CENTER FOR
HERITAGE CONSERVATION

TEXAS A&M UNIVERSITY
College of Architecture

Documentation and Conditions Assessment of Jacob's Ladder, St. Helena (CHC 2020-01-04)

Report prepared for the British Napoleonic Bicentenary Trust and St. Helena Government

Brent R. Fortenberry, Associate Director, Center for Heritage Conservation
Jane Ashburn, Architectural Conservator

Introduction

Architectural documentation and preliminary conditions assessment were undertaken by Principal Investigator Brent R. Fortenberry, Associate Director of the Center for Heritage Conservation at Texas A&M University. Post-documentation conditions assessments were completed by Ashburn. Fortenberry spent one of the seven days (18–25 January 2020) of the field research period at Jacob's Ladder. It is a major and accessible component of Jamestown's heritage landscape is also one of the most accessible for heritage tourists and stakeholders.

Objectives

1. Undertake comprehensive digital documentation of Jacob's Ladder as a part of ongoing heritage conservation management.

2. Complete a preliminary conservation conditions assessment of Jacob's Ladder in preparation for conservation costing from an architectural conservator and historic building structural engineer.

Assessment Methodology

Jacob's Ladder was visited one day during the research trip. A combination of documentation and assessment methodology was undertaken.

Photogrammetry

In addition to the laser scan data, the exterior of the fort was captured using 350 aerial photographs from a DJI Mavic Air Drone. These photographs were processed in Capturing Reality software to create 3D textured mesh models that were then combined with laser scan files to create the completed model.

Photography

Fortenberry also captured ground photos using a Sony a7 camera for detailed conditions photography.

Conditions assessments and recommendations were made by in-person visual inspect as well as a digital inspection of the 3D models.

Full Dataset Access

A full copy of the dataset can be view and downloaded using this Google Drive Link. Note that for the 3D and photogrammetric models, one needs a program specialized software. Static images and site report components, however, are easily viewed.

https://drive.google.com/drive/folders/1k93XTR9X7_hTB004u5g6aOlJSV1tNGZ9?usp=sharing

Jacob's Ladder History

Jacob's Ladder is a Grade I listed monument adjacent to Jamestown, St. Helena. It runs from Jamestown up 'Ladder Hill' to the village of Half Tree Hallow at the summit. What survives today are the remnants of a horse-driven cable railway installed in 1829 by the Saint Helena Railway Company designed to carry materials from Jamestown to Ladder Fort at the summit. The railway was designed by J.W. Hoar, a local engineer, and the Royal Artillery Engineers under the supervision of Lt. G.W. Mellis. Cars would run on a pair of iron rails fixed onto wooden joists that were attached to the rock face. It rises some 603 feet above sea level, is 924 feet in length and comprises 699 steps–it has an average rise of 11 inches. By 1871 the Ladder has fallen into disrepair and was dismantled with the central pedestrian stairways staying intact. Today Jacobs Ladder is a significant heritage tourism attraction in Jamestown. A conditions assessment was carried about in 2015 and updated by the government in 2020.

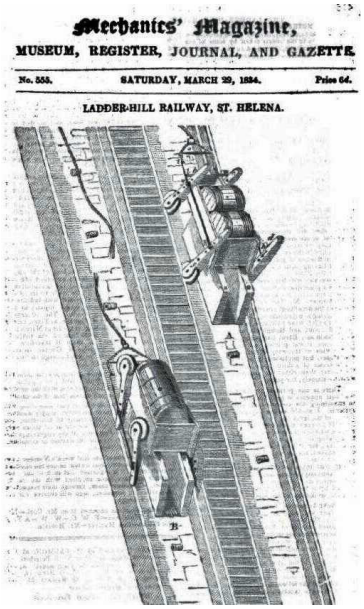
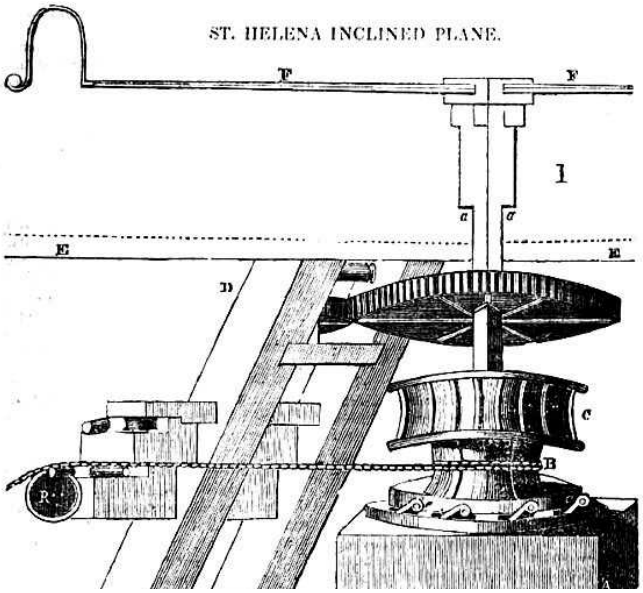


Figure 1 (Right): Mechanic's Magazine rendering of the Ladder.

Figure 2 (Below): The Ladder's winding mechanism.



Location

Jacob's Ladder sits at a height of 1,916 feet and commands a rocky peak and is approximately one mile to the south and east of Jamestown.

Figure 3: Google Earth imagery of Jacob's Ladder in detail (Image: Google Earth).

Figure 4: Detail of Google Earth image of Jacob's Ladder (Image: Google Earth).

Figure 5: Oblique 3D Google Earth Imagery of Jacob's Ladder (Image: Google Earth)

Digital Documentation

The following images represent the aerial- and ground-based photogrammetric data. Combined, the 3D model comprised over 80 million triangular mesh components, textured using the embedded photographic data, with an accuracy of 4 mm.

Raw digital data and completed digital models in various formats are available through the Google Drive link above. This combined model can also be programmed as a part of physical and digital exhibitions of the fort and other heritage sites. Digital models themselves can additionally be annotated with heritage building information and history.

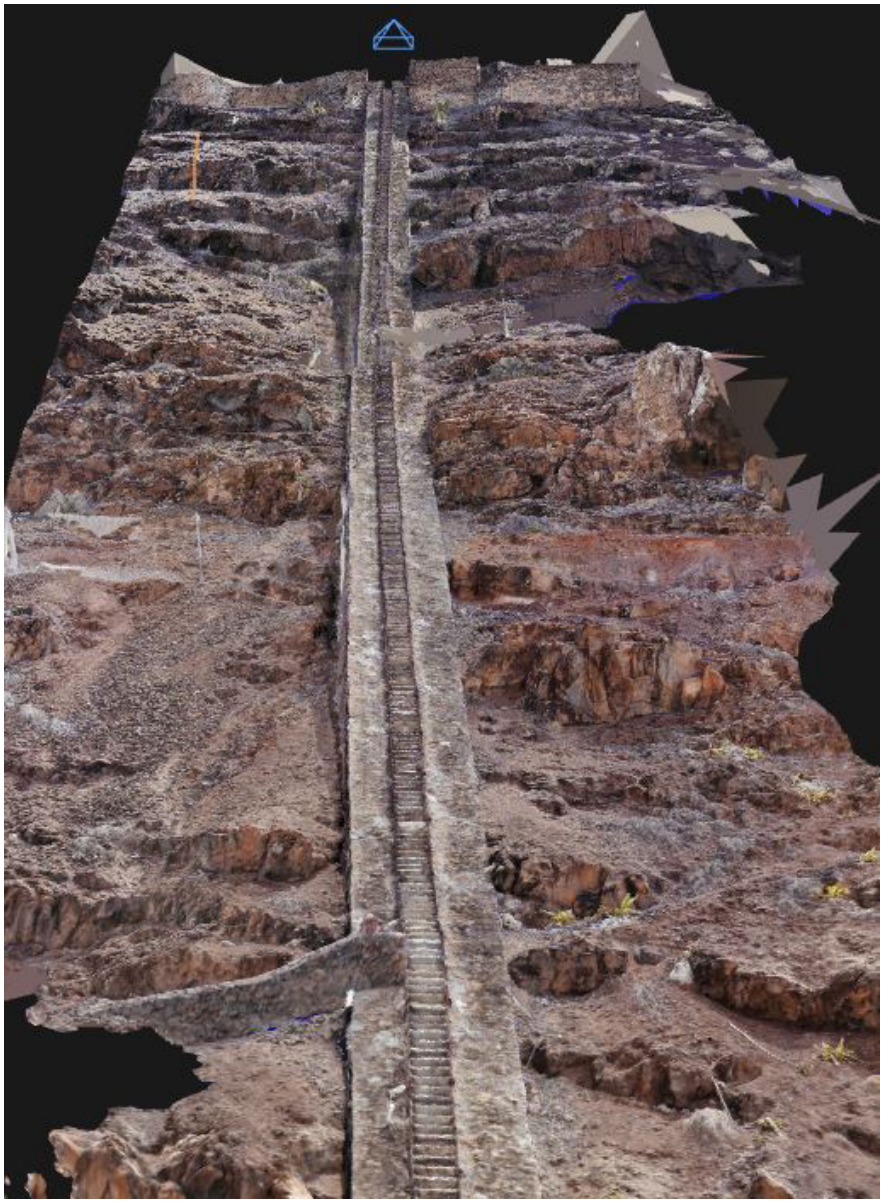


Figure 6:
Photogrammetric model, looking up the ladder (looking south) (Model: B. Fortenberry)

Digital Documentation

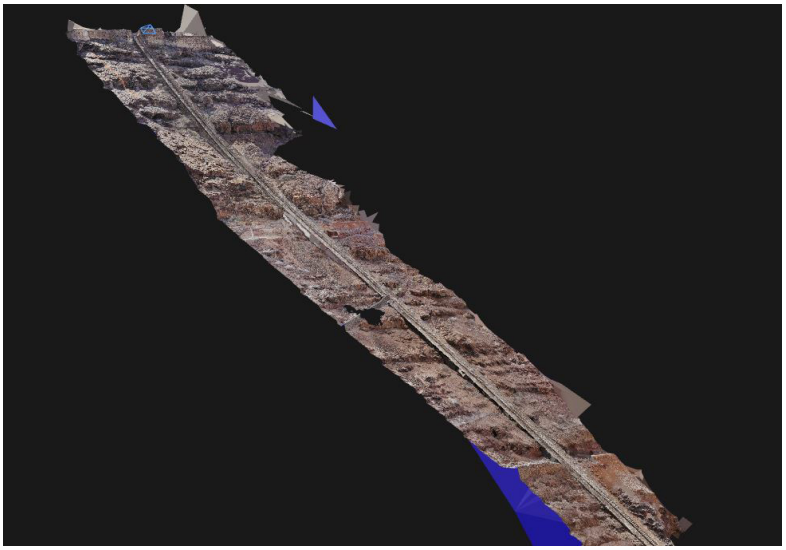


Figure 8:
Photogrammetric model, obliue view looking west (Model: B. Fortenberry).

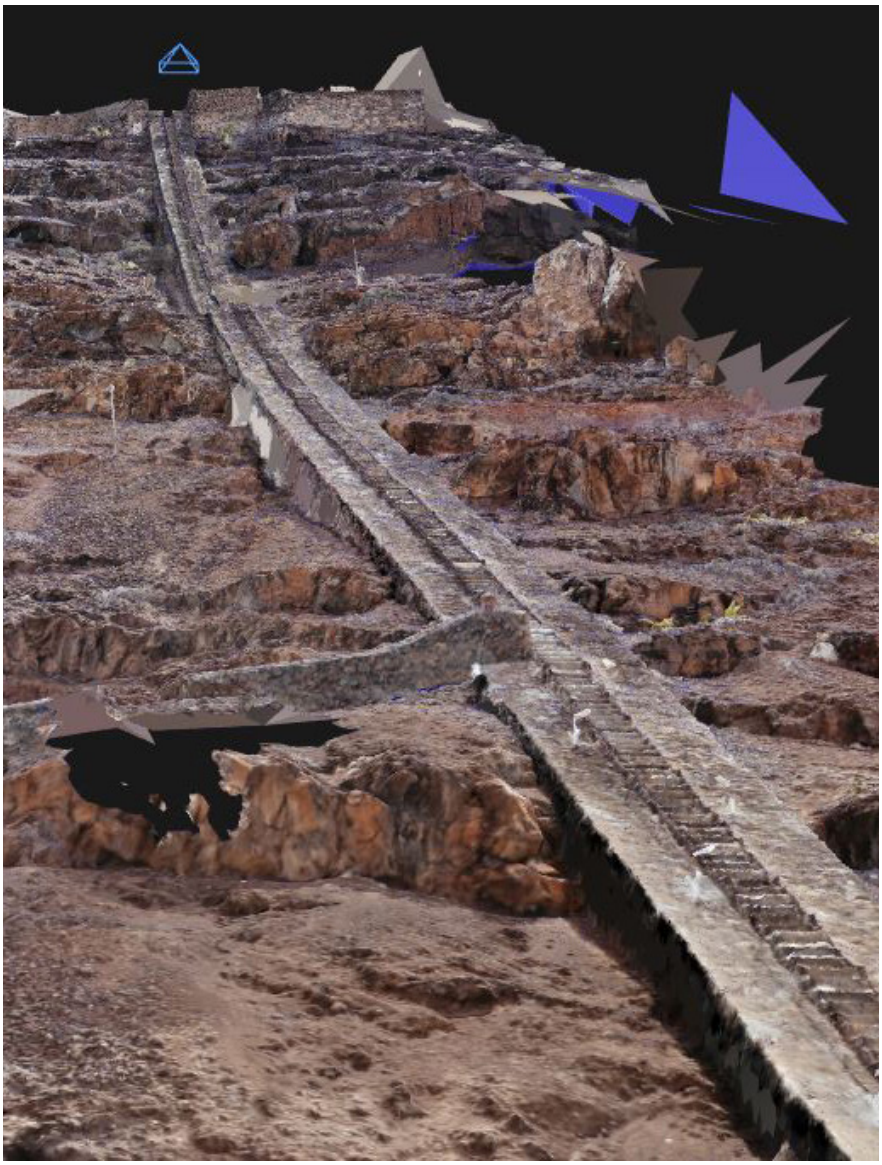


Figure 9:
Photogrammetric model, looking southwest from base of the ladder (Model: B. Fortenberry).

Introduction to Conditions

These conditions were observed through on-site visual inspection and digital model data analysis by Fortenberry and Ashburn. There are several instances in the following recommendations where additional expertise is suggested. Several experts have been recommended to the charity.

Where possible, it is recommended that local experts be consulted. While all recommendations are important, at the end of the report is a triaged list of conservation conditions provided. The triaged list are structural in nature and critical to ensuring the integrity of the site.

Figure 10: View of Jacob's Ladder from central Jamestown (Image: B. Fortenberry).

Conditions of Steps

The steps run the entire length of the site. The steps are in various states of condition with varying amounts of cracking and wear present. Generally the steps are in good shape and appear to be structurally sound with normal use-wear present. The steps are skim-coated with a cementitious coating. Some of the steps have metal straps on the riser. A large majority of the cracks take place on the skim coating and do not appear to be structural. Additionally there is significant cracking occurring at the interface between the step and the side rails. The steps feature various bio-growths and soiling and as such vary greatly in color. Some of the original steps have been removed and replaced by a modern cementitious block, left uncoated (with visual similarities to those repairs done at High Knoll Fort in 2001).

Figure 11: Base of Jacob's Ladder (Image: B. Fortenberry).

Conditions of Steps

Figure 12: Summit of the ladder showing step failure and metal strapping (Model: B. Fortenberry).

Figure 13: Base of the ladder showing steps in better condition than the summit (Image: B. Fortenberry).

Conditions of Steps

Figure 14: Soiled steps mid-way up the ladder (Model: B. Fortenberry).

Figure 15: Detailed view of strapping and failing steps at summit (Image: B. Fortenberry).

Conditions of Steps Recommendations

1. Remove the metal straps from the risers that are present bracing some of the steps. These straps hold water to the surface of the steps, allowing bio-growth and causing cracking and further deterioration of the surface. If the step is found to be structurally unsound once the strap is removed, steps need to be taken to rebuild the step under the supervision of an architectural conservator and conservation contractor. If rebuilt, care should be taken to preserve the physical appearance of the historic steps.

2. Clean and treat steps with a conservator approved bio-cide solution such as D2 to remove bio-growth and soiling.

3. Cracks should be triaged for repair. Those cracks exceeding 5mm in width should be repaired with a structural restoration mortar. Smaller cracks should be monitored, but not filled as a small amount of cracking is to be expected in a skim coat of this age. This is due to the fact that crack repair requires the drilling out of the surrounding area in order to place in restoration mortar. As such, smaller cracks do not necessitate repair, provided that are not structural. An architectural conservator should be consulted for mortar selection.

4. The skim coating should be monitored for delamination. Delaminating or failing skim coats can be re-attached using conservation-grade consolidates. If a large section of skim coating is missing, the area may be re-coated, if deemed necessary by heritage stakeholders.

5. The rust jacking (i.e. the expansion of corroded metal breaking surrounding surfaces) of the handrail has caused significant cracking to occur in the steps. The broken areas around the handrail connections should be repaired using a structural restoration mortar. Care should be taken to preserve and reattach large pieces of the steps. Where possible, care should be taken not to expose the embedded metal if cracks are not present. Exposing embedded metal will drastically advance the timeline of corrosion.

Handrails and Stringers

There are handrails on either side of the steps, the entire length of the site. The handrails are connected by stingers. Both the handrails and stringers appear to be in fair condition. They appear to be structurally sound. There is significant corrosion present on these metal elements and some rust jacking (i.e. the expansion of corroded metal breaking surrounding surfaces) is occurring.

Figure 16: Handrails that are out of plumb, braces recommended (Image: B. Fortenberry).

Handrails and Stringers

Figure 17: Handrail out of plumb at base of the ladder (Model: B. Fortenberry).

Figure 18: Separation from handrails at base from steps, mid-way up the ladder (Image: B. Fortenberry).

Handrails and Stringers Recommendations

1. Connections between stringers and handrails should be inspected regularly, for corrosion and structural integrity. This is for the safety of visitors.

2. The handrails and stingers should be treated with an anti-corrosion solution. They should then be coated to prevent further corrosion.

3. If found to be lacking in structural integrity, braces should be crafted and placed at regular intervals along the length of the railing. A structural engineer should be consulted for details and plans for bracing. All bracing should have the appearance of the historic metalwork.

4. The rust jacking (i.e., the expansion of corroded metal breaking surrounding surfaces) has caused significant cracking to occur at the ends of the steps. If, during the repair of the surrounding surfaces, the metal is found to be no longer viable, the metal elements should be replaced. Replacement metal elements should appear visually similar to the historic elements, however, it is recommended to use a marine grade stainless steel where possible. This will slow future corrosion damage. A structural engineer can recommend specific grades of steel that are appropriate for use in the site's climate.

Stone Abutments

There are stone abutments on both sides of the original rail tracks. These appear to be constructed with rock rubble, coated in a skim coat of cementitious mortar. They appear to be in good condition.

Figure 19: Stone abutment connection with historic path, note exposed utilities (Image: B. Fortenberry).

Stone Abutments

Figure 20: Recently re-pointed stone abutment section (Model: B. Fortenberry).

Figure 21: Stone abutments with bio-growth present (Image: B. Fortenberry).

Stone Abutments Recommendations

1. A structural engineer should be consulted to inspect the connections between the abutments and the hill surface. This area has been identified as an area of concern, as failure in the abutments will cause complete failure of the steps.

2. Clean and treat stone abutments with a conservator approved bio-cide solution such as D2 to remove bio-growth and soiling.

3. Tubes, electrical lines, and other wiring should be placed to the side of the abutments, rather than on the top. This will prevent water from pooling in these areas, leading to bio-growth and cracking. It is also in line with preserving the historic character of the abutments.

Other Metal Elements

There are various metal elements present, mainly the straps on the steps. These straps are corroded. They appear to be in fair condition.

Figure 22: Support strapping on steps at ladder summit (Image: B. Fortenberry).

Other Metal Elements

Figure 23: Upper section of ladder near summit showing step strapping (Model: B. Fortenberry).

Figure 24: Metal strapping present on stair, mid-way up the ladder (Image: B. Fortenberry).

Other Metal Elements Recommendations

1. If chosen to leave in place, the straps on the steps should be treated with an anti-corrosion solution. They should then be coated to prevent further corrosion. .

Triage Recommendations

1. IMMEDIATE: Treat for corrosion and coat all metal elements with an anti-corrosive treatment.

2. SHORT TERM: Re-attach and loose step elements using a structural restoration mortar.

Figure 25: Ladder in context with steel netting (Image: B. Fortenberry).