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PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

International action contributing to activities of Member States for the preservation and presentation of cultural property

Shibam and Wadi Hadramawt, Report No. 3

by
Ronald Lewcock
Jacques Heyman

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THE PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

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Report prepared for the Government of
The People's Democratic Republic of
Yemen by the United Nations Educational,
Scientific and Cultural Organization
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U N E S C O

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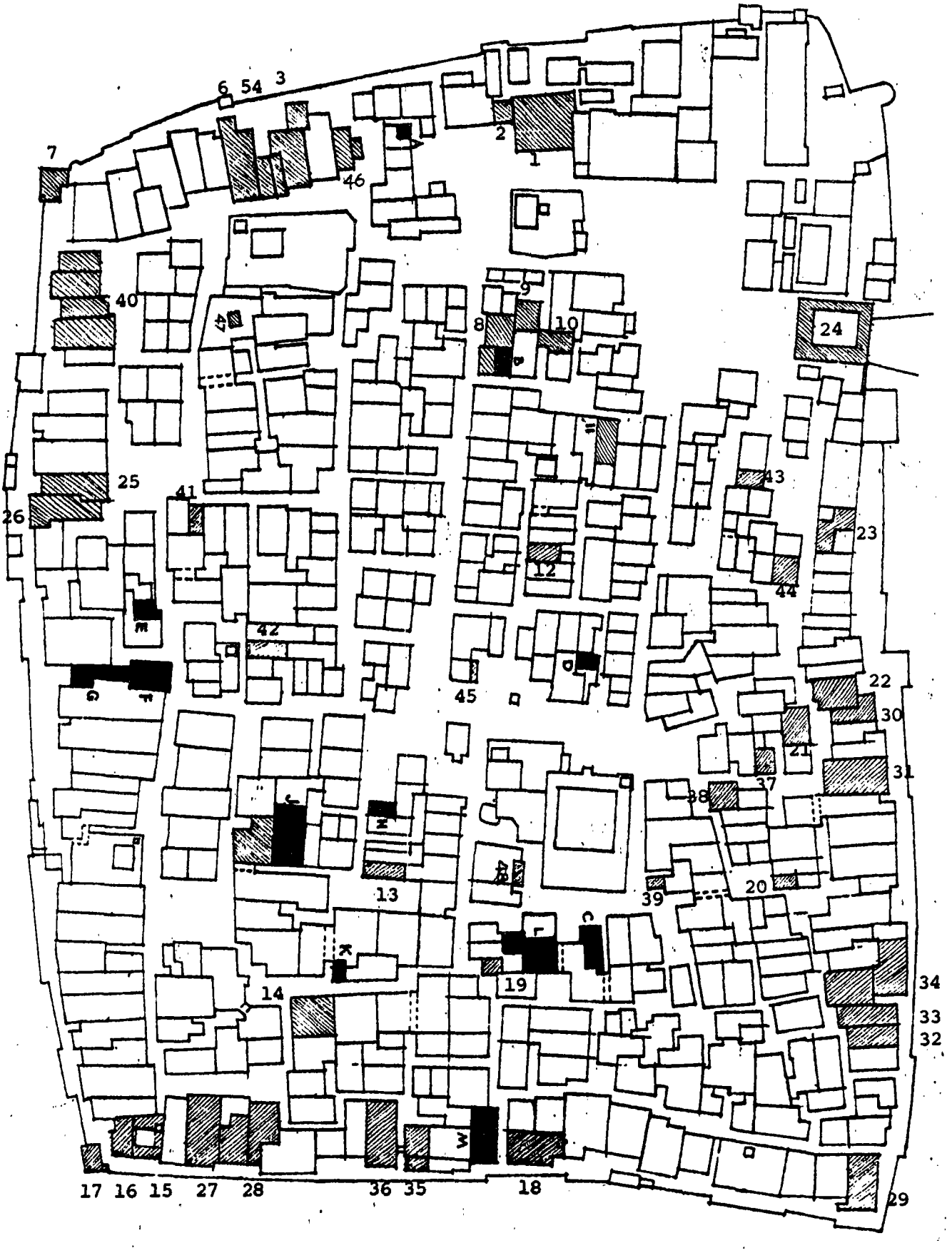

1. Plan of the old city of Shibām indicating the buildings which are decayed or damaged (Nos.1 to 48) and those which are ruins (Letters A to M).

Seriously deteriorated buildings Collapsed buildings

Part A - by Ronald Lewcock

LIST OF ILLUSTRATIONS :

Preface

1 At the request of the Government of the People's Democratic Republic of Yemen, the Director-General of Unesco arranged for a mission to be carried out in that country from 25 March to 9 April 1982, financed under the Organization's Regular Programme for 1981-1982. This mission was a follow-up of two previous missions carried out by Ronald Lewcock (see report No. 1, Serial No. FMR/CLT/CH/81/306, report No. 2, Serial No. FMR/CLT/CH/82/114, Unesco, Paris, 1981 and 1982 respectively).

2 Part A of this report presents the findings of Ronald Lewcock concerning the architectural content, while Part B presents the findings of Jacques Heyman concerning the structural engineering aspects. Ronald Lewcock also acted as technical coordinator during the mission.

3 The terms of reference of the mission were the following:

"In connnection with the task of preparing an Emergency Plan for the monuments threatened by collapse in Shibām, the consultants shall diagnose the causes of collapse of monuments and elaborate proposals for their restoration by:

a) preparing an emergency plan of action for the houses, city wall and other buildings of Shibām urgently needing conservation to prevent collapse, also for other sites and monuments in the Wadi in a similar situation;

b) making proposals for emergency action regarding a workshop for temporary drainage in Shibām; and

c) ensuring the technical coordination for the emergency programme in Shibām and Wadi Hadramaut."

PART A - Report by Ronald Lewcock

1. INTRODUCTION

4 Working with Professor Heyman we surveyed the most serious of the cracked and partially collapsed houses in Shibām, in order to ascertain the causes of the cracking, and measures which might be most effective to (a) prevent cracking in future and (b) rehabilitate the damaged buildings.

5 At the same time, careful examination of the old city wall was undertaken, and a tentative design of a possible technique of reconstruction of the wall was prepared after discussion with Professor Heyman on which tenders of cost may be prepared.

6 The embankment of the Muzaᶜ Dam broke as a result of flooding while we were in the Hadramawt, and a strategy for reconsideration of the design and strengthening of the dam and its spate was prepared.

7 After the arrival in Saiwūn of an architect and a draughtsman from the Ministry of Construction on the day Professor Heyman departed, further studies of Shibām houses were undertaken. At the same time a complete external photographic record, with metric dimensioning, was made of all buildings which are to be demolished, or are likely to be damaged by collapse in the foreseeable future. These buildings are indexed on the map, Plate 1. Those to be demolished are listed in order of urgency in Appendix A.

8 In the Hadramawt, meetings were held with the Maᶜmūr of Saiwūn, Mr. Saᶜid Nasir Yadain, with members of his staff, and with the Secretary of the Socialist Party in the Hadramawt, Mr. Juman Ba'Raba. In addition, several meetings were held with the Director of the Wādī Hadramawt Agricultural Project, Mr. Farouk Ibrahim, and with the irrigation engineer to the Dept of Agriculture, Mr. Rejai Kareem, whose generous contribution to the preparation of plans leading to the possible resolution of the flooding problems is gratefully acknowledged.

9 In Aden, gratitude must first be expressed to officials of the Yemenī Centre for Cultural Research, Archaeology and Museums, and in particular the Acting Director-General, Mr. ᶜAli Agīl bin Yahya, on whose shoulders many of the problems of realising the Wādī Hadramawt project rest, in his position as Secretary of the High Commission for Assisting the Shibām, Wādī Hadramawt Campaign.

10 In addition, I would like to thank those other officials of the Yemenī Centre who assisted me so ably in Aden and the Hadramawt,

particularly Mr Abdulla al-Mallahi, the Director of the Department of Museums and Archaeological Sites, and Mr Mohammed Balafayr, who accompanied us to the Hadramawt and provided valuable assistance.

11 In Aden, meetings were held with the Minister of Culture and Tourism, H.E. Mr. Rashīd Thabet, the Deputy Minister of Planning, Mr Abdulla Abadan, with the Deputy Minister of Construction, Mr Taleb bin Shamlan, and with Mr Faisal al-Attas of the Ministry of Local Administration.

12 I would like to thank also the Resident Representative of the UN Development Programme, Mr. Roland Reifenrath, and his Programme Officer, Mr. Ahmed al-Aidroos Fadaq. Mr. Saloh Saeed Attamimi from the library in Tarim acted as a valuable translator in the Hadramawt.

13 Finally, I would like to thank the architect from the Ministry of Construction who accompanied me in Shibām, Mr. Ismail Ba^{c}Haroon, and his assistant, Miss ^{c}Awatif al-Sakkāf, who measured a large Shibām house.

2. SHIBAM CONSERVATION STUDIES

A. THE HOUSES

2.1 Survey of Buildings with Professor Heyman

14 Professor Heyman was able to visit and examine in detail only a representative selection of the houses which have been identified as needing major repairs. His conclusions, discussed in Part B of this report, are, briefly, that there are four causes for the cracking due to water, and, also, that there is the possibility that some cracking might also be due to the movement of earth under the outlying houses due to slipping of the soil behind the collapsed portions of the city wall.

15 The damage done by water could be summarised as follows:

(a) leaking water pipes

(b) leaking surface drains

(c) leaks in the underground drainage system

(d) by leaking of rainwater through roofs and crevices.

16 The first three of these related to cracking in the lower storeys of the buildings. Four trial pits were dug in order to examine reconstruction of the foundations. One of the pits proved difficult to complete as the foundation of the house lay so far below the present ground level. Of the other three foundation constructions, two were in mud brick only, with no stone layer between the natural ground at the footing and the wall itself; on the other hand, one of these two did have longitudinal beams of elb wood strengthening the wall at ground level. The third foundation proved to have a substantial stone foundation, made in a mixture of lime and ash and splayed so that it was wider at the bottom than the top. Although it proved impossible to get underneath the stones to examine the work, old builders assured

us that the centre of this wall would have been built on longitudinal logs of elb wood resting on a layer of salt above a layer of animal dung. The wall above this foundation had not developed cracking, the site on which it was built being a substantially sloping one - which would mean the fairly rapid draining-off of any surface water.

17 The conclusion from the examination of these foundations was that in the case of the mud foundations ground water would be disastrous to the strength of the walls above; in the case of the stone foundations it is possible that ground water containing acids from animal and human sewerage waste might, if it were carried down to the level of the lime drudging between the stones, lead to the disintegration of the joints and the movement of the stone foundation. In the latter case, however, it was not strictly necessary to postulate this acid attack, as water penetrating to the bottom of the foundation would itself tend to cause settlement due to liquefaction of the clay beneath the foundation construction. Professor Heyman judged the houses which were severely cracked but still inhabited,to be all eventually repairable, providing great care was taken in the use of the right techniques, and each house received individual study from a skilled architect with the advice of an experienced structural engineer. Detailed reports of the examination of four of the houses follow; these serve to illustrate the varieties of the problems and some consideration of the types of possible solutions:

18 2.2 House 29 (Bayt ᶜAbdu Rahman al-Jerū)

19 This house lies at the south west corner of the city, where the wall was badly damaged during the flooding of 1977. A pool of water can be observed to lie almost continuously below the wall on the western side of this house, and it is possible this water may be seeping in under the clay sub-strata. As the city walls are broken down so extensively, there has been considerable movement of earth. According to the owner,

new cracks are forming all the time. The house is broken about 12 feet inside the southern wall (there is a crack running along the length of the house). A similar crack can be observed to run about 12 feet inside the western wall. It is evident that the city wall has to be rebuilt to a permanent strong position before anything worthwhile can be done to repair the cracking. The possibility of providing temporary shoring for this house was considered, but this seems prohibitively difficult. When the building is eventually strengthened, the south-west corner should receive attention first. If, after this work was done, cracking should continue to the east and north there should then be more rebuilding in a second operation.

2.3 House 33 (Bayt Salim bin Mubarak)

This house also lies on the city wall, a few houses to the east of the house discussed above, that is, on the southern wall. Like several other houses on this side of the city there is a basement which extends down about 1½ levels below the entrance level. The main cracking, which is fairly extensive, occurs in this basement. The floor is nearly at water table level, so there is damp penetration upwards; rising damp is causing spoiling of the plaster surfaces and some of the structural walls. The cracking here is also growing continuously, and it is observable that the city wall outside has bulged markedly. On the other hand, the drains behind this house are also likely to be leaking into the ground flanking the basement. It seemed sensible here to postpone further structural repairs until both the city wall and the drains have both been dealt with.

2.4 House 26 (Bayt Abū Bakr La'jūm)

Another house situated on the city wall, this time on the northern wall. Water is getting in underneath this house from broken drains;

in addition, the owner has not repaired the plaster on the outside of the plinths of the house. The whole of this house is still cracking and moving, in spite of the introduction over the last eleven years of fifty props, each made of a single piece of elb wood with a stone base and a cross member at the top, into the ground floor level. Many of these props are repeated on the two floors above. There are other inserted pieces of wood acting as splices across the cracks. This woodwork Professor Heyman regarded as a fundamentally sound way of strengthening the building once it had cracked. But he did not expect the cracking to cease until the leaking of the drains under the house had been completely dealt with. The cracking of this house was most severe at the back, where a projecting wing is crumbling. Consideration was given to a number of possible techniques for dealing with this back wing; that which in the end proved most favoured by Professor Heyman as being most likely to be satisfactory being the demolition of the back part of the house and its reconstruction with new foundations. This technique has its own dangers (half the house will be left standing while half is taken down), but as the house is probably cracked right across, in any case, this may not make a great deal of difference: there is already evidence that the front of the house can stand without support of the back half.

24 2.5 House 40 (Bayt ᶜAwad ᶜOmar Masafar)

25 This house, on the northern wall of the city, has progressive cracking of a type similar to that in house 26. The house was judged to be repairable. The back corner would have to be reinforced, or even completely rebuilt, and possibly a good deal of the remainder of the northern wall of the house. Otherwise the main problem with this house is that it needs urgent general repairs.

2.6 City Gate:

26 Professor Heyman examined the structure of this building and concluded that the cracking did not indicate any serious structural problems. The building merely needs general repairs.

27 The above sample of the survey of houses gives a clear idea of the causes which Professor Heyman believes are responsible for the cracking. To summarise, they are caused by water, either entering during rainfall through the roofs and terraces or seeping in under the foundations and the floors of the house below ground level, or they are caused by movement of the ground due to failure of the city wall. The latter is felt likely to be the less serious of the two causes.

2.7 Strategy for Major Repairs

28 We examined the techniques which were used by the traditional builders of Shibām to repair buildings which had cracked. In principle these involved attaching wooden props on either side of the crack and if possible "splicing" the walls on either side of the crack together with short cross pieces of wood inserted into the thickness of the wall. Each prop has, on the ground floor, its own stone foundation of at least two layers of stone laid in ramad, and carries on the top a short cross piece which is propped against the woodwork of the beam of the ceiling. In the case of external work, the props sometimes extend as far as the third floor or beyond as single pieces of wood (iron pipes and RSJ's have recently been introduced, but these are not generally favoured by the builders as they are liable to rust). In the case of extensive internal cracking for several floors above the ground, level wooden props are inserted on either side of the cracks or openings on every level that is affected.

29 This was felt to be fundamentally a sound way of strengthening the structure, but, as indicated in the examples above, there were certain cases where it was felt that extensive rebuilding is justified in the interests of the reduction of continuous maintenance costs.

30 In discussion with the most senior of the builders (ᶜUstādh Faidān) he indicated that reinforcing the cracked corners of houses was better than attempting to rebuild them in mud brick. The cost of this work for a large house which was extensively cracked might be as much as a quarter of its new cost, which could vary from YD 125,000 to YD 150,000. He estimated that such a repair would last 30 years at least.

31 The implications of the researches carried out on the old houses for the long term planning programme are as follows:

32 (a) The first major work of the programme should be the installation of a permanent drainage system, together with a system for the removal of surface storm water from the old city. As it is important not to excavate into the ground any more often than it is necessary, in order to reduce the movement of the foundations of the houses to a minimum, it will be necessary to integrate the laying of all other services at the same time; ie, electricity, telephone lines, and communal television aerial cable.

33 (b) The second urgent item in the long term programme will be the construction of a permanent city wall (discussed below under Section B).

34 (c) Only when these two works are well advanced will it be sensible to begin major repairs to any of the houses. The possibility of propping or shoring some of the houses in the meantime was considered, but rejected as impracticable. When the major repairs to the houses are finally undertaken, it will be necessary to treat each

house as a special case to receive individual study by the technical director and his structural adviser (see paragraphs 000 and 000 below).

2.8 Urgency of Minor Repairs and General Maintenance

35 Our inspection of the condition of the houses emphasised again the urgency of the repairs to roofs, and to the plaster dadoes lining the streets.

36 We were informed (by the Secretary, Mr ᶜAli Aqil) that the High Committee for assisting the Shibām/Wādī Hadramawt campaign, held in Saiwūn on 24th February 1982, allocated money for this work. At the time of our survey these repairs had not yet been started.

37 In discussion with the Maᶜmūr of Saiwūn and his staff, and in subsequent discussions with the Secretary of the High Committee, Mrᶜ Ali Aqil, it was suggested that a responsible officer might be stationed at Shibām to supervise the allocation of the funds and the quality of the execution of the repair work; it was further felt that the appointment of such an official might hasten the completion of this important maintenance work.

2.9 The Demolition of Abandoned Buildings which are in danger of collapse

38 Examination of the deserted ruins in the old city confirmed the fears expressed in earlier reports that these ruins represented potential dangers to the public: a number of them are overhanging other premises, are in an advanced state of disintegration, and may collapse at any time.

39 A list was prepared of all those buildings which urgently warrant demolition. We were informed by the Secretary, Mr ᶜAli Aqil, that at the same meeting of the High Committee on the 24th February 1982 money was allocated for this purpose. A list of the most dangerous buildings was therefore prepared in descending order of urgency, as follows:

40 18. Bayt bin ᶜOthmān

8. Bayt Masjid Maᶜrūf

4,5,6. Bayts Sālim ᶜOmar Bā ᶜObeyd

13. Bayt Ibn Suᶜyadān

B. Bayt M. Agil Bā Muslam

G. Bayt Ali Jabrām

41 Instructions should be issued to the supervising technical officer that the wooden windows and doors of the external facades should be carefully removed and stored ready for the reconstruction of these buildings at a later date. During the demolition work all parts of the internal woodwork which are reusable, including the ceiling beams, should be carefully removed and stored in the same way.

3. THE CITY WALL

3.1 Survey of the City Wall with Professor Heyman

42 An examination of the city wall was made. It was observed that after the rains of the 30th March 1982 the wall was further collapsed in several places and a section of the wall on the northern side developed large cracks which were matched by wide cracks in the earth behind (see Plate 3.e) which will fall away in the near future.

43 The following conclusions were reached as a result of the examination of the wall.

44 (a) Not all the city wall needs to be rebuilt. Some of it is substantially constructed in stone set in ramad or cement and seems well tied back into the ground behind.

45 (b) Approximately three-quarters of the city wall needs to be completely rebuilt with a substantial waterproofed section of stone below and an upper part of clay, both sections tied back into the ground behind by cross walls at regular intervals.

46 (c) Previous estimates for the reconstruction of the wall were examined and were thought to be inadequate.

3.2 Strategy for Major Repairs

47 Following discussions with the most senior of the old traditional builders (ᶜŪstādh Sidān) it was decided to request him to prepare an estimate for the reconstruction of the wall in an essentially traditional way, with two modifications:

48 (i) The stone foundation, set in a mixture of lime and ash, would extend six feet above ground level and three feet below ground level.

49 (ii) The wall would be tied back by cross walls into the ground behind. For the sake of this estimate it was judged that the cross walls would be roughly triangular in section, that is, deepest at the outer face and tapering to a point near the houses behind. They would average 30 feet apart and 12 feet in length (see diagram 1). For estimate purposes the cross walls would be constructed of reinforced concrete. The municipal engineer of Saiwūn, Mr ᶜAwād Baᶜghrag, undertook to provide money and assistance to enable the ᶜūstād to undertake the detailed survey of the existing city wall which would be necessary in the preparation of his estimate.

50 It is intended that the work of rebuilding the city wall should proceed as soon as possible. At the time of implementation it is intended that the Technical Director and the Technical Sub-Committee should reconsider the design of the permanent wall and introduce changes, if necessary, which may modify the estimate.

51 The permanent rebuilding of the city wall is therefore dependent on two factors: the availability of the funds from the International Campaign, and the prior appointment of the Technical Director and his Engineering Consultant.

4. THE MUZA^{C} DAM

4.1 Survey of the Flood Damage of the 30th March 1982 with Professor Heyman

52 The flood damage was surveyed on 31st March at 3 pm. A brief account of the sequence of events leading to the breaking of the dam, obtained from eye witnesses, follows together with a description of the extent of the damage.

53 Rain fell at the dam and over the old city of Shibām (four kilometres away) for 45 minutes, but the source of the flood which descended on the dam and the old city was the catchment area of the Wadi Sarr to the north west, where it rained for 2½-3 hours, beginning at 4.30 in the afternoon.

54 The floods reached the dam at 8 pm on the night of 30th March as a low stream. But the volume of water descending from the Wadi increased rapidly until three hours later, by 11 pm, the flood had broken through the main deflection embankment about 600 metres from the eastern end of the stone dam: From a narrow beginning this breach eventually widened until a gap of 300 metres had been made in the embankment, through which water poured down into the old wadi bed alongside the old walled city.

55 At 12 pm farmers noticed damage beginning to the stonework of the eastern abutment of the stone dam (several days before Professor Heyman and I, in the course of a survey, had noted that this eastern abutment had lost some of its stonework and needed urgent repair). At the same time the level of the water began to rise to the top of the embankment about 100 metres to the east of the stone abutment. Within half an hour the water had broken its way through at both places and within a few minutes more there was a second breach in the embankment about 150 metres long, from the circular stone termination pier at the eastern end of

the stone dam to the point where the second breach in the embankment had occurred. The whole of the eastern stern abutment was completely washed away, stonework totalling in length about 8 metres and in height about 5 metres. At the same time (that is about 12.30 pm) a considerable part of the stonework of the western abutment was damaged. This comprised mainly the upper part of the stonework where there had once been a spillway, together with the stonework on either side of it.

56 Also at about 12.30 pm the top courses of the main dam wall were pushed off in two places: in the centre, the top 80 cms was destroyed in sections totalling about 4 metres long. In the eastern quarter of the main dam wall, even more damaged to the stonework was caused, extending down about 1 metre to 1.20 metres from the top over a length of about 8 metres.

57 With the breaking of the eastern abutment down to ground level, a great deal of the water further east which had already passed the dam was observed to flow back and join the waters in the wadi bed which were flooding past the old city.

58 Meanwhile a third main breach in the embankment occurred about halfway along towards Shibām (between 2 kilometres and 2½ kilometres). This breach was only about 30 metres wide, but it allowed water to flow into the date plantations on the western side of the city. Slightly nearer the dam there was damage to the top of the embankment, and another breach had clearly begun to form when the waters subsided.

59 Inhabitants of the old city observed that the breaking of the embankment may have been fortunate, because the distribution channels are so silted that, had the embankment not broken, the water would have been up to the lower levels of the old city wall on the northern side.

60 As the embankment broke, the waters rose to a higher level on the Sihail side.

61 Comparison of this flood with other earlier floods shows that the great flood which occurred early in 1978 and this one were of the same size. In both cases water came from one wadi, and in both cases some damage was done to houses in the three villages near the dam. These three villages have requested that embankments to a level higher than that of the stone dam should be built around them to protect them from future floods.

62 This flood and that of 1978 were caused by waters coming essentially from one of the big wadis above Shibām. There are, in fact, four wadis which might disgorge water onto the old city should a future rainfall extend over a wider area; the inhabitants are particularl concerned at the possibility that rainfall over the Wadi Do^{c}ān and the Wadi Sarr might occur at the same time, in which case a much greater flood of water would descend at the same moment on the dam and the old city. This happened 50 years ago, when the village behind the dam was destroyed, but not the dam. At that time, the volume of water which could be acommodated behind the dam was 2 metres deeper it has since silted up.

4.2 The Urgency of Immediate Repairs to Protect the Old City

63 Within three days of the breaking of the dam and its embankments, the Governor of Saiwūn had given his permission for the use of a bull-dozer from the Wadi Ḥadramawt Agricultural Project to effect repairs to the broken embankments. Because of the scale of the damage, however, it is expected that even the rapid piling up of earth to form a new embankment will take several months. The cost of this work will be

jointly borne by the Governorate and the agricultural co-operative. It is estimated that the cost will be YD 2,000.

64 It is hoped that stone masons will also be quickly instructed to reconstruct the damaged shoulders and repair the broken lip of the stone dam.

4.3 Strategy for the Study and Improvement of the Dam and Distribution System at Muza[c]

65 The present construction of the embankment is done by simply piling up the earth without compacting it. This allows water to penetrate easily into the loose earth construction of the embankment and dissolve it; hence the embankment collapses from below upwards.

66 It is essential to compact the embankment, as it is built up, to protect it from this undermining and also to protect the surface from erosion by the strength of the current. To achieve this, the embankment should be built in a series of layers each about 1 metre deep, and each compacted by the use of heavy rollers before the next layer is moved into place.

67 Filling the gaps in the embankment by piling up earth involves only 10,000 cubic metres of material costing approximately YD 2,000. The cost of replacing the whole of the embankment with a compacted construction to a total of 6½ kilometres in length (130,000 cubic metres of material) would cost approximately YD 90,000.

68 While compacting protects against undermining and erosion, such an embankment would be better protected against both rodents and against the strength of the current if it were faced with stone on the upper side, the stonework being grouted with lime mortar with an ash catalyst.

(This is preferred to cement as it is less likely to crack in the extreme conditions of expansion and contraction due to diurnal fluctuations in temperatures.) This additional stone facing would cost YD 67,000 per kilometer. If the facing extended for 3 kilometres on the north-west side and one kilometre on the south-east side the total would be YD 268,000.

69 A very rough estimate for the total cost of improving the dam and its embankment so that it is less likely to be broken by future floods is therefore YD 358,000. This does not include the cost of providing protection embankments around the three villages near the dam, nor of any extra work which might be necessary should the revised design of the dam indicate that the stone work or the embankments need to be raised - which seems quite likely.

70 As the expenditure envisaged in upgrading the dam is clearly quite considerable, it seems unwise to proceed with it without a careful study of the whole system of damming and distribution of the water. Such a study can only be undertaken after a complete and accurate survey of the dam site has been prepared. The survey would require a qualified land surveyor and four chain men to spend a month in the field and a further month in preparation of the drawings. It is hoped that the agricultural department will provide the land surveyor and his team together with the use of a vehicle to prepare the necessary survey. Once the survey is completely ready, it would take a dam construction engineer two months on the site to reconsider the functioning and height of the dam and distribution system.

71 The reconsideration of the dam and its embankments will necessitate the services of a consultant, preferably one obtained from the FAO for two months. It is intended that he should be brought in as soon as the survey is complete and that his task description should be "the

improvement of the protection of the old walled city of Shibām against flooding, together with the protection of the neighbouring villages, and the development of the spate system in the area".

5. THE STUDY OF CONSTRUCTION TECHNIQUES

72 The examination of the foundations, and the discussions with the builders on the techniques they used to strengthen the earth construction, which include the use of such materials as animal dung and salt, and the addition of salt to the earth-straw mixture, indicate that it is important to study the chemical composition of the building materials in Shibām, particularly as this may affect their life and long term strength. It is therefore planned to bring an expert on the analysis of building materials as soon as possible (as proposed in the campaign report No.1 of September 1981, paragraphs 151 and 141). At the same time the possibility of controlling insect attack on wood will be investigated (as outlined in the same report paragraphs 150 and 141).

73 It is an essential item of policy in the conservation of the old city of Shibām that the original techniques of construction executed by builders trained in the traditional ways shall be used as much as possible. Any traditional techniques of construction will be modified only after careful consultation with expert technical consultants. Modern techniques will be avoided unless they have been definitely found superior to traditional techniques, and are consciously accepted by agreement of all concerned as a reasonable part of project policy.

6. THE ARCHAEOLOGICAL PROGRAMME IN SHIBĀM

74 As the historic city of Shibām is thought to have been in existence from at least the second century AD, and possibly from a much earlier date, a part of the campaign must be to trace and reveal the extent and nature of this history.

75 The existence in the Fitzwilliam Museum in Cambridge, England, of a splendid bronze lion's head from Gabusa, 3 kilometres away to the north-east of the old city, and the known existence of great stone foundations in Jujah, about 3 kilometres to the north-west, indicate that these two sites are likely to contain major archaeological evidence of the history of the ancient city, which should be investigated archaeologically.

76 At the same time, investigation of the high mound on which the old walled city is built must not be neglected. It is tentatively proposed that excavations should take place, in the form of trial trenches, in the centre of the Maydan in front of the Great Mosque and also in other open spaces in the city, including sites which have been cleared ready for the reconstruction of houses.

77 In addition, all contracts for excavation within the old city, for whatever purpose, should include a clause requiring the presence of a practical archaeologist during the excavation, and requiring the contractor to provide additional trial trenches and rescue services when these are archaeologically necessary.

78 This archaeological work will be given a special funding, which is included in the modified programme of work (paragraph 136).

7. IMPLEMENTATION STRATEGY

7.1 Immediate Implementation

79 There is a need for an executive immediately in Shibām to administer and supervise the funds made available for buildings by the Government of Yemen. This executive should be either an architect or a man experienced in supervising practical building matters and handling the instruction, inspection and payment of building workers. He should be given the power to determine the extent of the works necessary on each building, their cost and a reasonable standard which must be achieved by the building workers. This official must reside in Shibām or within a short distance of it so that he can be in a daily attendance in the old city.

7.2 Structure for the Implementation of the International Campaign when Funds are Available

80 The desirability is suggested of having a Yemeni executive President or executive Director of the project, who would be coordinator of the administrative work of the project manager and the practical work of the technical director and his staff. Such a man would be appointed by the High Committee to live in the Wādī Ḥaḍramawt, preferably in Shibām, and act as the figurehead of the execution of the campaign within Yemen. It is suggested that he should be one of the leading citizens of the Republic, widely respected in his own right, so that his personal kudos and reputation for personal integrity would put everyone in the country behind the project.

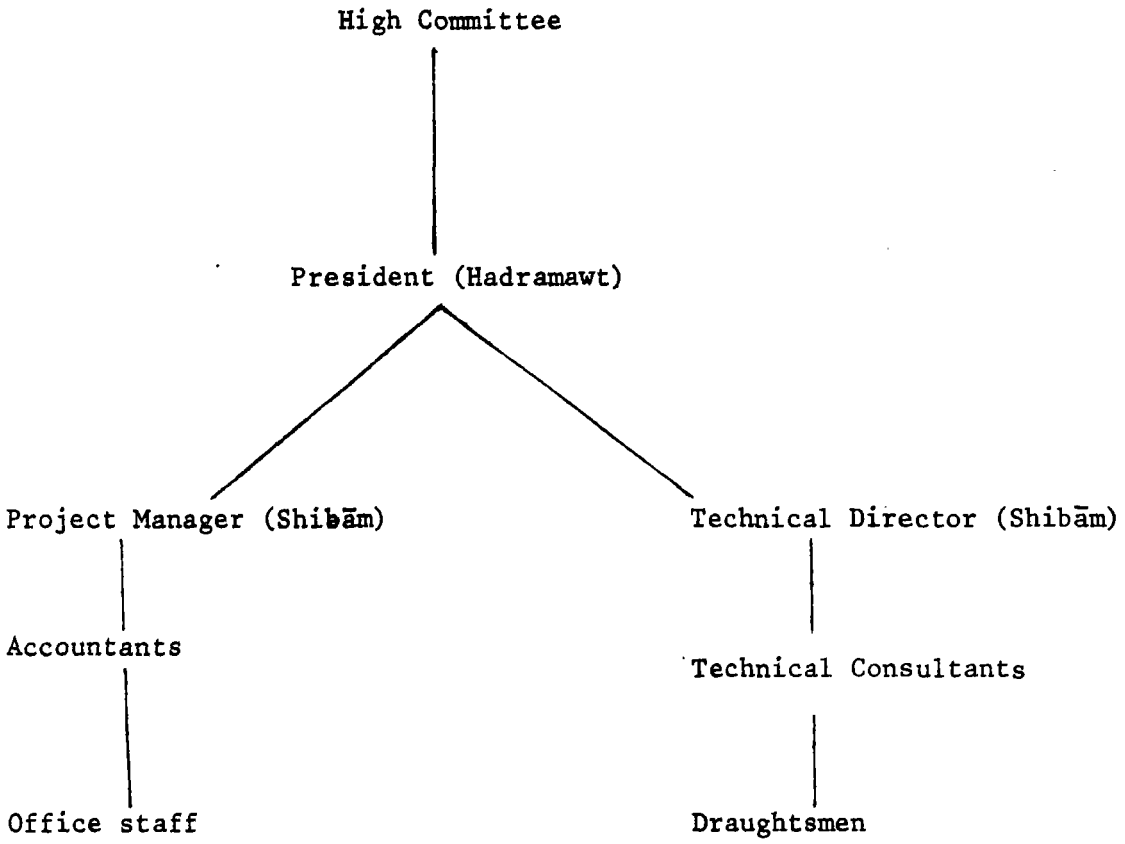
High Committee
President (Hadramawt)
Project Manager (Shibām)
Technical Director (Shibām)
Accountants
Technical Consultants
Office staff
Draughtsmen

Figure 1

81 Figure 1 shows the proposed relationship between the High Committee, the President and the two branches of the executive - the Project Manager and his administrative and accounting staff on the one hand, and the Technical Director and his advisers and consultants who sit on the technical sub-committee on the other.

82 The Technical Director must be an architect with considerable expertise and experience in the problems of conservation and of urban rehabilitation. It is hoped that a Yemeni of sufficient calibre and experience who is enthusiastic to take on this task can be found - if not, he would have to be an ex-patriate. The Technical Director should be appointed as soon as funds from the International Campaign begin to be available.

83 A civil engineer consultant to the technical advisory team will have to be a highly experienced civil engineer in daily practice in design work of a general and unusual sort; he will work in Shibām at least four times a year, in the first instance for a month and subsequently for visits of 2-3 weeks. During each visit this civil engineer consultant will be able to consult on five of the houses which need major strengthening or partial reconstruction.

84 The remainder of the technical advisory subcommittee will be composed of those consultants who are able to attend the meetings, together with their Yemeni counterparts and all members of technical ministries who are involved in the campaign.

8. ADVERTISING FOR THE TECHNICAL DIRECTOR AND THE ENGINEERING CONSULTANT

85 It is to be anticipated that men of the calibre who would be needed for the work of Technical Director and the Engineering Consultant may need some notice before they can transfer from their present work to work in Shibām. For this reason it is suggested that these posts be advertised as soon as funds from the International Campaign begin to be available.

86 It is suggested that, in the case of appointments overseas, prospective candidates should first be reviewed by a committee in Paris and that a short list of three candidates in each category should be returned to the Government of the Republic for the final selection.

9. MODIFIED PROGRAMME OF WORK

87 Note: Estimates of cost in Yemeni Dinars are indicated by the figures on the right hand side. Pending the completion of the technical studies, many of these figures are only tentative. Similarly, the programme of works and their scope is still provisional. In some cases estimates have not yet been made, either because these are difficult to do at this stage, or because it is uncertain whether this aspect of the plan will actually be included in the long-term programme. It is intended to devote the latter part of 1982 to finalizing the programme and to determining the final cost.

4.A PROGRAMME: 1982

88 I. Emergency Work on Shibām: State 1 March-April 1982

89 1. Detailed structural survey and analysis of all dangerous houses, recommending either:

(a) Temporary abandonment;

(b) Method of repair and strengthening, if possible;

(c) Demolition, if it is not possible to repair. In this case the windows and doors of old facades and any other recoverable parts of the best houses will be taken out before demolition, and stored, ready for rebuilding into the reconstructed houses.

90 2. Temporary repairs to Muza^{c} Dam and its embankments ± YD 4,000

91 II. Emergency Work on Shibām: Stage 2 April-June 1982

92 1. Immediate repairs to prevent damage by rain, to be executed:

(a) By Ministries of Housing and Construction

(b) By private owners

93 2. Fix water pipes on houses and in streets, where they are loose.

94 3. Demolition of houses recommended in I.1(c) above.(See paras.38-41)

95 4. Replastering roofs of houses and government building with ramad, where necessary.

96 5. Replastering plinths of houses and government buildings with ramad, where necessary.

97 6. Repairing open drains with ramad.

98 7. Repairing underground drains where leaks can be established.

99 8. Replastering walls of houses and government buildings with earth/straw plaster. (Tentative rough estimate of items 1 to 5: YD: 100,000)

100 9. Temporary repair of walls of old city YD. 100,000

101 III. Technical studies for the long-term programme. March onwards 1982

102 1. Studies by technical consultants

(a) Structural problems in houses, city wall and Muza^{c} Dam.

103 (b) Improvement of building technology to reduce maintenance.

104 (c) Greatly improved permanent drainage for sewerage water and storm water, plus treatment and disposal plants.

105 (d) Underground wiring for electricity, telephones and TV aerial (communal).

106 (e) Sanitation - possible range of techniques for improving the hygiene of the traditional "long-drop" lavatories and vertical drainage

of the houses in the old city, without markedly changing their appearance externally or ruining the houses internally.

107 (f) Conservation of buildings.

108 (g) Provision of emergency services: fire, ambulance, maintenance, etc.

109 (h) Vehicular circulation and parking, together with overall town planning, relating the old walled city to Sihail and the surrounding areas.

110 (i) Provision of tourist facilities.

111 (j) Revival of traditional hand crafts.

112 (k) Effect of changes on the life and expectations of the people (socio-cultural studies)

113 (l) Provision of museums illustrating the uses of the buildings and all aspects of the way of life of the people and the city.

114 2. Coordination of the technical studies by the echnical oordinator in consultation with the Yemeni technical counterparts, the High Committee for assisting the International Campaign, and UNESCO Headquarters, leading to the preparation of stimates and a phased long-term program.

IV. Preparation for the International Fund-raising Campaign

115 1. Application by the PDRY government for placement of Shibām and the Wādī Ḥadramawt on the World Heritage List (December 1981).

116 2. Application by the PDRY government to UNESCO for the International Appeal to the launched, based on a technical report (submitted to Paris 28 February 1982).

117 3. Preparation by UNESCO of a book containing accurate historial and factual information on Shibām, and illustrating its character and importance. At the same time, a companion brochure and a film will be prepared. These are intended for distribution in the PDRY and to all member countries of the United Nations.

118 4. Preparation by the PDRY govenment of a series of TV films on Shibām and the campaign in the Wādī Ḥadramawt. It is intended that these will be shown in the PDRY to awaken interest and to maintain information, and also that they will be shown on loan, to help the campaign.

119 5. Preparation of attractive posters, postcards, tourist guides, and maps of Shibām and the Ḥadramawt. These will be distributed to Yemeni embassies and foreign governments, and also sold in the PDRY.

120 6. Issue of a special series of postage stamps to mark the launching of the International Campaign and publicize it world-wide.

4.B LONG-TERM PROGRAMME

121 (Note: Estimates of the time are provisional pending specialist technical reports which will begin to be received in April 1982).

I. Shibām Conservation

Phase 1 1982-83

122 1. Installation of underground services in one coordinated operation: sewerage drains, storm water drains, water supply, electricity, telephone and TV aerial wiring. (Estimated 9 months). YD 2 million

123 2. Construction of a stronger, permanent city wall. (Estimated 12 months) YD 1½ million

124 3. Strengthening to a lasting condition of Muza^{c} Dam and embankments. (Estimated 21 months) YD ¾ million

125 4. Installation of sewerage disposal system for each house. (Estimated 6 months) YD ¾ million

126 5. Conservation of the most seriously damaged buildings, demolition and reconstruction as necessary. (Estimated 18 months) YD 1.125 million

127 6. Rebuilding of demolished houses, barracks on the corners of the city wall, and the Mosque of Hara. YD 1.875 million

Phase 2 1983-85

128 1. Provision of improvements in amenities and services:

129 (a) parking areas YD ¼ million

130 (b) public buildings, markets, schools, clinic, etc. YD 1 million

131 (c) provision of emergency services for firefighting, access by ambulances, etc. YD ½ million

132 2. Provision of tourist amenities:

133 (a) Revival of traditional handcrafts within the city YD 100,000

134 (b) Establishment of tourist shops and guide services YD 100,000

135 (c) Establishment of "old house" museums allowing visitors to see the traditional

way of life, furnishing and utensils within several houses of different types YD 250,000

(d) Design and construction of a luxury hotel.

136 3. Archaeological investigation of the site of Shibām (at Jujah, Gabusa, and within the old city) YD 250,000.

137 II. Wādī Hadramawt

Phase 1 1982-84

138 1. Protection of major archaeological sites:

(a) From flooding: by construction of deflection dams where necessary for Mashgha, Sūnah and Raybūn. YD 2.5 million

139 (b) From pillage or vandalization: by surrounding the sites with fences and/or introducing 24 hour guarding. YD 500,000

140 (c) From the weather: by conservation of the exposed buildings. YD 500,000

Phase 2 1983-85

141 1. Presentation of archaeological sites to the public: by beautifying them with planting, arranging parking areas, routes through the sites and facilities for guide services. YD 500,000

142 2. Presentation of historic Islamic sites to the public. YD 500,000

143 3. Construction and arrangement of a new museum at Saiwūn and the provision of new manuscript facilities at Tarim. YD 3 million

144 4. Construction of historic buildings and selected urban areas throughout the wadi. YD 1½ million

145 5. Revival of crafts and cultural activities including dance and music. YD 500,000

146 6. Construction of a Centre for Art and Culture YD 1½ million

147 A tentative total estimate, allowing ± 4 years of inflation, would therefore seem to be in the region of YD 25-30 million. It should be pointed out, however, that this figure will vary according to the tasks finally fixed upon as part of the Campaign.

10. AN OUTLINE POLICY FOR THE FUTURE OF THE OLD CITY OF SHIBĀM

148 In an earlier report (Report 1 on the Campaign, September 1981, section 36, paragraphs 122-127, 137-139) discussion of the conservation of Shibām included brief comments of a number of points of policy which had determined strategy. These may be summarized as follows:

149 1. The whole of the city within the walls operates as a single organic unit — and cannot be subdivided for conservation purposes.

150 2. Sihail, the outlying suburb of Shibām across the wadi, which will not form part of the conservation scheme, permits the retention of a wholly fluid and changeable situation for those who prefer it. The authorities are convinced that the number of people who would like to live in old Shibām far exceeds the accommodation. It must be one of the intentions of the conservation policy that this desirability of the old city as a place of residence should be preserved far into the future.

151 3. There should be a buffer zone of date plantations and unbuilt wadi bed around the old city, so that unspoilt views of it from a distance are preserved.

152 4. Buildings already erected in the wadi, outside of the city wall but close to it, must be reduced in height to no more than two storeys, so that they do not block views of the top of the city wall and the tower houses behind. The removal altogether of every building is not considered desirable, as,if they were kept low, a few of such buildings would set off the height of the houses behind. By providing scale in the foreground they would greatly accentuate the visual drama of the cliff of houses rising behind and above them, a striking effect which would be lost if they were removed.

153 5. Height restrictions should be imposed around the old city - in Sihail, lower than the rooftops of the old city (20 m is suggested). Elsewhere, low enough to keep open and unspoilt the distant views of the city from the main roads to the east and west.

154 6. The original external appearance of the houses within the walled city should be maintained. Where alterations are desired, these will only be permitted after approval by the advisory staff of the conservation agency. There is precedent for this policy in the customary laws of Shibām, going back,it is said,for 500 years. (Even if the owner wished to rebuild his house, he was not permitted to build according to a new plan or height, and had to replace windows and doors in exactly the same positions.)

155 7. Generally, the interiors of the houses may be altered as much as the owners desire. Only in the case of a few houses designated as museums for total preservation, or if the exterior is likely to be affected, would special permission have to be obtained.

156 8. Conservation of private houses will be achieved by grants-in-aid to the owners and/or tenants for the execution of specific works, to be supervised jointly by the owners and the conservation agency. Government-owned houses will, however, be conserved directly by the conservation agency.

157 9. Repairs or improvements to the interiors will be made at the discretion and the expense of the owners, except where they affect the main structure, the exterior or the ablution system of the houses. If any of the latter is to be affected the owners will have to obtain permission from the conservation agency, who may decide that, if the works are permitted, it will pay part of the expense.

158 10. The preservation of the daily life of the people is an essential aim of the campaign. Every effort will be made to work in close harmony with the community leaders in order to maintain the vital spirit of the community - who must not feel penalized because they are living in a conservation zone. For this reason, all applications to permit change of use or modification will be given the most sympathetic attention.

159 In order to clarify the policy of the campaign still further it may be necessary to consider the effects of tourism on the population and the old city.

160 In the first place, any gross commercialism or exploitation would be totally alien to the spirit of conservation.

161 As much as possible, tourist hotels, tourist shops, vehicular parks and tourist restaurants should be kept hidden, preferably away from the old city.

In detail it is proposed that:

162 1. The first tourist hotel might be built near the new school in the date groves on the southern side of the main road to the east of Sihail.

163 2. The first tourist shops and guide service bureaux should be built behind the arcades between the inner and outer gates of the old city.

164 3. The first tourist restaurant, serving coffee, tea, cold drinks and other light refreshments should be situated on the top floor of the new palace within the wall of the old city, above the rooms now occupied by the Deputy Ma^{c}mur's office and archives.

165 4. Tourist buses and tourist cars should be parked in a car park to the east of that palace, outside of the walls and hidden within the

date plantations. From thence a small staircase leads up through the walls between the hospital and the school, which provides easy access to the open square within the gate.

166 Further issues of policy concern other aspects of the future life of the inhabitants of the old city:

167 (a) Animals It is intended that the traditional way of life of the people, which is still practised in the city, should be allowed to persist with as little interference as possible, and to evolve with time in a natural way.

168 The traditional pattern of use of the houses provides accommodation for animals within the houses on the ground, and sometimes the first, floor. But these animals were not allowed, until recently, to remain in the streets of the houses during the day; they were collected soon after dawn by two herders appointed by the city government for the purpose, and herded out of the town into the surrounding fields, where they grazed until dusk. The large numbers of animals being driven in through the city gates in a cloud of dust at sunset, and distributed house by house back to their owner by coded knocking at each house door, used to be one of the sights of Shibām. The revival of this practice, by the simple expedient of hiring two herders again, would free the city of one of the causes of deterioration of the buildings: the accumulation of animal dung and urine in the clay of the city streets.

169 (b) Private car ownership and parking It is reasonable to assume a gradual increase in car ownership among people residing in the old city. Parking areas would be provided among the date palms to the north and west of the old city wall, in addition to that already provided (above) on the eastern side. Direct access from

the car park up staircases and through the city wall would ensure that the maximum distance of pedestrian travel from car to house would be about 150 metres.

170 (c) Access by emergency vehicles and service vehicles While private car access into the narrow streets of Shibām would be prohibited, access of ambulance, firefighting and public utility services (garbage collection, electricity repairs, telephone maintenance, water supply and sewerage engineers) would be facilitated by the provision of narrow vehicles for each service. Delivery vehicles for the sūq would likewise be achieved by a fleet of small, narrow minitrucks. These would be allowed access from 6 am to 8 am and from 6.30 pm to 8 pm.

171 (d) Instilling new life into the city As part of the conservation programme the opportunity should be taken to explore ways of revitalizing the economy of the old city, through the development of trade, craft and home industry activities, and efficient merchandising of the products thus created. Social and cultural life should likewise be stimulated by the provision of adult education facilities and social organizations.

172 The campaign might take as one of its targets the growth of a sense of participation of all the people of the country in a national cultural identity, symbolized by Shibām. At the same time, it could help to generate an awareness at an international level of the historical and cultural significance of Shibām and the Wādī, and to encourage mutual appreciation between widely differing cultures.

PART B - by Jacques Heyman

Introduction

In his reports on Shibam and Wadi Hadramawt*, Dr. Ronald Lewcock made a study of the architectural heritage of the medieval city of Shibam, and also recommended the appointment of a civil engineer to investigate in more detail the structural problems encountered in the city, and this present report presents my findings following a stay in Shibam for a period of a week at the end of March 1982.

Dr Lewcock was present during my visit, and we were accompanied by Mr. Abdullah al-Mallahi, the Director of the Department of Museums and Archaeological Sites of the Yemeni Centre for Cultural Research, and also by the Director of the YCCR branch in Mukalla, now in charge of coordination of the intended work at Shibam, Mr Omar al-Aidroos, and by an interpreter.

A description and brief history of Shibam is given in Dr Lewcock's first report, and details will not be repeated here. The walled city stands on a small elevation in a flood plain, the Wadi Hadramaut, and can be seen to be in various stages of disrepair. The building materials used in the city, both for the walls and the houses, are wood (used sparingly), stone (also used sparingly), and above all unbaked clay bricks reinforced with straw. A clay/straw plaster is used to obtain smooth surfaces, and waterproofing is provided by the application of "ramad" plaster (a mixture of lime and wood ash).

A "mud architecture" of this sort may seem at a first consideration to be dangerously insecure, particularly in view of the fact that very many of the houses have five storeys, some have six or seven, and at least one has eight. In fact the construction is massive. The main stresses in the material arise from self-weight, contributions from wind loading being very small. The bricks of dried mud have a large natural compressive strength, and there is no danger that they will crush under their own weight at a height of building less than 30 m. Indeed, the reserve of strength at this level is

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* Report No. 1, Serial No. FMR/CLT/CH/81/306, Unesco, Paris, 1982
Report No. 2, Serial No. FMR/CLT/CH/82/114, Unesco, Paris, 1982

large, and it can be estimated more precisely, if necessary, when the results of tests being made at the request of Dr Lewcock are available. However, as will be noted below, the precise reserve is not relevant in the assessment of the safety of the structures at Shibam; this assessment results from the study of other factors. (In confirmation of this general statement, I saw no trace in any of the buildings of any failure which could be attributed to overloading of the material.)

The mud architecture of the Yemen is in this sense strictly comparable with Western medieval architecture, in which the building material is stone. The same techniques of analysis can be used to such lowly-stressed material, and the same principles applied. Modern structural theory will dictate that individual elements must not be too "slender", or buckling (of a column, or of a complete wall) will occur; it is difficult, in Shibam as in a Gothic cathedral, to find any such dangerous elements. The only other requirement reduces to the idea that the building as a whole is of the right geometrical shape, so that forces may be accommodated comfortably within the thickness of the material.

The geometry at Shibam is particularly simple, since the arch form is virtually non-existent; there are some timid pointed openings in walls, but windows and doors are provided with wooden lintels. (The arch was of course used in Shibam, notably in mosques, but occurs only in the main gate in the buildings studied.) In its simplest form, then, the structural requirement for a house at Shibam is that the walls should provide adequate vertical paths for the self-weight of the house to be carried comfortably to the ground.

The mud bricks are, as has been stated, very strong as far as their crushing strength is concerned, but the material of the walls is weak in tension. This implies that cracking is likely to occur, and indeed will occur in response to shrinkage, temperature changes, small movements of foundations, and so on. The mere existence of such cracks is no sign of immediate danger, but merely an indication that the structure has responded to some external action. Provided that the movement has been "once-for-all", then simple measures can be taken to restore the visual integrity of the structure. Correspondingly, if the structure is in continuous movement, then no good will be done by repairing individual cracks, and the building must be viewed with concern.

These general precepts will be illustrated below by specific recommendations for some of the houses at Shibam. However, if the material is adequately strong,

and cracks are in themselves not alarming, then the question must be asked as to the cause of the observed defects in the buildings. The prime answer to this question has been identified by Dr Lewcock; it is the action, in one form or another, of water. It is obvious that in a building made of dried mud, the roof must be protected from rain, the walls from internal saturation with water, and the foundations from leakage: if such protection is not afforded, the dried mud will revert to natural mud of little structural strength.

The tall houses of Shibam

Dr Lewcock has listed 45 houses which require more or less urgent attention; these are given, with a location map, in his Supplementary Report. Twenty of these houses are studied in the Appendix to this present report. The comments result from my inspection of these particular houses, but the pathology of the remainder is expected to give rise to no recommendations of a type different from those in the Appendix, since the defects seem to fall into well-defined groups.

The old builders at Shibam had given Dr Lewcock, and gave us again, details of the construction of the houses. For the foundations, the ground was dug to a depth sufficient to find "firm" material. (To confirm these descriptions, we made three excavations adjacent to existing walls of (collapsed) old houses. The overlying material seemed in all three cases to be of made ground of poor load-bearing quality, and it was not until a depth of up to 2 m that relatively undisturbed soil was found. Such a depth accords with general ideas deduced from the talks with the builders.) At the bottom of the excavation was placed first a layer of animal droppings, covered with a layer of salt. On this "blinding course" was then placed, parallel to the walls, timbers of perhaps 100 mm diameter, with interstices packed with stones, and this preliminary work was finished with a layer of ramad (the waterproof mixture of lime and woodash).

On this footing was then constructed a masonry wall of stones in ramad mortar, of width perhaps 600 or 700 mm, and this was carried up to street level to finish the foundation work. However, the masonry was also provided with battered masonry surfaces, so that the width at the street, say 700 mm, is broadened out to perhaps 2 m at the foot of the excavation. The back-filled foundation would thus show stone strip footings of 700 mm at street level, but the work below ground could be much more massive. Such a foundation was exposed by one of the trial excavations (although we did not undercut the footing to try to find the timber and blinding layer). It must

be said, however, that the two other excavations revealed no masonry below ground; the mud walls were apparently carried straight into the ground with no further foundation. No firm conclusions can be drawn from the evidence of a mere three holes, but it is certain that not all of the houses were provided with the foundations described by the builders.

The mud bricks are placed in position with a "mortar" of the same material, that is, clay and straw, so that, when dry, the walls of a house are more or less homogeneous. Further, as already noted, the surfaces are plastered, also with the same material. There is some evidence of occasional reinforcement of the walls by the insertion of lengths of unsquared timber running parallel to the surface. These strong external walls form one of the structural elements of a house; the other is provided by the more or less central massive stair well, again constructed from the clay bricks. The bricks themselves vary in size, but batches seem to be standardized; large bricks could measure 450 × 300 × 60 mm, but some are as small as 200 × 200 mm.

The ceilings in each room are formed by the floor of the next storey. In the larger rooms one or two timber baulks are supported each on one or two timber columns, depending on the overall dimensions of a particular room, and this construction may be repeated through several storeys. Between the timber baulks, and between the baulks and the walls, small squared or unsquared timbers, closely spaced, carry the clay floors. Thus, in general, the bending action of the floors is absorbed in the timbers, and vertical loads only are imposed on the walls and central stair.

The walls are reduced in thickness as the building rises; the internal dimensions seem to be held constant, so that the external profile tapers slightly from ground to roof. There is no difficulty here with a single house, but the buildings are accretive, a new house often being started by leaning against its neighbour, so that a small (and irregular) "terrace" results. If the added house is built true, then the taper will lead to a wedge-shaped gap between it and its existing neighbour, and such rain traps were clearly avoided as far as possible by the builders. If, however, the wedge is eliminated, then the added house will have an unsymmetrical lean against its neighbour, and such houses can indeed by found in Shibam. There is no structural worry in such an inclination, but the visual effect is disconcerting.

The houses are terminated by flat roofs surrounded by parapet walls, forming terraces. These terraces and parapets are waterproofed by the

application of ramad plaster; the same material is used to waterproof the lowest storey, at street level, against splashing. Special precautions are also taken to waterproof those areas affected by the discharge of sewage from the houses. Excrement collected in the "long-drop" lavatories, and liquid wastes (which may be discharged from any storey of a house) collect (with some splashing) in open sewers. For houses round the walls, the sewers usually pass through the walls, and the sewage is dispersed into the ground round the outside of the city; for internal houses, the sewage goes into the ground, presumably to be dispersed to cesspits.

It should be mentioned that at the present time there are large numbers of sheep, goats and hens permanently in the streets, together with some donkeys and camels; rats are also evident. There is thus a subsidiary problem of animal excrement to supplement the (worse?) human problem.

Dr. Lewcock has noted in his report, Serial No.FMR/CLT/CH/81/306, some of the main causes of the deterioration of houses. A first group of defects arises from poor maintenance of the external surfaces. The clay/straw plaster over the main portion of the external walls apparently has a life of 25 to 30 years, and after this must be renewed if the main walls are to be protected adequately. It is evident that this maintenance work is not being carried out as it should, and many of the houses show large areas where the plaster has fallen away, exposing the underlying wall.

Similarly, the ramad waterproofing to the parapets and roofs, to the dado at street level, and to the splash surfaces for sewage, has a life of about 50 years. Again, the ramad is not being renewed as it should. At roof level water is entering the walls and penetrating downwards, leading to vertical fissures in the walls, cracking near beams, cracking in floors, and so on, and these cracks appear to spread steadily down the house with the passage of time. The deterioration of the ramad at ground level leads to penetration of the walls by rain water.

Most importantly, failure of the sealing of the sewage system can lead to penetration of the foundations by liquid effluent. The foundations are particularly vulnerable also to the main-water supply introduced fairly recently into the city. The distribution pipes lie only just below street surface (and in some cases are only half buried); a leaking joint in the system can lead to severe penetration by water of the foundations.

Either leaking sewage or leaking mains water is clearly the cause of a number of major defects in some of the houses in Shibam. A corner of a

house may be seen to have moved by a few centimetres; at is has dropped away, severe cracking has developed in the lower storeys. (In some cases, timber or steel buttressing has been used to prop such a decayed corner, either as a permanent "cure" or pending more extensive rebuilding.) In other instances of houses backing on to the walls of the city, the entire back of a house may have dropped, and several houses have "broken their backs", with the front part separated from the back by cracks running up the full height of the house.

In all these cases of settlement, it is very likely that the penetration of water into the foundations (particularly those jerry-built foundations with little or no stone) has caused such a weakening of the material that the weight of the house can no longer be supported locally, and local settlement has ensued. The bursting of a water main may be regarded as accidental (but clearly the distribution system needs overhaul), but the penetration of sewage can be prevented quite easily; it is not being prevented as it should.

A first priority, then, and indeed a first requirement before any major maintenance work is carried out, is to make sure that the causes of deterioration are removed; traditional methods of upkeep of the houses must be restored. (At the moment there is every indication that almost nothing is being done to stop the general decay; it may be difficult, for one reason or another, to overcome this collective inaction, but damage is now proceeding at a fast and accelerating rate. Unless maintenance is restored immediately, then it may be that in 10 years there will be little of Shibam worth saving.)

Once, however, the causes of deterioration are removed, then restoration of the houses is relatively simple, or at least straightforward. A first principle is that a slightly misshapen house is just as strong as one built true. If the distortion has been caused by one of the defects described above, but the movement has been arrested, then all that is necessary is to make good the defects. This is not in fact a question of pure cosmetics. The stuffing of a crack with new plaster (as has been done in some few cases) if of no use; it will simply crack again after a time. The crack must be rebuilt by widening it artificially until firm material is reached, and then a proper renovation of the wall must be made. This is well understood by the old builders in Shibam; I saw one crack being repaired in an ideal way, which included the provision of periodic short horizontal timber ties let into the wall.

For more extensive repair work, for example to the sunk corner of a house, again it must be ensured that the prime cause (as a leaking sewer)

has been removed. It may well be necessary to rebuild the whole corner, perhaps up to second floor level. In the west, a contractor would probably choose to "needle" the corner on props, and remove the entire wall, and it may be possible to do this also in Shibam. However, one at least of the old builders is prepared to renew the wall in about ½ m strips, including remedial work to the foundations, and seemed quite happy to contemplate such major rebuilding.

Structural work to the houses would seem to be confined to one or other of these main operations, namely the stitching of individual cracks, or the more extensive rebuilding of larger sections of wall, associated with renovation as necessary of associated foundations. Some few of the houses that I saw, already abandoned, must surely be demolished; of the others, some seemed to be incapable of repair in the above ways. When the work is put in hand, then detailed and precise decisions (which can of course be modified as the work proceeds) must be made for each individual house. At least £3 million will be spent on at least 45 houses, and the scale of the work is such to warrant the appointment of a structural engineer (preferably from a large established consulting firm) to make major decisions as a result of periodic visits to the site. This matter is referred to again in the final section of this report.

The city walls

The city is completely surrounded by a high defensive wall, about 4 m high (of course higher in places, and lower in others, to suit the uneven terrain). Behind the wall is a fill, seemingly largely of made ground, with a horizontal surface about 3 m above the foot of the wall and about 3 m wide. Thus the wall forms a parapet about 1 m high, or slightly more, for a person standing on the fill. It is possible to walk round the city behind the parapet, with the houses nearest the road forming the inner boundary of this walkway. As mentioned above, sewage from these houses splashes at their feet, and is collected in open drains and passed through the city wall.

The wall itself is in various states of repair. Parts have been renewed (some successfully, some not), while other, older parts seem in good condition. Parts, however, are in poor condition, and parts have collapsed. The materials of the wall are the same as those of the houses; the causes of distress are the same. In the case of the city wall, the main active agents causing deterioration seem to be leakage of sewage and, to some extent, storm water.

The north wall seems, at the moment, to be the soundest of the four. However, there was heavy rain on two or three days of my visit, and new initial cracks have appeared which would seem almost sure to lead to the collapse of about a 6 m section of the wall. Vertical cracks this distance apart have formed in the wall; they connect with a semicircular crack in the horizontal surface of the fill behind. When collapse occurs, something between a semi-cylinder and a semi-cone of the fill will fall away, and the support to the houses behind will be weakened. This type of failure has occurred in other places, but there are also other modes of collapse.

In one place the city wall (on the western side) has fallen, but the fill is in place, retained apparently by "wing" walls (at right angles to the city wall) running back from the city wall towards the houses. One of the old builders believes that the correct way to reconstruct the city wall is indeed to make it integral with a set of wing walls running back through the fill. Whether it was actually built in this way throughout is not known; certainly no wing walls are visible in some of the fallen portions. Further, there was clearly inadequate bond between the main wall and the wing walls in the portion described at the start of this paragraph.

However, the form of construction described by the old builder, if it could be carried out so that the city wall and the buttressing wing walls act together, should certainly give a strong overall structure, both to retain the fill, and to provide necessary support to the houses behind. There are other ways of designing the city wall, however, and a final decision must be made on grounds of economics, aesthetics, and practicability. A modern engineer would no doubt make use of reinforced concrete to build a strong and effective structure; what must be explored is the question of how far modern techniques can be incorporated in a new wall without doing violence to the traditional aspect of the city.

In the meantime, an estimate should be obtained for rebuilding the wall using local builders and existing techniques; such a design can then be compared, on a basis of cost and strength, with a "modern" alternative.

The design of the city wall cannot proceed in isolation. The wall and the terrace behind must provide support for the houses on the perimeter of the city, and provision must be made for the requirements of any new services that may be installed in Shibam. In particular, the design and construction of a new sewerage system must go hand in hand with that of the wall.

The Muza Dam

The Muza Dam was viewed on 28 March 1982, and again three days later; between these two visits a severe flood had caused considerable damage to the system.

The wadi is liable to such flooding after rain, and the natural channel for the water lies to the south side of Shibam. The Muza Dam was built some 450 years ago about 4 km above the city in an attempt to direct the flood waters, at least in part, to the north of Shibam. I do not fully understand either the intention or the operation of this diversion, and the comments in this section must be interpreted in a general way only. What is clear is that the system of flood control was due in any case for expert appraisal; the recent damage has now made the appraisal urgent.

The main dam, of stone, is perhaps ½ km or more long. When I first viewed the dam I formed the impression that the masonry was in good condition; there was some undercutting on the rear face of the dam, and some vegetation had rooted in the stones, but there was nothing requiring more than routine maintenance (which appeared to have been neglected in recent times).

The dam is about 4 or 5 m high on its rear side. However, successive floods have evidently deposited silt in the main bed of the wadi, and this level is now 2 or 3 m higher than the ground at the rear. There are indications in the stonework of the dam that it has been raised by about 1 m at some time in the past; presumably the accumulation of silt had rendered the dam less and less effective as a diversion of flood water. Similarly, there had at one time been a spillway (of something over a metre in height and a few metres long); this too, at some time in the past, had been blocked by raising the dam to its full height in this region (the additional masonry was much lighter than that in the main body of the dam).

The water diverted by the Muza dam was contained by an earth embankment (or bund) constructed between Muza and the city. Dr Lewcock notes in his Reports that these embankments had been causes of concern, and that it was feared that they might not be strong enough to contain a substantial flood; indeed, a scheme of masonry reinforcement for the bund had been proposed. In the event, the flood of 29/30 March destroyed substantial portions of the bund, releasing virtually the full flow of water to the south of the city, where it caused damage to the road and to some houses, just outside the city wall. In the largest breach, adjacent to the stone dam, about 200 m of the embankment was destroyed.

There was also damage to the stone dam itself, although this did not appear to be very widespread when viewed from the opposite bank of the flood

channel. The masonry blocking the spillway had been swept away, together with further small portions of the top of the dam in this area; further downstream there was similar damage to the top of the dam. At the end of the dam a deflecting spur was demolished, together with a wing wall at the rear.

Although this damage could not be closely inspected on 31 March, it would appear that the stone dam could be repaired without too much trouble. However, I do not know whether this would be the right course of action. The presence of the dam for more than four centuries has ensured that the bed of the wadi has steadily risen, and the degree of protection afforded to Shibam has diminished. In addition, two villages neighbouring the dam are now becoming more and more exposed to flooding, and may themselves require local protection.

The whole matter must now be studied in close detail by experts in the design of flood protection schemes. This study may well take some time, but there is an urgent need for temporary works to protect the undefended city of Shibam, which should be put in hand as soon as possible.

Summary and conclusions:

Dr. Lewcock has estimated in his Report No.2,Serial No.FMR/CLT/CH/82/114 that Phase 1 of the conservation of Shibam would cost about 7 million Yemeni dinars (over £ 10 million); this figure excludes work to the flood protection system. This last has now assumed such a major aspect that it should probably no longer be considered as part of the general conservation programme, but should be treated as a separate operation.

The estimate for the city itself includes the reconstruction of the city wall, the rehabilitation of the houses, the installation of a sewerage disposal system, and the installation of a variety of underground services. All of these works require very close coordination, and it will be essential to establish effective and continuous direction. It is not my intention in this report to suggest how this direction should be established, but I am concerned with the way in which technical decisions concerning the reconstruction of the wall and the rehabilitation of the houses may be implemented.

I recommended earlier that a structural engineer should be put in charge of work concerning the houses and the wall. He should make an initial visit to the site, and make decisions about a general strategy for repair of the wall, together with detailed advice for the restoration of

4 or 5 houses. Thereafter perhaps 4 or 5 houses should be restored every 3 months or so, and it will be necessary for the engineer to make short visits to Shibam to approve work already done and to plan for the next period of 3 months. Day to day decisions will have to be made, however, and this will require the presence of a junior engineer permanently stationed at Shibam. A possible arrangement for the technical direction of all the work at Shibam might therefore be to establish an office in the city for the duration of the campaign. The staffing of this office would consist of a technical director of the work (a very senior man, probably an architect, with full authority to make all the technical decisions regarding the wall, the houses, the sewerage system, and the services), the junior engineer referred to above (who would be responsible to the technical director for day to day engineering decisions), and one or two technically qualified assistants (who can take survey measurements, make drawings, and so on). It is only with the establishment of an office of this sort that the very large programme of work can be carried out effectively.

RECOMMENDATIONS:

The recommendations for conservation work at Shibam are therefore as follows:

1. A decision should be made about the administration of the work necessary to the Muza dam. This flood-protection scheme is likely to be on such a scale that it would be best to keep it separate from the work to the city itself.

2. The work at Shibam is also on a very large scale, and it will be necessary to consider how the work may be controlled. It is suggested that an office be set up in the city, with a senior technical director in overall charge, a junior engineer, and one or two technical assistants.

3. There is need for very close coordination of the rebuilding of the walls and the houses, the work on the installation of the services, and the creation of a new sewerage system.

4. A structural engineer should be appointed to make overal technical decisions regarding the rebuilding of the city wall and the rehabilitation of individual houses. He should probably continue to visit Shibam three or four times a year as the work proceeds.

5. The first priority in the rehabilitation of the houses must be to restart the traditional ways of maintaining the roofs and walls. There is evidence of severe neglect over the last decade, and deterioration of some of the houses is now proceeding very quickly. A further decade of such neglect will lead to the destruction of a large number of the existing houses.

In this connexion, it is certain that the introduction of a main-water supply has greatly increased the problems of maintenance. Much more water is now being used in the houses, with correspondingly greater discharge into the open sewers. These were not designed to take such large volumes of liquid effluent, and much consequent damage has occurred to both the houses and the city wall.

6. Once the decay has been arrested, then the steps outlined in this report (and in the Appendix) may be put in hand to remedy existing defects.

7. The decision should be made now to proceed at once with the conservation of Shibam. Any delay in making this decision will inevitably involve further widespread deterioration in the state of the city.

Appendix

Notes on some of the houses in Shibam in more or less urgent need of repair. The numbering of the houses is that given in Dr Lewcock's Supplementary Report; his plan is reproduced here as frontispiece.

1. The old "Sultan's Palace". An imposing building near the main square. It is in good structural condition. There is some small leakage from the roof, and some consequent small cracks need thorough attention. Ramad plaster needs renewal.

2. House abutting The Castle. Not seen in detail. Broken-backed. Treat as 3 and 6 below.

3. Houses 3 to 6 are on the east wall. House 3 has a broken back, due to settlement nearest the city wall. The city wall is in a bad state in this region. The cause of both the collapse of the wall and the broken back of the house is leaking sewage, or accumulation of storm water, or both. The causes must first be removed, and the fill behind the city wall made secure, before the house is tackled. Extensive rebuilding of the back part of the house will be required.

4,5. Similar to 3, but in a more advanced state of decay. Portions of the backs of these houses collapsed in Jan/Feb 1982, apparently in a high wind.

6. As 3.

7. The "fort" at the north-east corner. In an advanced state of decay, but safe.

13. A house in the centre of town. Sewage from several houses has penetrated under one corner, causing considerable settlement and extensive cracking. Sewage disposal must be dealt with. Corner can then be rebuilt.

14. This house was studied in detail in Dr Lewcock's Supplementary Report. A burst water main led to severe settlement of one corner of the house with consequent extensive cracking of the walls. The corner is now propped temporarily with three wooden shores, whose lower portions are encased in a continuous buttress of clay bricks; the shores are about 4 m long and the buttresses about 2 m high. From conversation with the builders it seems that the feet of the shores are founded on stone blocks, but they appear to bear only on small timber lintels over existing windows at their upper ends. Thus the shores are supporting only a relatively small portion of the weight of the house, and the crack patterns indicate that further settlement has occurred since they were inserted (? about 3 years ago).

Permanent remedial work will include the taking down and rebuilding of the corner of the house, up to 2 or 3 storeys as necessary. In addition, the settlement has caused the whole house to pull away from its neighbour to the west, and this separation crack must be made good to prevent penetration of water and further extensive damage. Further, the top of the house has been increasingly poorly maintained against the effects of rain.

This house is an example of one showing a combination of the major defects encountered at Shibam. It can be saved provided work is put in hand soon; delay of a year or two may make the house fit only for demolition.

20. This is an old house, cracked, not too badly, inside and out. There seems to be no immediate urgency. The drains and foundations must be attended to, and then the cracks stitched.

23. This is a broken-backed house on the south wall. As No. 3.

24. The main gate of Shibam, and one of the few examples of the arch in the buildings of Shibam. The double gateway is buttressed massively, and the heads of the arches are tied with timber. There are signs of some small movements, but there seems to be no structural worry. The whole is in need of maintenance and minor repair work.

26. This is a typical house on the north wall. There is settlement and cracking towards the back of the house, almost certainly caused by a cracked drainage system and consequent penetration of the foundations by water. It may be necessary to take down the whole of the back of the house, to make good the foundations, and then to rebuild.

29. An extensively cracked house on the south-west corner of the city. The outermost corner of the house has settled; the adjacent city walls are broken down; and there is a standing pool of water below the wall. There is evidence therefore of water, but there is no obvious immediate cause for the distress to the house. The corner should be taken down and rebuilt, and the work must be phased carefully with the rebuilding of the city wall and the installation of a main sewer.

33. A typical house on the south wall. There is damage in the basement at floor level, indicating that water may be rising from below; these basement cracks have been growing for five or ten years. (There are reported to be cracks due to rain at roof level - not examined.) Further and extensive examination of the house is needed before recommendations can be made.

35. A house at about the centre of the west wall. The rear of the house is falling away, and the house is broken-backed. The back should probably be taken down and rebuilt.

36. Adjacent to 35 with the same general pattern of behaviour. (The city wall was repaired in this area about 20 years ago.)

37. This house was not seen inside, but is clearly badly cracked on the exterior; it is leaning against its neighbour. The sewer drain seems to be blocked, with waste flowing down the street outside, and the sewer is perhaps also broken underground. When these external defects have been remedied, it may be that major stitching work will suffice to save the house.

38. An old house near the Friday mosque, showing light cracking which does not seem serious. The roof needs extensive treatment.

40. A house on the north wall in a poor state of repair, with cracking both front and back; those in the front can be stitched. The back of the house has had wooden props inserted; a permanent rehabilitation will probably involve the demolition and rebuilding of the rear of the house.