

ARMY RESEARCH LABORATORY



Digital Radiography and X-ray Computed Tomography Slice Inspection of an Aluminum Truss Section

by William H. Green

ARL-MR-791

September 2011

NOTICES

Disclaimers

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of manufacturer's or trade names does not constitute an official endorsement or approval of the use thereof.

Destroy this report when it is no longer needed. Do not return it to the originator.

Army Research Laboratory

Aberdeen Proving Ground, MD 21005-5066

ARL-MR-791

September 2011

Digital Radiography and X-ray Computed Tomography Slice Inspection of an Aluminum Truss Section

William H. Green

Weapons and Materials Research Directorate, ARL

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188		
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) September 2011		2. REPORT TYPE Summary		3. DATES COVERED (From - To) January 2011–February 2011	
4. TITLE AND SUBTITLE Digital Radiography and X-ray Computed Tomography Slice Inspection of an Aluminum Truss Section			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) William H. Green			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Research Laboratory ATTN: RDRL-WMM-D Aberdeen Proving Ground MD 21005-5066			8. PERFORMING ORGANIZATION REPORT NUMBER ARL-MR-791		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT A sectioned specimen that had been removed from a larger aluminum truss structure, which was designed to sustain mechanical load while minimizing its weight and structural complexity, was provided. The specimen was inspected by digital radiography and slice x-ray computed tomography to determine if the vertices, or nodes, exhibited any porosity or shrinkage cavities and, secondly, if any other casting defects were present.					
15. SUBJECT TERMS digital radiography, x-ray CT, NDE, cast aluminum, alloy F357, truss					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 14	19a. NAME OF RESPONSIBLE PERSON William H. Green
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED			19b. TELEPHONE NUMBER (Include area code) (410) 306-0817

Contents

List of Figures	iv
1. Introduction	1
2. Description of Specimen	1
3. Results	1
Distribution List	6

List of Figures

Figure 1. Photograph of cast Al truss section specimen.	1
Figure 2. Digital radiograph of Al truss section specimen.	4
Figure 3. Computed tomography scan through two selected vertices (bottom) of Al truss section specimen.	5

1. Introduction

A sectioned specimen that had been removed from a larger aluminum (Al) truss structure was provided. The specimen was inspected by digital radiography (DR) and slice x-ray computed tomography (XCT) to determine if the vertices, or nodes, exhibited any porosity or shrinkage cavities and, secondly, if any other casting defects were present.

2. Description of Specimen

The specimen had a two-tier structure with eight ligaments at each vertex, four that are horizontal and four that are diagonal, as shown in figure 1. The overall size of the specimen was ~69 mm (2.7 in) × 187 mm (7.4 in), with spacing between the tiers (outside surface to outside surface) of ~37 mm (1.5 in). The specimen material was cast F357 Al alloy.

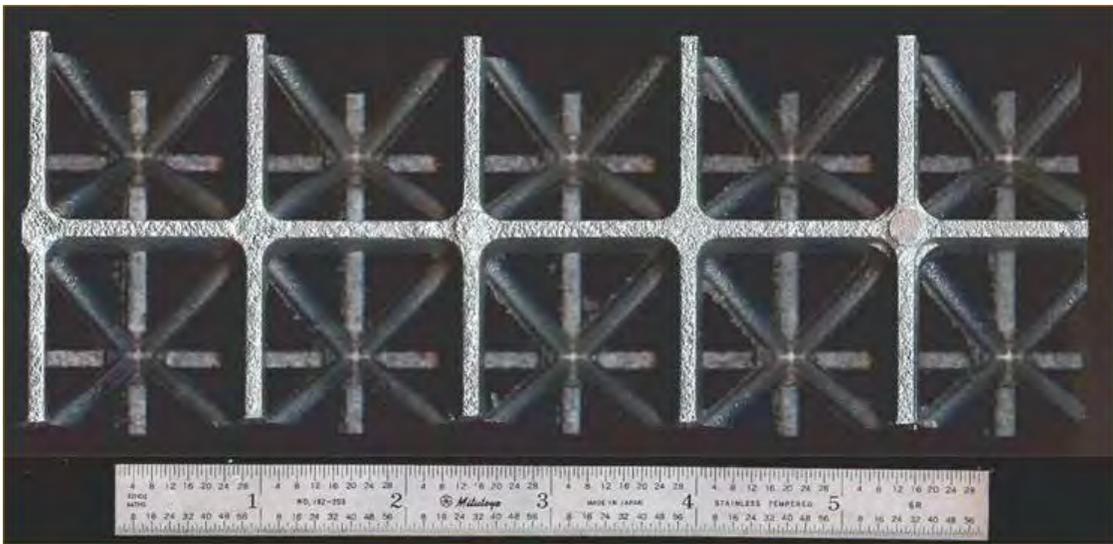


Figure 1. Photograph of cast Al truss section specimen.

3. Results

The DR and XCT scans of the specimen were done using the 225-keV microfocus x-ray tube and II/CCD camera setup in centered rotate-only mode. The DR scan parameters are listed as follows:

- Source Voltage 180 kV (microfocus source)
- Source Current 0.044 mA
- Focal Spot Size 5 μm
- SID 641.50 mm
- SOD 325.00 mm
- Mag Factor ~2.0 (1.97)
- Image Matrix 1966 \times 1024
- Image Width (x) 90.21 mm
- Detector Image intensifier and CCD camera (total 14 bit, true 12 bit)

The XCT scan parameters are listed as follows:

- Source Voltage 180 kV (microfocus source)
- Source Current 0.044 mA
- Focal Spot Size 5 μm
- SID 641.50 mm
- SOD 325.00 mm
- Mag Factor ~2.0 (1.97)
- Image Matrix 1024 \times 1024
- FOR 90.00 mm
- Image Size 90.00 \times 90.00 mm (x by y)
- Scan (Slice) Location Third horizontal row of two vertices/nodes from the bottom of DR (cross-sectional image)
- Slice Thickness 0.60 mm
- Detector Image intensifier and CCD camera (total 14 bit, true 12 bit)

Note: SID = source-to-image-distance; SOD = source-to-object-distance; CCD = charged coupled device; and FOR = field of reconstruction.

The DR and single XCT scans of the specimen are shown in figures 2 and 3, respectively. The specimen was positioned vertically, standing on end in the DR to maximize the magnification factor. The through-thickness DR did not indicate the presence of any porosity or shrinkage cavities in the vertices of the specimen. The DR also did not indicate the presence of cracks or other internal casting defects in the specimen. The lack of these types of defects was further exhibited by the representative x-ray CT scan (slice) taken through one of the horizontal rows, relative to the DR, of two particular vertices. The CT scan was taken through the third row of two vertices from the bottom of the DR. The vertices are at the bottom of the image in figure 3, which also shows the rest of the material penetrated by the cross-sectional scan. The material at the top of the image is located at the other tier of the two-tier truss structure. The darker shade of gray between the two vertices is not an indication of lower density in this case but is due to geometry effects of relatively long x-ray path lengths through the horizontal material section at the bottom of the image.

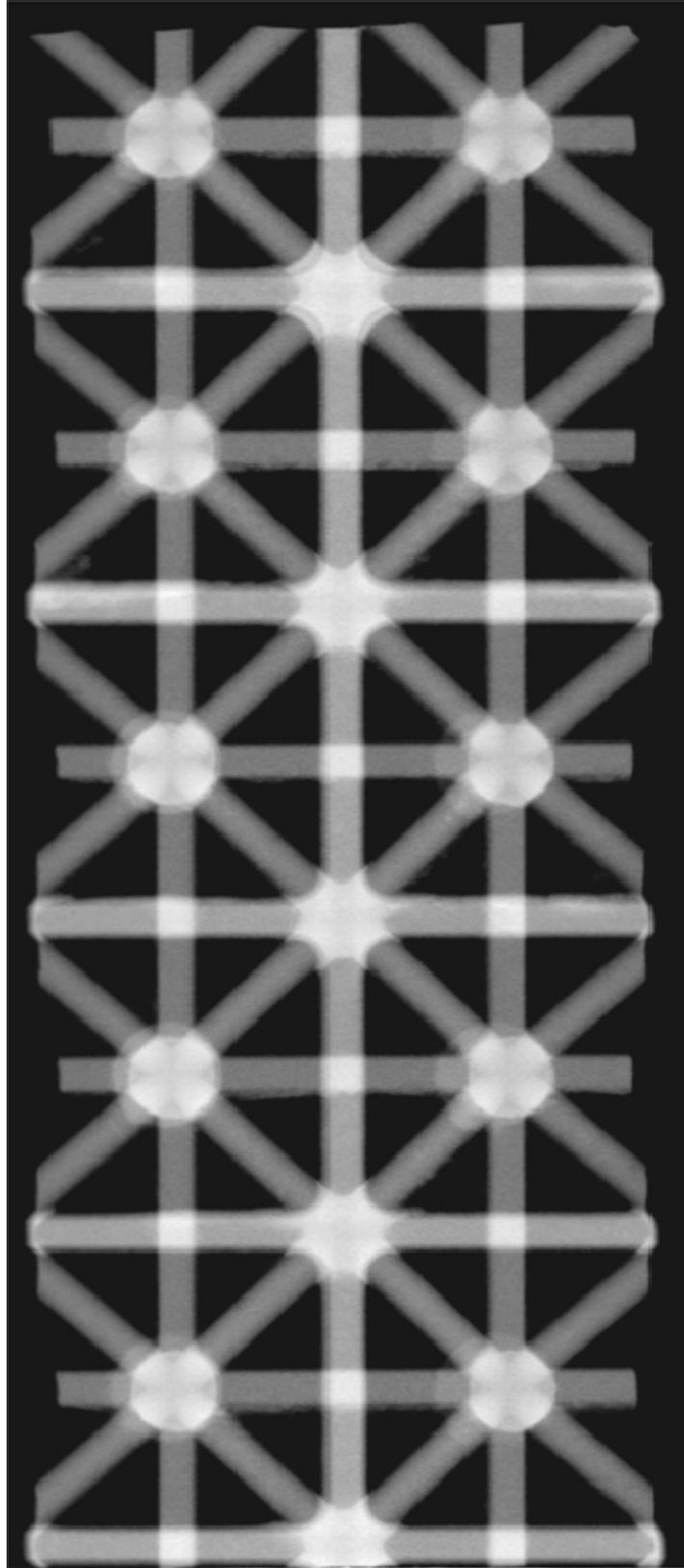


Figure 2. Digital radiograph of Al truss section specimen.

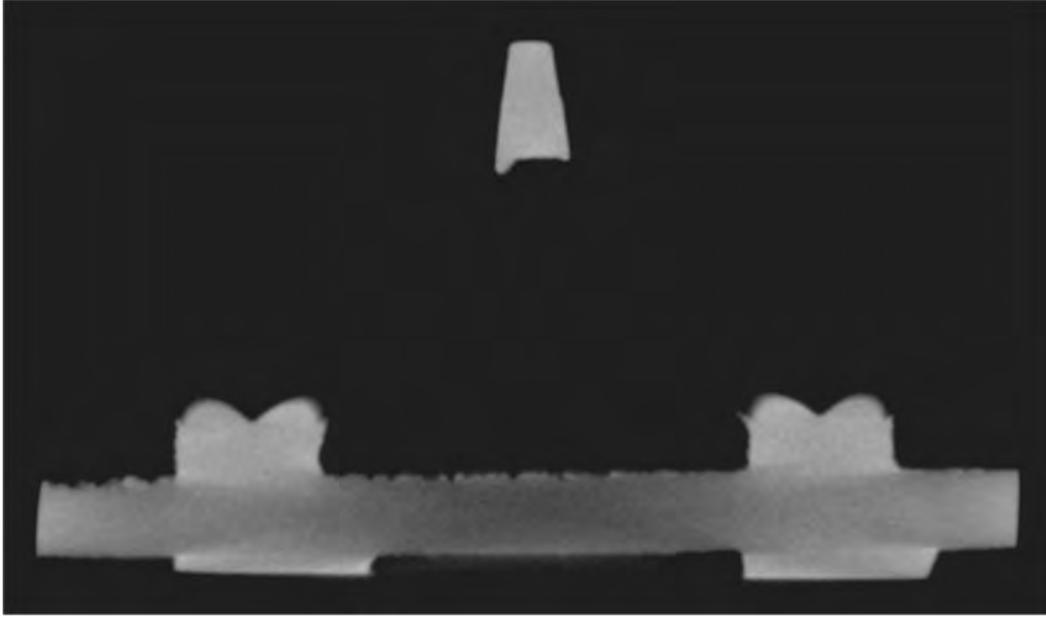


Figure 3. Computed tomography scan through two selected vertices (bottom) of Al truss section specimen.

NO. OF
COPIES ORGANIZATION

1 DEFENSE TECHNICAL
(PDF INFORMATION CTR
only) DTIC OCA
8725 JOHN J KINGMAN RD
STE 0944
FORT BELVOIR VA 22060-6218

1 DIRECTOR
US ARMY RESEARCH LAB
IMNE ALC HRR
2800 POWDER MILL RD
ADELPHI MD 20783-1197

1 DIRECTOR
US ARMY RESEARCH LAB
RDRL CIO LL
2800 POWDER MILL RD
ADELPHI MD 20783-1197

1 DIRECTOR
US ARMY RESEARCH LAB
RDRL CIO MT
2800 POWDER MILL RD
ADELPHI MD 20783-1197

1 DIRECTOR
US ARMY RESEARCH LAB
RDRL D
2800 POWDER MILL RD
ADELPHI MD 20783-1197

NO. OF
COPIES ORGANIZATION

ABERDEEN PROVING GROUND

7 DIR USARL
RDRLWMM C
C PERGANTIS
RDRL WMM D
R BRENNAN
E S C CHIN
W H GREEN (2 CPS)
M PEPI
R SQUILLACIOTI

INTENTIONALLY LEFT BLANK.