, the disadvantage is weak durability. Asbestos plate is used as a material for the outer walls and roof tiles. The asbestos plate used on the outer wall is 5 mm thick, with a length of 1 m and a breadth of 3 m.

The steel bar and a wooden truss roof, with the joint fixed by steel bolts. The advantage of the construction is that it involves the shortest construction period of all the principal structures. However, the disadvantage is low sustainability due to erosion. The lengths of steel pillar and steel beam are 3 and 2 m, respectively. These materials were manufactured in Italy.

The steel bar and asbestos plate structure involves steel pipes and asbestos plates. Although the durability of the building is better than any other prefabrication method, the construction period is longer than the others (Fig.2.).

The timber structure is assembled using wooden pillars, wooden partition walls and a wooden truss roof, while the exterior wall is covered by a clapboard siding. The lengths of the pillar and wall are 3 and 2 m, respectively. This construction has good thermal insulation, but does not have good durability (Fig.3.).

3.2 Masonry Method

The masonry method, known as the vernacular construction method in North Ethiopia, is famous in Gondar, and all traditional circular houses\textsuperscript{14} are built using stone masonry. After the Italian occupation, Italian architects investigated traditional buildings and indigenous materials and attempted to adapt the vernacular method (stone structure) because there was a shortage of imported construction materials. Seven types of masonry method were used in Gondar: brick, cement block, stone, stone & brick, stone + brick, stone + reinforced concrete (RC) and stone + RC & stone.

The brick structure involves the construction of the wall using piled-up bricks and a wooden truss roof. Bricks are fixed using mortar and are 6 cm thick, 24 cm long and 12 cm wide (Fig.4.). The Italian army manufactured a large number of bricks and constructed a brickyard around Che-Che-La\textsuperscript{15}. However, these bricks were mostly used for partition walls rather than for the principal structures of the buildings.

The cement block structure is uncommon in Gondar, with only one existing building having been constructed in this way. This construction is put together using walls of piled-up cement blocks, which are 10 cm thick, 30 cm long and 15 cm wide. As it was difficult to produce cement in Gondar during the occupation, all cement was transported from Italy.

The construction of the stone structure involved piling up local basalts, which were mined from the quarry around Qusquam Castle\textsuperscript{16}. This construction method leads to good thermal insulation and strong durability. Basalt comes in lengths ranging from 15 to 20 cm, and in widths of 5 to 10 cm (Fig.5.).

The stone & brick structure method combines these two types of structure in one wall, which is uncommon.

The Stone + RC structure is built using a stone masonry wall and an RC beam. It is a practical construction method and generally uses a double
roof (an RC deck roof and a wooden truss roof) to protect against rain leakage. The advantages of this construction method are both good thermal insulation performance and strong durability. In particular, the combination of local materials (the stone wall) and transported material (the RC beam) means that it is possible to construct Italian buildings higher than two storeys. The basalt used in this construction method varies in size from 40 to 60 cm in length and width, similar to that used in the building of the Fasiladas Castle.

The stone + RC & stone structure involves both methods sharing a wall. This is unusual in Gondar.

3.3 RC Construction Method

The RC construction method, which requires the concrete structure on the site, is not common for Italian buildings in Gondar. Making the concrete structure on the site is not common for Italian buildings in Gondar.

The advantage of this method of construction is its potential for making a variety of shapes and attractive spaces. However, it was difficult to construct Italian buildings in Gondar using this method due to a shortage of cements and reinforcing-bars. Pre-cast concrete boards were used for some of the buildings. The Italian army collected most of the aggregate from the Angreb River. This was the first trial of the RC construction method in Gondar. Three types of RC construction method exist in Gondar: RC, RC & Brick and RC & Stone.

The RC structure is the construction method used for the foundations, walls and roof, using reinforced concrete, and sometimes pre-cast concrete boards. As previously mentioned, this construction method, although strong, was not commonly used.

The RC & brick structure combines RC- and brick-type structures in one wall. This is unusual in Gondar.

The RC & stone structure combines RC- and stone-type structures in one wall and is also unusual in Gondar.

4. Current Condition of Principal Structures

In my previous research, I described the relationship between the current condition of Italian buildings and the construction methods used. The condition of Italian buildings in Gondar varies significantly, with some buildings in excellent condition and others in poor condition. The most common construction methods used in Gondar are the stone + RC & stone structure and the RC construction method. The stone + RC & stone structure is common in Gondar due to the availability of local materials and the ability to construct buildings higher than two storeys. The RC construction method is not common in Gondar due to the shortage of cements and reinforcing-bars.

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Table 1. Classification of Principal Structures of Italian Buildings

| Construction Methods    | Principle Structures                    | Number of Buildings |
|-------------------------|-----------------------------------------|---------------------|
| Prefabrication Method   | Asbestos Plates                         | 44 (12%)            |
| Prefabrication Method   | Steel Bar                               | 3 (1%)              |
| Prefabrication Method   | Steel Bar + Asbestos Plates              | 3 (1%)              |
| Prefabrication Method   | Timber (Wood)                           | 51 (14%)            |
| Masonry Method          | Brick                                   | 10 (3%)             |
| Masonry Method          | Cement Block                            | 11 (3%)             |
| Masonry Method          | Stone                                   | 116 (32%)           |
| Masonry Method          | Stone + Brick                           | 3 (1%)              |
| Masonry Method          | Stone + RC                              | 2 (1%)              |
| Masonry Method          | Stone + RC & Stone                      | 102 (28%)           |
| Masonry Method          | RC Construction Method                  | 1 (1%)              |
| RC Construction Method  | RC                                      | 13 (3%)             |
| RC Construction Method  | RC & Brick                              | 2 (1%)              |
| Total                   | Total                                   | 352 (100%)          |
* RC refers to reinforced concrete. ** & means two buildings joined together and sharing a wall, such as row houses. *** + indicates a mixed structure.

Table 2. Comparison between Condition of Preservation and Principal Structure

| Principal Structure     | A   | B   | C   | D   | E   | F   | N   | Total |
|-------------------------|-----|-----|-----|-----|-----|-----|-----|-------|
| Asbestos Plate          | 24  | 0   | 0   | 12  | 6   | 1   | 1   | 44    |
| Brick                   | 5   | 20  | 3   | 0   | 0   | 0   | 0   | 10    |
| RC                      | 5   | 38  | 4   | 3   | 1   | 0   | 0   | 13    |
| Stone                   | 83  | 71  | 6   | 14  | 8   | 1   | 1   | 160   |
| Stone + RC              | 76  | 74  | 2   | 12  | 8   | 1   | 1   | 160   |
| Timber (Wood)           | 6   | 12  | 2   | 14  | 19  | 0   | 0   | 51    |
| Other                   | 5   | 31  | 2   | 13  | 3   | 0   | 1   | 16    |
| Total                   | 204 | 14  | 65  | 38  | 12  | 9   | 10  | 352   |
* 'A' to 'F' and 'N' stand for 'good condition' (A); 'some damage to outside wall' (B); 'some damage to inside parts' (C); * both B & C (D); 'serious damage' (E); 'ruins' (F); and 'no information' (N).

Table 3. Comparison between Building Uses and Principal Structure

| Principal Structure     | Commercial | Factory | Governmental Office | Hospital | Hotel | House | House & Commercial | Mixed Function | School | Other Uses | Total |
|-------------------------|------------|---------|---------------------|----------|-------|-------|-------------------|----------------|--------|------------|-------|
| Asbestos Plates         | 1(2%)      | 0(0%)   | 0(0%)               | 1(2%)    | 1(2%) | 37(85%) | 4(0%)             | 0(0%)          | 0(0%)  | 0(0%)     | 44(100%)|
| Steel Bar               | 0(0%)      | 0(0%)   | 0(0%)               | 0(0%)    | 0(0%) | 1(2%)  | 13(3%)            | 0(0%)          | 0(0%)  | 0(0%)     | 13(100%)|
| Brick                   | 0(0%)      | 0(0%)   | 0(0%)               | 0(0%)    | 0(0%) | 1(2%)  | 1(2%)             | 0(0%)          | 0(0%)  | 0(0%)     | 2(100%) |
| Brick + Steel Bar       | 0(0%)      | 0(0%)   | 0(0%)               | 0(0%)    | 0(0%) | 1(2%)  | 13(3%)            | 0(0%)          | 0(0%)  | 0(0%)     | 13(100%)|
| Timber (Wood)           | 0(0%)      | 0(0%)   | 0(0%)               | 1(2%)    | 1(2%) | 0(0%)  | 44(87%)           | 0(0%)          | 1(2%)  | 41(70%)   | 51(100%)|
| Other                   | 0(0%)      | 0(0%)   | 0(0%)               | 0(0%)    | 0(0%) | 0(0%)  | 4(0%)             | 0(0%)          | 1(2%)  | 1(2%)     | 6(100%) |
| Total                   | 204        | 14      | 65                  | 38       | 12    | 9     | 10                | 352            |

Table 4. Comparison between Number of Storeys and Principal Structure

| Principal Structure     | G0  | G+0,B1 | G+1 | G+1,B1 | G+2 | Total |
|-------------------------|-----|--------|-----|--------|-----|-------|
| Asbestos Plates         | 44  | 0(0%)  | 0(0%)| 0(0%)  | 0(0%)| 44(100%)|
| Steel Bar               | 3   | 0(0%)  | 0(0%)| 0(0%)  | 0(0%)| 3(100%) |
| Brick                   | 3   | 0(0%)  | 0(0%)| 0(0%)  | 0(0%)| 3(100%) |
| Brick + Steel Bar       | 51  | 0(0%)  | 0(0%)| 0(0%)  | 0(0%)| 51(100%)|
| Timber (Wood)           | 10  | 0(0%)  | 0(0%)| 0(0%)  | 0(0%)| 10(100%)|
| Cement Block            | 1   | 0(0%)  | 0(0%)| 0(0%)  | 0(0%)| 1(100%) |
| Stone                   | 107 | 1(1%)  | 7(6%) | 1(1%)  | 0(0%)| 116(100%)|
| Stone + Brick           | 2   | 0(0%)  | 1(33%)| 0(0%)  | 0(0%)| 3(100%) |
| Stone + RC              | 58  | 57(39%)| 36(55%)| 3(3%)  | 0(0%)| 102(100%)|
| Stone + RC & Stone      | 0   | 0(0%)  | 1(100%)| 0(0%)  | 0(0%)| 1(100%) |
| RC                      | 6   | 46(66%)| 0(0%)  | 6(46%) | 1(8%)| 53(100%) |
| RC & Brick              | 2   | 0(0%)  | 0(0%)  | 0(0%)  | 0(0%)| 2(100%) |
| RC & Stone              | 1   | 0(0%)  | 0(0%)  | 0(0%)  | 0(0%)| 1(100%) |
| Total                   | 290 | 3      | 51    | 5      | 3    | 352    |
**G** indicates ground floor; **B** means an underground basement floor.
Of the Asbestos-plate Structures, 55% are in good condition. However, damage to an exterior asbestos wall also damages the corresponding inner wall. Both Stone + RC and Stone are in good condition, while Timber Structures show the most serious problems.

I also revealed the relationship between the current condition of the Italian buildings and their ownership:

Almost all government-owned buildings are in good condition, with 77% having A status. However, 36% of Kebele-owned buildings need immediate maintenance. Of the privately-owned buildings, 54% are in good condition and 27% require repairs. Government sectors own 83% of all Italian buildings (government, Kebele, RHAA). It is thus necessary to cooperate with governmental sectors, as well as citizens, and discuss methods for protecting the Italian buildings.

Here, I examine in greater detail the extent of damage to the main buildings.

Of those buildings constructed using the asbestos plate structure, serious damage includes the erosion of the plywood of the inner wall and the cracking of the exterior asbestos wall. As for maintenance, a local architect has covered some of the cracked asbestos walls with cement, while some of the eroded plywood has been replaced.

Of those buildings with the timber structure, outside damage includes erosion of the clapboard siding, while internal damage involves the collapse of the ceiling and deterioration of the wooden wall. The most serious damage is the deterioration of the internal wooden wall, because once this wall has been eroded by water or ants, the outside clapboard siding will be damaged by it.

Of those constructed using the brick structure, most damage involves the erosion of the brick and the collapse of the ceiling. However, this damage does not present a threat to the main structure, because the damaged brick can be covered with mortar and the ceiling can also be maintained.

Of those that used the RC structure, damage involves the erosion of the render work and cracking of the flat roof. The render work carried out on the external wall is easy to repaint. However, the cracked roof is difficult to maintain. Therefore, in this case, the flat roof tends to be improved by turning it into a double roof, often using a wooden truss roof.

Of the buildings constructed using both the stone structure and the stone + RC structure, damage is rarely found, aside from small cracks in the internal wall, which are not serious.

5. Analysis of Principal Structures
5.1 Comparison between Building uses and Principal Structure

Table 3. indicates the relationship between a building's use and its structure. My fieldwork shows that Italian buildings in Gondar are still mostly used for the purpose for which they were originally built.

Of those built using the asbestos plate structure, 85% are used as residential and 9% are residential with a shop. Of those of steel structure, 33% are residential, with 33% of the buildings combining a home and a shop. Almost all Italian buildings constructed using the prefabrication method are used for residential purposes.

Of those built using stone structure, 36% are residential, 19% are schools, 13% fall under the categories of 'other' and 'government office' and 8% are shops. Of those using stone + RC structure, 55% are residences and 20% are government offices. Of those using brick structure, 50% are residences, 30% are governmental offices and 10% are factories. The masonry method is chiefly used for residential buildings and also for governmental offices, schools and shops. In addition, almost all schools and governmental offices are constructed using stone structure or stone + RC.

Of those in RC structure, 46% are residential, 23% are shops and 15% are governmental offices. Of both RC & Brick and RC & Stone, 100% are shops. The RC construction method is chiefly used for residences and governmental offices and shops.

5.2 Comparison between Number of Storeys and Principal Structure

Table 4. indicates the relationship between the number of storeys and the principal structure.

All the principal structures classified as the prefabrication method are Ground (G) +0; in other words, this method applied only to one-storey buildings.

Of those buildings in both brick structure and cement block structure, all the buildings are G + 0. Of those in stone structure, 92% are G + 0. In contrast, of those buildings in stone + RC structure, 41% have more than one storey.

Of those buildings in both RC & brick structure and RC & stone structure, all are G + 0. On the other hand, 54% of the buildings constructed using RC structure have more than one storey.

6. Conclusion

Sections 2, 3, 4 and 5 highlight the importance of Gondar's Italian buildings and factors that should be considered when planning to preserve these buildings.

1) Italian buildings involved three types of construction method -prefabrication, masonry and RC—which are subdivided into 14 types of principal structure.

2) All construction materials in the prefabrication method were transferred by Italians to Gondar and constructed in a short period of time. In contrast, local materials and vernacular techniques were often used for the masonry method.

3) The prefabrication method was mostly used for residential purposes, while the masonry method had a
variety of uses.

4) Although all the buildings constructed using the prefabrication method are one storey high, most of the buildings higher than one storey used the stone & RC structure.

5) Gondar has 47 buildings constructed using asbestos plate, which is a material with serious health dangers. Asbestos plate is not normally used for interior parts, but used for walls and roof tiles.

Future fieldwork will involve detailed research into the spatial layout of buildings and their environment as residences, along with further archival research focusing on architectural drawings and history.

Notes
1 I conducted nine periods of fieldwork in Gondar (October 2003, February–March 2003, March 2004, February 2005 and December 2005), in Jimma (March 2005), in Harar (August 2005) and in Addis Ababa (September 2005 and December 2005).
2 ARCCCH: Authority for Research and Conservation of Cultural Heritage.
3 Department of Architecture and Urban Planning (Building College), Addis Ababa University.
4 Reference 1, pp.15-22.
5 Reference 2, p.16.
6 Reference 3, pp.455-487.
7 Reference 4.
8 Vittorio Gregptti, Stefano Zagnoni, Giuliano Gresleri and Gian Paolo Consoli.
9 Reference 5, pp.17-27.
10 Reference 6. IsIAO: Istituto Italiano per l’Africa e l’Oriente.
11 Reference 1.
12 INCIS: National Institute for Housing Government Employees.
13 AOI: Africa Orientale Italiana.
14 Reference 7, 8.
15 Che-Che-La is 2 km from the central part of Gondar; it was the first Italian settlement during the Italian occupation.
16 Qusquam Castle is a part of Fasiladas Palace, a UNESCO World Heritage site, and has a quarry around it.
17 The RC beam of the construction was made using precast concrete.
18 Fasiladas Castle is the main part of Fasiladas Palace, a UNESCO World Heritage site.
19 Precast concrete board is manufactured in the factory using reinforced concrete, and is a prefabrication method.
20 Angreb River flows along the boundary of Gondar city and the aggregate is collected at the riverbank.
21 Reference 9, 10.
22 Reference 1.
23 ‘A’ to ‘F’ and ‘N’ stand for ‘good condition’ (A); ‘some damage to outside wall’ (B); ‘some damage to inside parts’ (C); ‘both B & C’ (D); ‘serious damage’ (E); ‘ruins’ (F); and ‘no information’ (N).
24 Kebele and RHAA are governmental organizations.

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