



ARL-TN-0770 • Aug 2016



Modification of General Research Corporation (GRC) Dynatup 8200 Drop Tower Rebounding Brake System

by David Gray, Robert Kaste, and Bradley Lawrence

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.



Modification of General Research Corporation (GRC) Dynatup 8200 Drop Tower Rebounding Brake System

by David Gray and Robert Kaste
Weapons and Materials Research Directorate, ARL

Bradley Lawrence
Bennett Aerospace, Cary, NC

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) August 2016		2. REPORT TYPE Technical Note		3. DATES COVERED (From - To) 13 November 2015–3 February 2016	
4. TITLE AND SUBTITLE Modification of General Research Corporation (GRC) Dynatup 8200 Drop Tower Rebounding Brake System				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) David Gray, Robert Kaste, and Bradley Lawrence				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) US Army Research Laboratory ATTN: RDRL-WMM-B Aberdeen Proving Ground, MD 21005-5069				8. PERFORMING ORGANIZATION REPORT NUMBER ARL-TN-0770	
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 is unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT The Double Column GRC Dynatup 8200 Drop-Weight pneumatic rebound brake system was intended to prevent secondary tup impacts on test specimen after the initial strike. Our investigation lead to the discovery of multiple impacts from a single test. To achieve a single mass impact of energy on laminate material test panel, we successfully modified the braking system. The details of which are explained in this report.					
15. SUBJECT TERMS 8200 drop tower, drop weight impact, compression after impact, rebound brake system, secondary impact					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 14	19a. NAME OF RESPONSIBLE PERSON David Gray
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (Include area code) 410-306-0852

Contents

List of Figures	iv
1. Introduction	1
2. Background of Impact Test	1
3. Conclusion	6
4. References	7
Distribution List	8

List of Figures

Fig. 1	GRC Dynatup 8200 drop tower	2
Fig. 2	Original equipment manufactured pneumatic brake actuators	2
Fig. 3	IDT Os5 4K high-speed digital camera to capture tup impact period ...	3
Fig. 4	Tup impact period sequence stills of generic laminate using old pneumatic rebound system.....	4
Fig. 5	New upgraded 3-inch pneumatic cylinders.....	5
Fig. 6	Tup sequenced impact stills from carbon fiber composite laminate test material	6

1. Introduction

The Double Column GRC Dynatup 8200 Drop-Weight pneumatic rebound brake system was intended to prevent secondary tup impacts on test specimens after the initial strike. Our investigation discovered multiple impacts from a single test. To achieve a single-mass impact of energy on a laminate material test specimen, we successfully modified the braking system, the details of which are explained in this report.

2. Background of Impact Test

The Dynatup 8200 drop weight test system was designed and manufactured in 1982 by GRC (Fig. 1). This model has a mass weight range of 7 to 34 lb (3.18 to 15.42 kg), a maximum drop height of 36 inches (0.91 m), and can produce energy impacts (potential energy) up to 96 ft-lb. (120 J). The US Army Research Laboratory has performed low-energy (<100 J) impact experiments per ASTM D7136/D7136M-15¹ with this system since 2001. The 8200 system was originally supplemented with two 1-inch bore/1.5-inch stroke 120-psi pneumatic actuators with 0.18-inch ID air supply lines that are used as a rebound brake system (Fig. 2). These actuators deploy via a pneumatic valve when a velocity optical sensor is tripped from a blade flag attached to the cross head milliseconds before the initial tup impact. There is an inherent lag time between initial impact and the actuators deploying due to the system's pneumatic solenoid valve response time. This pneumatic system was intended to prevent secondary tup impacts on test specimens after the initial strike.



Fig. 1 GRC Dynatup 8200 drop tower

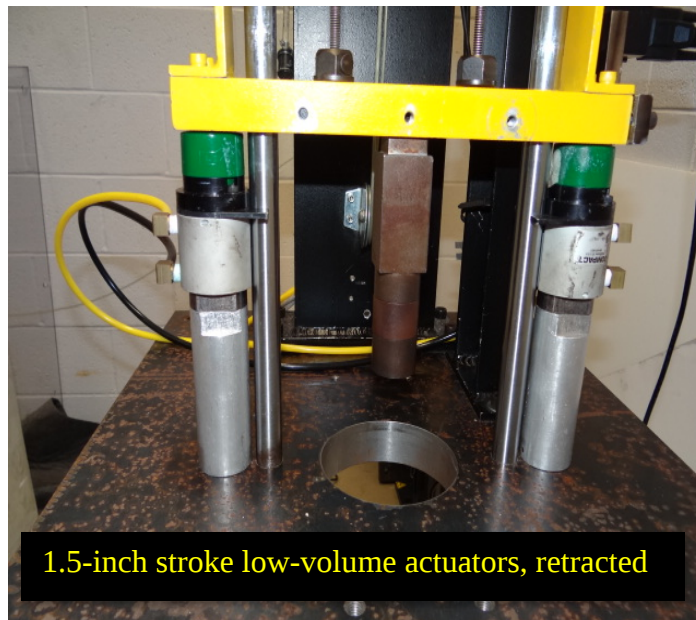


Fig. 2 Original equipment manufactured pneumatic brake actuators

Recently, it was suspected that releasing masses greater than 11 lb (5 kg) from heights greater than 30 inches (0.76 m) produced an undesirable secondary tup impact during the crosshead rebounding period. In test cases where coupons require ASTM D7137/D7137M-12² Compression After Impact test, the coupons are required to be subjected to a single impact from the ASTM D7136 test. Having

multiple impacts from the drop tower testing can have direct influence on the coupon's residual strength. We set up a single Integrated Design Tools (IDT) Os5 4K high-speed digital camera with a frame rate of 1000 fps to capture the tup impact and rebound period on a generic scrap 0.20-inch-thick laminate (Fig. 3). We discovered the current system proved to be insufficient to halt repeated impacts from heavier mass assemblies for a single test. The Instron Impulse data collection software used by the test frame has a maximum recording time period of 100 ms. This misses the recording time period of the second and third impacts that start to occur around 500 ms. The nature of the rebound in amplitude and period after the initial impact can vary as the reaction is based on the material stiffness. Figure 4 shows tup impact period sequence stills.

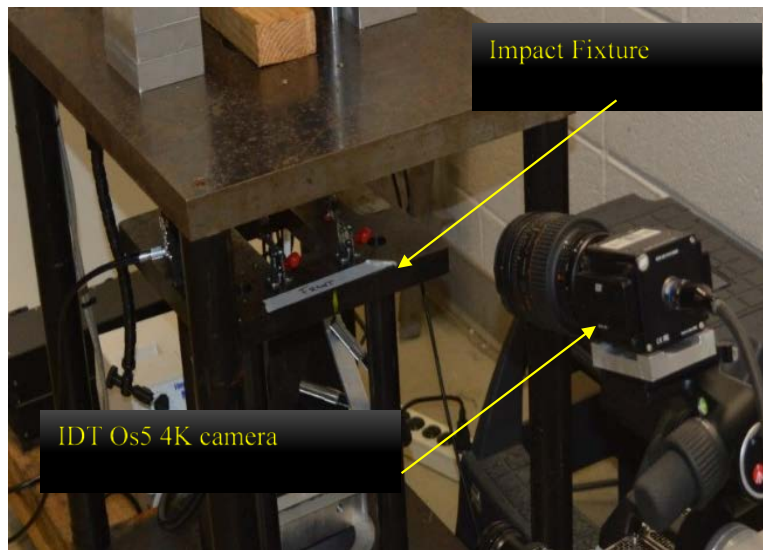


Fig. 3 IDT Os5 4K high-speed digital camera to capture tup impact period

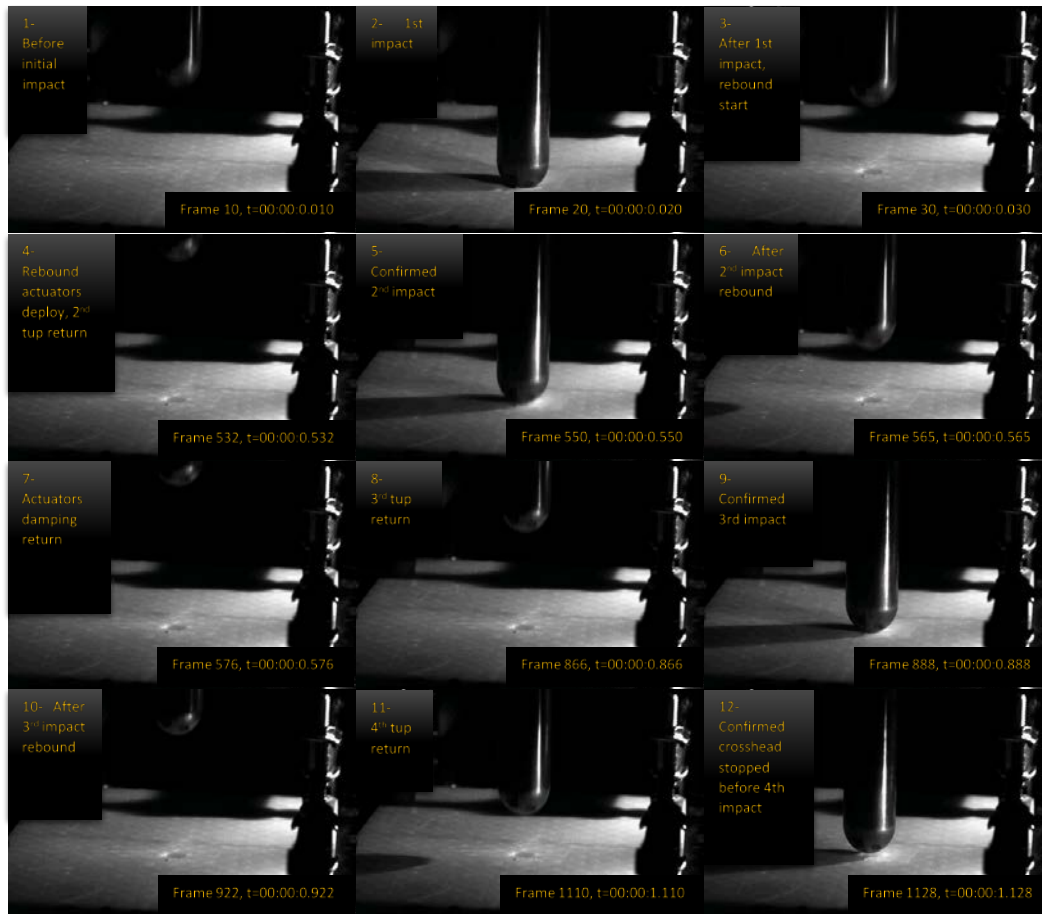


Fig. 4 Tup impact period sequence stills of generic laminate using old pneumatic rebound system

To correct this deficiency, larger 2-inch bore, 3-inch stroke 120-psi pneumatic cylinders with 3/8 inch OD/0.245-inch ID airlines were used to upgrade the rebound system (Fig. 5). To verify the effectiveness of the new system, the IDT Os5 4K camera was used again to capture the tup impact and rebound period at 1000 fps.

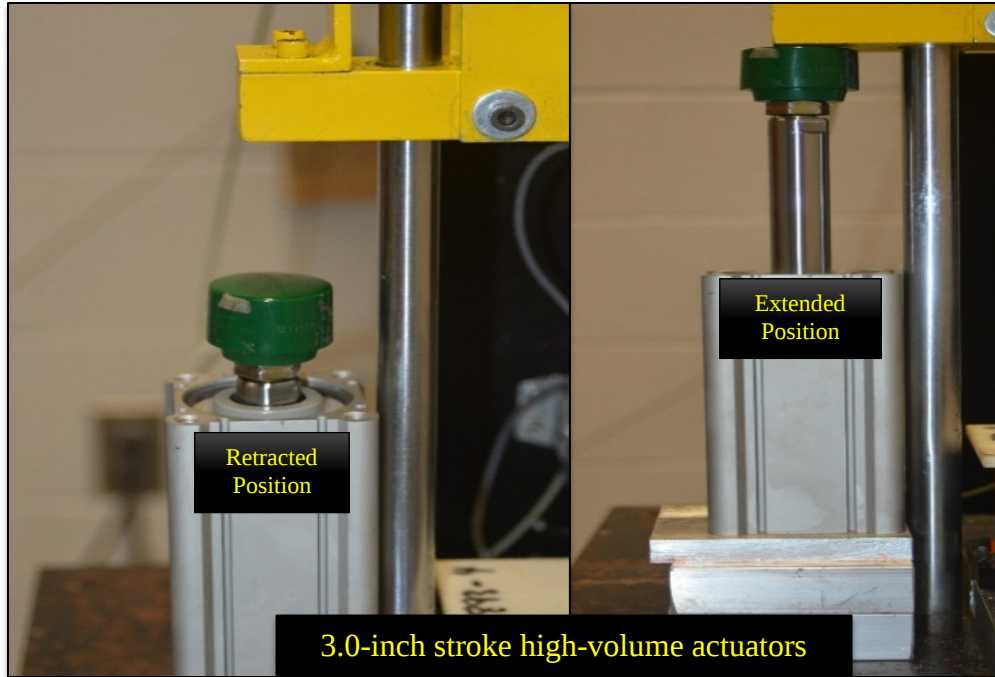


Fig. 5 New upgraded 3-inch pneumatic cylinders

Figure 6 shows sequenced stills from a 0.24-inch-thick carbon fiber composite material impact test using the updated 3-inch rebound cylinders. With a 26.5-lb mass (12.02 kg) at 33-inch (0.838-m) drop height, the test yields an impact energy of about 74 ft-lb. (100 J). The sequence shows the tup prior to impact, impacting, rebounding from the plate, and being stopped by the pneumatic system prior to secondary contact.

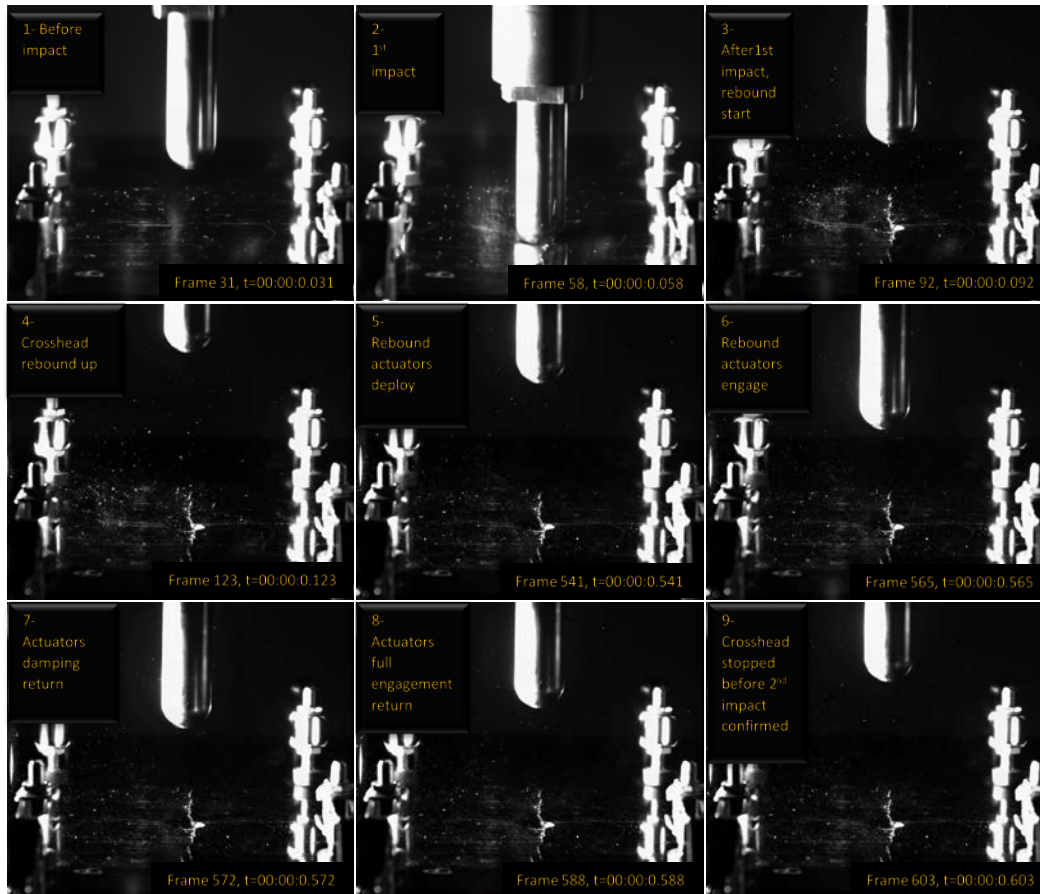


Fig. 6 Tup sequenced impact stills from carbon fiber composite laminate test material

3. Conclusion

We were able to successfully perform drop-weight standardized testing per ASTM D7136/D7136M using a heavier cross head mass assembly dropped from various heights with a single impact. Using high-speed photography, verification was made that a single impact was achieved on generic laminate material coupons. The GRC Dynatup 8200 Drop Weight system was outfitted with 2 large bore, longer stroke pneumatic actuators and 3/8-inch OD/0.245-inch ID airlines. This update eliminated the secondary rebound impacts that had occurred with the previous pneumatic system under the same drop conditions.

4. References

1. ASTM D7136/D7136M-15. Standard test method for measuring the damage resistance of a fiber-reinforced polymer matrix composite to a drop-weight impact event. West Conshohocken (PA): ASTM International; 2015.
2. ASTM D7137/D7137M-12. Standard test method for compressive residual strength properties of damaged polymer matrix composite plates. West Conshohocken (PA): ASTM International; 2012.

1 DEFENSE TECHNICAL
(PDF) INFORMATION CTR
DTIC OCA

2 DIRECTOR
(PDF) US ARMY RESEARCH LAB
RDRL CIO L
IMAL HRA MAIL & RECORDS
MGMT

1 GOVT PRINTG OFC
(PDF) A MALHOTRA

3 DIR USARL
(PDF) RDRL WMM A
B LAWRENCE
RDRL WMM B
D GRAY
R KASTE