

#### University of Moratuwa, Sri Lanka. Electronic Theses & Dissertations www.lib.mrt.ac.lk

# STRATEGIES FOR THE IN-SITU AND EX-SITU **CONSERVATION OF TIMBER SHIPWRECKS AND ARTEFACTS WITH SPECIAL REFERENCE TO THE** MARITIME ARCHAEOLOGICAL EXCAVATIONS AT **GALLE HARBOUR**

A Thesis submitted to The Faculty of Architecture, University of Moratuwa Sri Lanka In fulfillment of the Final Year Examination of the requirements for

The Master of Science Degree in Architectural Conservation of Monuments and

Sites (ACOMAS)

Kasthuri Arachchilage. AnushaKasturi

2008

92943

### Declaration

I declare that this thesis represents my own work and that it has not been previously included in a report submitted to this university or to another institution for a degree, postgraduate diploma or other qualification.

### **UOM Verified Signature**

Signature K.A.Anusha Kasturi

### **UOM Verified Signature**

Course Director (ACOMAS) Archict. D.P. Chandrasekara Department of Architecture Electronic Theses & Dissertations www.lib.mrt.ac.lk

## Contents

Abstract

Acknowledgment	
List of illustration	
Introduction	1
Chapter 1 : Archaeological Sites in Galle Harbour and legal protection of the	
Underwater Cultural Heritage	8
	0
1.1 Locations of the Sites	8
1.2 Polices and political context	12
1.2.1 Local approaches	12
1.2.1.1 Antiquities Ordinance No.9 of 1940 and Antiquities (Amendment) Act,	
No 24 of 1998	12
1.2.1.2 The Maritime Zone Law, No 22 of 1976	13
1.2.1.3 The Cultural Property Act No.73 of 1988	14
1.2.1.4 Archaeological Sites of National Importance Act, No.16 of 1990	14
1.2.1.5 National Archaeological Policy	14
1.2.2 International approaches	15
1.2.2.1 Protection of Cultural Property in the Event of Armed Conflict in1954	15
1.2.2.2 Prohibiting and Preventing the Illicit Import, Export and Transfer of	
Ownership of Cultural Property in1970	16
1.2.2.3 World Cultural and Natural Heritage in 1972	16
1.2.2.4 Waterlogged Wood Working Group (1979)	17
1.2.2.5 United Nations Convention on the Law of the Sea 1982(UNCLOS 82)	17
1.2.2.6 International Council on Monuments and Sites (ICOMOS) Charter for the	
Protection and Management of the Archaeological Heritage 1990	18

1.2.2.7 International Committee on the Underwater Cultural Heritage (ICUCH)	19
1.2.2.8 The UNESCO Convention on the Protection of the Underwater	
Cultural Heritage (2001)	20

Chapter 2 : Causes of decay and protection of the marine wood in the sea	25
2.1 Seabed environment and agents of the deterioration	25
2.1.1 Biology of marine shipwrecks	20
2.1.1.1 Molluscs	29
2.1.1.2 Crustaceans	32
2.1.1.3 Bacteria	33
2.1.1.4 Fungi	33
2.1.1.5 Algae	34
2.2 Environmental condition of the Galle harbour sites	34
2.3 The structure of wood	35
2.3.1 Type of cells in wood	37
2.3.2 Properties of wood University of Moratuwa, Sri Lanka.	42
2 3 2 1 Water content of wood	44
2.3.3 Technology	45
2.4 Techniques for the protection of wood in the sea	46
2.4.1 Use of natural resistant timbers	46
2.4.2 Toxic barriers and coatings	48
2.4.3 Wood preservatives	48
2.4.4 Physical barriers	49
2.4.5 Continual beaching and drying	50
2.5 Type of effects for archaeological marine wood	50
2:5.1 Physical damage	50
2.5.2 Chemical decay	51
2.5.3 Biological effect	52
2.5.4 Man made activities	56
2.6 Factors influencing the preservation of the wooden shipwrecks in various sites	

Condition	56
2.6.1 Mary Rose shipwreck in England	56
2.6.2 Vasa shipwreck in Sweden	57
2.6.3 Avondster shipwreck in Sri Lanka	59
Chapter 3 : Strategies for the conservation of timber shipwreck and artefacts	69
Chapter 5 : Strategies for the conservation of chapter surplice	
3.1 In situ preservation of wooden shipwrecks	70
3.1.1 Recording	71
3.1.2 Cultural resource assessment	72
3.1.2.1 Method	72
3.1.3 Pre- disturbance conservation assessment	74
3.1.3.1 Method and materials	75
3.1.3.2 Project design for a pre- disturbance survey on Site E in Galle Harbour	82
3.1.3.3 Practice of the pre-disturbance survey in the Galle Harbour	86
3.1.3.4 Evaluation of the site condition	89
3.2 Choice of the preservation technique ity of Moratuwa, Sri Danka.	91
3.2.1 Leave sites undisturbed for divers to visit eses & Dissertations	92
3.2.2 Underwater museum www.lib.mrt.ac.lk	92
3.2.3 Burial and reburial	95
3.2.4 Raising the ground water table in a plastic containers	99
3.3 History of waterlogged wood treatments	99
3.4 Passive treatment of marine archaeological wood	100
3.4.1 Excavation storage	103
3.4.2 Packing and transport	103
3.4.3 Storage in the laboratory	106
3.5 Conservation process in the laboratory	107
3.5.1 Definitions and aim of the waterlogged wood conservation	115
3.5.1.1 The choice of the conservation method	116
3.5.1.2 Treatment considerations	117
3.5.2 Active treatment of marine waterlogged wooden artifacts with Polyethylene	

Glycol (PEG)	119
3.5.2.1 Pre- assessment of archaeological wood for PEG treatment	119
3.5.3 Properties of the PEG	126
3.5.4 Evaluation of the PEG treatment	127
3.5.4.1 Method	127
3.5.5 Application of PEG treatment	140
3.5.5.1 Examination	142
3.5.5.2 Cleaning	142
3.5.5.3 Desalination	143
3.5.5.4 Dismantling	143
3.5.5.5 Impregnation	145
3.5.5.6 Preventing biological activities	149
3.5.5.7 Reassemble	150
3.5.5.8 Drying	153
3.5.6 Display or storage	157
3.5.7 Research	162
3.5.8 Preventive conservation Iniversity of Moratuwa, Sri Lanka.	162
Electronic Theses & Dissertations	
Chapter 4 : Proposal for the preservation of the underwater cultural	
heritage in Sri Lanka	164
4.1 Issues concerning preservation of the underwater cultural heritage	168
4.1.1 Treats to the sites	168
4.1.2 Lack of information and research	169
4.1.3 Lack of human resources	169
4.1.4 Funds	170
4.1.5 Legal protection	171
4.1.6 Lack of public awareness	171
4.1.7 Lack of international co-operation	171
4.2 Proposals	171
4.3 Issues of the Ex- situ conservation	176

4.3.1 Threats for artefacts	176
4.3.2 Technical issues	176
4.3.3 Time	176
4.4 Proposals	176
4.5 Issues of the museum display and storage	178
4.5.1 Environmental monitoring and control	178
4.6 Proposals	184
4.7 Proposal for National Conservation Projects	189
4.7.1 In progress treatment for Paruwa from Lathpadura	189
4.7.2 Conservation proposal for Paruwa from Atthanagalla Oya	201
and the second	

Conclusion

### References

References as per Harvard system in text (Author, Year of publication)

1.



1. "

University of Moratuwa, Sri Lanka. Electronic Theses & Dissertations www.lib.mrt.ac.lk 206

#### Acknowledgement

As this research was conducted into a relatively new topic area of conservation to the Sri Lanka, I would like to acknowledge the following people and organizations for their support assistance and encouragement.

I would like to gain first thanks for internal supervisor Prof. Nimal de Silva (University of Moratuwa) and external supervisor Dr. Ian Godfrey (Head of Material Conservation in Western Australian Museum) for helpful advice, comments and encouragement. Also I would like to express my gratitude to Course Director Architect, D.P. Chandrasekara for his valuable comments. I would like to specially thank to Architect, C. De. Seram (University of Moratuwa) for his encouragement.

My sincerest thanks to Mr. Kalle Kasi (Research officer in Western Australian Museum) with whom I have had many fruitful conversations and who has most generously provided much of the information about comments of data analysis using Statistic Computer Program.

Thanks are also Mr. Jon Carpenter and Ms. Maggie Meyers, Department of Material Conservation, for taking time to read through earlier draft of this thesis for their focused comments. I would like to specially thank to Miss. Wendy Van Duivenvoorde, Mr.Patrick Backer, Dr Michel McCarthy, Dr. Ian Godfrey, Ms.Manjula Premarathna to their assistance for providing photographs, drawings and related information.

I would like to thanks to team of Maritime Archaeology Unit (in between 2001-2005) namely Mr.Rasika Muthucumarana, Mr.Palitha Weerasingha, Mr.W.M. Chandrarathna, Mr.S.M. Nandadasa, Miss.Darshani Samanthilatha, Mr.Gamini Saman, Miss.Wathsala, Ms. Nilanthi Weragoda, Mr.Saman de Silva, Mr.Ruwan for their assistance and information.

I specially thanks to Mr. Somasiri Devendra and Miss Nerina de Silva. My sincerest thanks to Mr. P. De Mel and Dr. Nissantha Perera in ACOMAS Laboratory (University of Moratuwa)

I would like to express my gratitude to my father Mr. K.A.Tikiribanda (pass away), mother Mrs. S.K.W.A.Perera, husband Mr.U.W. Karunasena, son Mr. Sudara Karunasena, daughter Miss. Selini Mihirandhi and sister Miss. K.A.N.P. Kasthuri to their assistance. For access to the artefacts, laboratory, library, computer and other assistance thanks are due to the Maritime Archaeology Unit (Galle), Department of Material Conservation in Western Australian Museum, Department of Archaeology, and Post graduate Institute of Archaeology.

Finally, thanks are also due to a number of my colleagues in Department of Archaeology(Diveesa, Reshani, Manju, and Nadika) and Western Australian Museum.



à.

University of Moratuwa, Sri Lanka. Electronic Theses & Dissertations www.lib.mrt.ac.lk

# List of Illustration

Figure	Page
1 Archaeological sites in Galle Bay	8
2 The habitats occupied by marine plants	25
3 Biological growing in underwater	30
4 Wood anatomy	37
5 Location of the wood cells	39
6 Principal structural features of the stem	40
7 Cell structures of wood	41
8 Decayed dead eye	51
9 Physical, biological and chemical decay	53
10 Soft and spongy wood (result of biological decay)	53
11 Sea shells on wood	54
12 Damage to Avondster timber by Shipworm/nystrom	55
13 Damage to Avondster timber by gribble of Moratuwa, Sri Lanka.	55
14 Wrecking process of the Mary Rose www.lib.mrt.ac.lk	56
15 Wrecking process of the Avondster ship	59
16 Avondster site and reconstruction of the ship	60
17 Avondster shipwreck excavation	61
18 Cross section of the excavation	61
19 Sediment layers outside of the shipwreck	62
20 Matting on starboard side underwater	63
21 Matting on excavated plank	63
22 Copper alloy sheathing	64
23 Lead sheathing	-
24 Traces of Teredo navalis on Avondster timber	
25 Better preservation of Avondster shipwreck timbers and	

26 Better preservation of Avondster shipwreck timbers an

27 Better preservation of Avondster shipwreck timbers and planks	66
28 Better preservation of Avondster shipwreck timbers and planks	66
29 Sketching underwater	71
30 Videography underwater	72
31 wood and sediment cores	75
32 Microelctrode and meters	75
33 Dissolved oxygen, salinity and temperature Electrodes and meter	76
34 Pneumatic drill	76
35 Electrodes and meters to measure pH and corrosion potential	
in waterproof housing	76
36 Chloride meter to measure chloride level in treatment solution	76
37 Core sampling James Matthews	77
38 Drilling, Hercules	77
39 Measurement, Hercules site	77
40 Drawing of the end grains	79
41 Using Planimeter for measuring drawing of end grain	80
42 Planimeter placed at start point of drawing ratuwa, Sri Lanka.	80
43 Pine (red deal type) wood ctronic Theses & Dissertations	81
44 Sketched Plan – Site E (1992)	90
45 Plan of Site E (1993) was drawn by Paul Clark	90
46 Plan of site E (2006)	90
47 Erosion of the metal in 2006	91
48 Erosion and missing rate of the metal in 2007	91
49 Erosion and missing rate of the metal in 2007	91
50 Submerged ancient tree	93
51 Schooner Sweepstakes	93
52 Sweepstakes hull	93
53 The underwater cave in the Park	93
54 Wooden anchor stock and geological formation	93
55 The Qait Bey Fort and Citadel	93
56 Paraohs light house	93

57 Alexandria findings	93
58 Filling sand bag	96
59 Tying sand bag	96
60 Polypropylene nets	97
61 Preparing net and sand bags	97
62 Wrapping sand bags with net	97
63 Tying the end of the wrapped sand bags	97
64 Tying middle of the wrapped sand bags	97
65 Bringing wrapped sand bags to boat	97
66 Tied by chain block	98
67 Trapped the sediments by net	98
68 Stabilized Avondster site after applying net (Post excavation)	98
69 Naturally formed sand waves alongside the Avondster site	98
70 Using lift bags to recover an object	102
71 Recovering Batavia ship timbers	102
72 Transporting Batavia hull timbers	102
73 Post-excavation storage of Batavia hull timbers oratuwa, Sri Lanka.	103
74 Packing materials Electronic Theses & Dissertations www.lib.mrt.ac.lk	104
75 Packing materials	104
76 Packing of waterlogged wood from excavation in Galle	105
77 Package of large objects	105
78 Package of large objects	105
79 Package of the small objects	/ 105
80 Package of the small objects	105
81 Wet artifact storage in Galle MAU laboratory	107
82 Wet artifact storage in Galle MAU laboratory	107
83 Batavia hull timber PEG treatment tank, Western Australian Museum	107
84 Paper documentation ; group and individual treatment records	109
85 Drawing of pulley block	110
86 Drawing of pulley block	110
87 Recording wooden barrel	111

88 CT scan of Batavia ship construction in Maritime Museum,	
	113
Geraldton Australia 89 Recognizing metal part in side of the wooden ship construction	113
	113
90 Longitudinal and radial view of CT scan	
91 Recognizing physical damage annual growth rings and metal in side of	114
the wood Maritime Museum, Geraldton, Australia	120
92 Assessing Avondster timbers	121
93 01GHL 15	121
94 01GHL14	121
95 01GHL06c	129
96 01/GHL/46 b archaeological woods from Avondster	129
97 01/GHL/46b cut into three pieces	130
98 Longitudinal and transverse sections (air dry) showing pin placements	150
99 Longitudinal and transverse sections (air dry) showing pin placements	130
100 Sections of the wood sample (air dry)	130
101 Longitudinal and transverse sections of No 2 (fresh water)	131
102 Longitudinal and transverse sections of No 2 (fresh water) ssertations	131
103 Longitudinal and transverse sections (impregnation with PEG)	132
104 Longitudinal and transverse sections (impregnation with PEG)	132
105 Mechanical cleaning waterlogged wood	143
106 The wooden barrel in-situ	144
107 In the laboratory- Top view with packing	144
108 Bottom view	144
109 Side view showing damage to timbers from the expanding resin	144
110 Numbered sections	144
111 Recording before dismantling	144
112 Cleaning before dismantling	145
113 Dismantling	145
114 Lump of resin after dismantling	145

115 A wooden base after dismantling		145
116 Spraying PEG onto the Mary Rose shipwreck		149
117 Spraying PEG onto the Vasa		149
118 Reassemble of Batavia shipwreck in Western Australian Museum		151
119 Reconstruction of the Mary Rose		151
120 Replacing a plank on the Mary Rose deck		152
121 Reassemble Vasa ship		152
122 The Vasa after rising		152
123 Vacuum freeze drying side view		153
124 Vacuum freeze drying inside		153
125 Vacuum Freeze Dryer during work		154
126 Measuring ice from Condenser of the freeze dryer		154
127 Stone anchor's arm after freeze drying		155
128 Climate chamber for controlled air drying		156
129 Vasa ship display in Sweden		157
130 Vasa ship display in Sweden		157
131 Batavia Shipwreck Gallery in Western Australian Museum		158
132 Batavia Shipwreck Gallery in Western Australian Museum		158
133 Mary Rose display in England		158
134'Viewing gallery' for visitors in Mary Rose Museum		158
135 Reconstruction of the Mary Rose (Elevation of the shipwreck		159
136 Display cases in Mary Rose museum	- 2	159
137 Audio visual theatre in the Mary Rose Museum		159
138 Exhibitions in National Maritime Museum Galle		160
139 Temporary exhibitions in Galle Dutch Reform Church for		
opening ceremony on 30/10/2004		161
140 Temporary exhibitions in Galle laboratory		161
141 Temporary exhibitions in Galle laboratory		161
142 Galle Harbour in 19 Century Sri Lanka		164
143 Model of Yathra in Colombo National Museum		166

144 Conserved Orukanda in Colombo National Museum	167
145 Splitting of the wood by uncontrolled drying	180
146 First stage of micro-organism in Galle laboratory premises	181
147 second or mature stage of micro-organism in Galle laboratory premises	181
148 Final or dead stage of microbiology	181
149 Black Ant in laboratory premises	182
150 Habitations of them on a Lab Coat	182
151 Algae growing on artefacts (Avondster Project)	182
152 Salt crystallisation on desalinated pottery surface (Avondster Project)	183
153 One hull of the Paruwa at the Labudola Ela bank in Lathpadura as	
discovered in 1992	189
154 Transverse Section (unknown tropical hard wood),	
magnification 10x/22 from Lathpadura Paruwa	192
155 Longitudinal section similar wood, magnification 10x/22	192
156 One end of the Paruwa with hole for tying rope at underwater in 1992	197
157 Drawing of the Paruwa ectronic Theses & Dissertations	197
158 The Paruwa when it arrived at Kukulegaga Holiday Resort	
on 30 November 2006, Note the sound surfaces of the wood	198
159 The Paruwa was placed in the overflow channel at the Kukulegaga	
Holiday Resort to re-hydrate. Note the severe cracking from	
exposure to the sun for five months	198
160 Detail of the cracking and gross distortion of the Paruwa	198
161 Detail of the severe cracking on the outside of the Paruwa	
like a brick wall	199
162 Detail of the cracked outer layer with much loss and the better	
preserved middle layer showing	199
163 Before cleaning of the Paruwa	199
164 In side cracking after cleaning	199
165 Sand bag barrier placed across the over flow channel to dry the site	199



### Abstract

The implementation of the waterlogged wood conservation has important implication for Sri Lanka. Firstly, there is a diverse and significant cultural heritage (multi user environment) in the sea. Secondly, there is a rich underwater cultural heritage in Sri Lankan inland waters. This thesis outline procedures we have initiated to conserve the unique non renewable, invisible heritage that should be systematically recovered preserved and studied.

This research focuses not only on the ex-situ conservation of waterlogged wooden shipwreck and artefacts from Galle harbour projects, but also local and international legal frame work its secure for underwater cultural heritage, how to environmental factors affect to waterlogged wood and its deterioration and preservation, predisturbance conservation assessment and in-situ conservation, research aspects and environmental monitoring and control in museum. This is also discussing the issues involved such as climate, money, time, technology, unawareness and conflicts of interest.

Polyethylene Glycol (PEG) treatment for waterlogged archaeological wood is mainly discussed as ex -situ conservation.

It is also briefly described conservation process has gained essential experience in working on large waterlogged archaeological wood structures in the field which having been allowed to dry out and with few available funds and little equipment, the innovative techniques applied to the Lathpadura Paruwa.

Future opportunities for further detailed conservation and research on waterlogged wood, possibly in association with those interested in ancient vessels and maritime archaeology at the remains at sea and inland water as it rapidly replaces its many ancient traditions are flagged.