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HE FRICTION SENSITIVITY

OBLIQUE IMPACT SENSITIVITY OF EXPLOSIVES

THE SKID TEST

HALF-INCH GAP SENSITIVITY TEST

SANL 712-009 (Jan-mar)

J. H. Van Velkinburgh

January, February, March 1970

ATOMIC ENERGY COMMISSION UNITED STATES OF AMERICA

DEVELOPMENT DIVISION

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MASTER

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The study of the friction sensitivity of HE and the mechanism of frictional initiation via an apparatus which subjects the explosive to shear while under a sustained normal loading force.

The use and study of a sensitivity test of large bare explosive charges to oblique impact, a condition resembling possible operational accidents.

The use of a sensitivity test to determine relative shock sensitivities of small diameter samples.

ABSTRACT

Vertical drop tests were completed on several explosives. Results are given and discussed.

Oblique impact tests were performed on the extrusion cast explosive RX-08-AZ. No reactions were observed in the severest of impacts.

Half-inch gap test series were performed on two lots of LX-09-0. Results are tabulated.

No experimental work with the friction test apparatus was done this period.

DISCUSSION

The Skid Test

Work has continued on the vertical drop test. Several more materials have been tested. The maximum spot diameter, billet weight and coefficient of restitution (COR) obtained from both the accelerometer and Fastax films are given in Table I.

The coefficient of restitution values obtained by the two different methods are in some cases significantly different. No acceptable explanation of these differences has been found. It was felt that the COR values from the Fastax films were the more reliable of the two values, in most cases. Thus, the acceleration time histories should probably be normalized so that the COR values are the same as those from the Fastax film.

Two oblique impact tests were done on the extrusion cast explosive RX-08-AZ. One test was done at 14° impact angle and 7.1-ft. drop height; no reaction was observed. The other was done at 45° impact angle and 20.0-ft. drop height. In this test the billet missed the sanded steel target, striking the concrete block instead. No reaction was observed. In neither test was any evidence of cracking or mechanical failure observed.

Half-Inch Gap Sensitivity

Half-inch gap series were performed on two lots of LX-09-0 (materials and labor were charged to Production accounts).

Lot	Density (g/cc)	$G_{50} \pm L_{95}$ (mils)
HOL 94-7	1.841	84 ± 8
HOL 94-8	1.838	88 ± 4

Table I

Vertical Drop Test Results
(11-inch Hemispherical Billets)

Material	Drop Height (ft)	Billet Wt. (lbs)	Maximum Impact Spot Diameter (in)	Coefficient of Restitution Accelerometer	Coefficient of Restitution Fastax
LX-04-1*	4.0	22.06	1.52	0.49	0.42
LX-07-1*	2.0	22.67	1.26	0.51	0.51
LX-09-0*	2.0	22.83	1.24	0.53	0.52
RX-04-DJ*	4.0	22.56	1.47	0.54	0.49
RX-04-DJ*	4.0	22.62	1.46	0.54	0.49
PBX-9011*	4.0	22.06	1.52	0.53	0.45
LX-04-1	4.0	21.86	1.43	0.50	0.48
LX-04-1	8.0	21.48	1.69	0.53	0.52
LX-04-1	8.0	22.62	1.69	0.51	Film Lost
PBX-9011	4.0	21.13	1.43	0.58	0.56
PBX-9011	8.0	21.42	1.72	0.36	0.50
PBX-9011	8.0	21.00	1.67	0.50	0.50
PBX-9404	0.5	23.13	0.81	0.63	0.63
PBX-9404	2.0	23.18	1.15	0.69	0.59
PBX-9404**	0.5	3.76	0.47	0.82	0.71
PBX-9404**	1.0	3.75	0.57	0.64	0.60
PBX-9404**	2.0	3.75	0.66	0.53	0.56
PBX-9404**	4.0	3.75	0.77	0.26	0.45

**Performed last period. Reported here because Fastax films not processed at time of last report.*

***6-inch diameter hemispheres.*

FUTURE WORK; COMMENTS; CONCLUSIONS

The vertical drop tests have been nearly completed. In this test acceleration versus time and maximum contact spot diameter are recorded. The derived velocity-time and position-time histories enable the determination of the constant that relates contact area to the vertical displacement of the billet. Permanent deformation and values of flow stress can then be determined. These values are obtained for several different drop heights (corresponding to different strain rates) and are being used in the normalizing of a computer code to describe the skid test. The experiments done to date are:

Explosive	Diameter (in)	Drop Height (ft)
LX-04-1	11	1,1,2,2,4,4,8,8
LX-07-1	11	2,2
LX-09-0	11	2,2
LX-10-0	11	1,2
PBX-9011	11	1,1,2,2,4,4,8,8
PBX-9404	11	1/2,1,1,2
RX-04-DJ	11	4,4
PBX-9404	6	1/2,1,2,4

A series of accelerometer instrumented skid tests at 45° and 14° of 11-inch diameter hemispherical billets onto standard skid test surfaces will commence shortly.

Table II

Vertical Drop Test
Acceleration-Time Histories

LX-04-1
4-ft. Vertical Drop
Accel. COR = 0.50

Time (ms)	Acceleration (gees)
.00	0
.05	30
.10	90
.15	210
.20	360
.25	550
.30	760
.35	960
.40	1170
.45	1330
.50	1420
.55	1440
.60	1420
.65	1300
.70	1140
.75	930
.80	720
.85	510
.90	330
.95	200
1.00	100
1.05	30
1.10	0

LX-04-1
8-ft. Vertical Drop
Accel. COR = 0.53

Time (ms)	Acceleration (gees)
.00	0
.05	60
.10	200
.15	430
.20	750
.25	1070
.30	1380
.35	1700
.40	1960
.45	2140
.50	2210
.55	2170
.60	1990
.65	1700
.70	1370
.75	1040
.80	720
.85	430
.90	210
.95	70
1.00	0

Table II - Continued

LX-04-1
8-ft. Vertical Drop
Accel. COR = 0.51

Time (ms)	Acceleration (gees)
.00	0
.05	60
.10	170
.15	390
.20	700
.25	1010
.30	1310
.35	1630
.40	1880
.45	2070
.50	2180
.55	2160
.60	2020
.65	1740
.70	1410
.75	1070
.80	740
.85	420
.90	210
.95	80
1.00	0

PBX-9011
4-ft. Vertical Drop
Accel. COR = 0.58

Time (ms)	Acceleration (gees)
.00	0
.05	50
.10	150
.15	300
.20	500
.25	760
.30	1070
.35	1380
.40	1590
.45	1700
.50	1730
.55	1630
.60	1440
.65	1170
.70	910
.75	660
.80	400
.85	220
.90	90
.95	20
.97	0

Table II - Continued

PBX-9011
8-ft. Vertical Drop
Accel. COR = 0.36

Time (ms)	Acceleration (gees)
.00	0
.05	90
.10	240
.15	520
.20	800
.25	1080
.30	1330
.35	1610
.40	1800
.45	1890
.50	1900
.55	1850
.60	1720
.65	1480
.70	1200
.75	850
.80	550
.85	270
.90	70
.94	0

PBX-9011
8-ft. Vertical Drop
Accel. COR = 0.50

Time (ms)	Acceleration (gees)
.00	0
.05	70
.10	210
.15	460
.20	770
.25	1130
.30	1460
.35	1780
.40	2010
.45	2160
.50	2210
.55	2150
.60	1960
.65	1630
.70	1220
.75	800
.80	460
.85	270
.90	170
.95	100
1.00	30
1.03	0

Table II - Continued

PBX-9404
1/2-ft. Vertical Drop
Accel. COR = 0.63

Time (ms)	Acceleration (gees)
.00	0
.05	20
.10	60
.15	110
.20	170
.25	250
.30	340
.35	420
.40	490
.45	520
.50	550
.55	550
.60	510
.65	460
.70	390
.75	320
.80	240
.85	160
.90	100
.95	50
1.00	20
1.03	0

PBX-9404
2-ft. Vertical Drop
Accel. COR = 0.69

Time (ms)	Acceleration (gees)
.00	0
.05	50
.10	130
.15	260
.20	400
.25	600
.30	810
.35	1010
.40	1200
.45	1310
.50	1330
.55	1240
.60	1090
.65	890
.70	680
.75	480
.80	290
.85	110
.90	30
.93	0

Table II - Continued

PBX-9404
6-inch Diameter
1/2-ft. Vertical Drop
Accel. COR = 0.82

Time (ms)	Acceleration (gees)
.00	0
.05	40
.10	110
.15	220
.20	400
.25	610
.30	800
.35	900
.40	930
.45	880
.50	730
.55	470
.60	260
.65	80
.70	0

PBX-9404
6-inch Diameter
1-ft. Vertical Drop
Accel. COR = 0.64

Time (ms)	Acceleration (gees)
.00	0
.05	20
.10	110
.15	280
.20	570
.25	950
.30	1250
.35	1390
.40	1360
.45	1080
.50	720
.55	360
.60	80
.65	10
.67	0

Table II - Continued

PBX-9404
6-inch Diameter
2-ft. Vertical Drop
Accel. COR = 0.53

Time (ms)	Acceleration (gees)
.00	0
.05	80
.10	260
.15	610
.20	1070
.25	1570
.30	1860
.35	1900
.40	1560
.45	1090
.50	600
.55	190
.60	20
.61	0

PBX-9404
6-inch Diameter
4-ft. Vertical Drop
Accel. COR = 0.26

Time (ms)	Acceleration (gees)
.00	0
.05	70
.10	270
.15	700
.20	1180
.25	1620
.30	1980
.35	2030
.40	1750
.45	1330
.50	870
.55	510
.60	200
.65	20
.67	0