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COMPARISON OF THE RELATIVE EFFECTS OF IMPACT TESTS ON GLASS USING STEEL AND POLYAMIDE IMPACT FACES

by

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PURPOSE

A controversy has arisen in Working Group No. 3 of the International Electrotechnical Commission Technical Committee 31 over the relative merits of using steel or polyamide faces for the impact test device for testing transparent parts of flameproof enclosures.

Steel is acknowledged to be the more severe and its occurrance in mines and other industries is far more common than polyamide. However, some delegates have argued that the polyamide impact face gives more consistent results because it does not tend to chip the surface of the glass.

At the last meeting of W.G. 3 in November 1974, it was agreed that we should conduct further research into this subject in four different countries. As the author is the member for Canada, we agreed to participate.

METHOD

In order to have comparable results between the participating countries, the following proceedure was agreed upon at the November meeting: Mild steel rings shall be used to support the glass having nominal dimensions as follows:*

(a) Diameter: 100 mm inside
110 mm outside

Thickness: 10 mm

(b) Diameter: 150 mm inside
160 mm outside

Thickness: 10mm

* In order to simplify the construction of the steel support rings it was agreed that the nearest standard pipe size could be used. Our ring measured 90 mm inside and 100 mm outside.

Squares of ordinary sheet glass of a size just to cover the ring completely and having a thickness of about 3 mm, 4 mm and 6 mm should be used as test pieces. The actual thickness will be measured before each test is made.

Two hammers of mass 250g and 1kg, first with face of hardened steel and secondly polyamide (Nylon 6.6), diameter of 25mm shall be used to drop on the centre of the test pieces of glass

10 samples will be tested in each test using:-

(a) 2 sizes of ring.

(b) 2 masses

(c) 2 face materials

(d) 3 thicknesses of glass

i.e. 240 tests

The members from Canada and U.K. will use the small ring and conduct 120 tests as above. The members from France and Yugoslavia will use the larger ring and conduct 120 tests as above.

The tests shall be made on each sample after measuring the surfaces by dropping the hammer onto the centre of the glass and increasing the severity of the impact energy in about 10% steps at first then about 25% steps in larger energies until breakage occurs.

RESULTS

The results are tabulated in Tables 1 and 2 and plotted on Figures 1, 2, 3 and 4.

DISCUSSION OF RESULTS

Estimates of the relative severity of steel as compared with polyamide for the impact face ranged from 2 to 3 times. Our results indicate that steel is more severe by a ratio of 1.6/1 for the 250 gram weight and only 1.1/1 for the 1 Kg. weight.

Another interesting result can be seen from the vertical bars on figures 1 to 4 inclusive which indicate the range of impact for each thickness of glass. Figures 1 and 3 for the steel impact face clearly show less "scatter" in results than Figures 2 and 4 for the polyamide impact face. This appears to contradict the argument that polyamide gives more consistent results.

Figure 1 shows that less impact energy was required to break the 5.74 mm glass samples than the 4.95 mm samples when using the 250 gram weight and the steel impact face. This is contrary to all of the other results and may have been due to inconsistencies in the glass used for these tests. However, the agreement at the meeting was that ordinary untreated glass would be used for these experiments. Although the glass samples, for each series of 10 tests, were all cut from the same sheet of glass, we noted that samples which were adjacent to one another before cutting often exibited wide variations in impact strength.

TABLE 1

RESULTS OF IMPACT TESTS ON GLASS PLATES

Sample No.	Glass Thickness MM.	Mass of Hammer	Impact Face Material	Height of Hammer To Break Glass CM.
1	2.69	1 Kg	Polyamide	10
2	"	"	"	6
3	"	"	"	5 1/2
4	"	"	"	6 1/2
5	"	"	"	10
6	4.95	"	"	11
7	"	"	"	14
8	"	"	"	16
9	"	"	"	33
10	"	"	"	15
11	5.74	"	"	33
12	"	"	"	22
13	"	"	"	26
14	"	"	"	33
15	"	"	"	22
16	2.69	1 Kg	Steel	10
17	"	"	"	7
18	"	"	"	8
19	"	"	"	5
20	"	"	"	6
21	4.95	"	"	18
22	"	"	"	14
23	"	"	"	16
24	"	"	"	24
25	"	"	"	17
26	5.74	"	"	22
27	"	"	"	20
28	"	"	"	19
29	"	"	"	18
30	"	"	"	24
31	2.69	250 g	Polyamide	22
32	"	"	"	19
33	"	"	"	18
34	"	"	"	15
35	"	"	"	14
36	"	"	Steel	13
37	"	"	"	16
38	"	"	"	10
39	"	"	"	11
40	"	"	"	19

TABLE 1 (continued)

Sample No.	Glass Thickness MM.	Mass of Hammer	Impact Face Material	Height of Hammer To Break Glass CM.
41	4.95	250 g	Polyamide	40
42	"	"	"	70
43	"	"	"	70
44	"	"	"	26
45	"	"	"	28
46	"	"	Steel	44
47	"	"	"	44
48	"	"	"	28
49	"	"	"	53
50	"	"	"	64
51	5.74	"	Polyamide	58
52	"	"	"	77
53	"	"	"	70
54	"	"	"	94
55	"	"	"	70
56	"	"	Steel	28
57	"	"	"	30
58	"	"	"	39
59	"	"	"	40
60	"	"	"	44
61	2.69	1 Kg	Polyamide	5 1/2
62	"	"	"	5 1/2
63	"	"	"	5
64	"	"	"	5
65	"	"	"	4
66	"	"	Steel	5
67	"	"	"	3
68	"	"	"	5 1/2
69	"	"	"	4
70	"	"	"	4
71	4.95	"	Polyamide	9
72	"	"	"	14
73	"	"	"	16
74	"	"	"	10
75	"	"	"	12
76	"	"	Steel	10
77	"	"	"	11
78	"	"	"	7
79	"	"	"	6
80	"	"	"	15

TABLE 1 (continued)

Sample No.	Glass Thickness MM.	Mass of Hammer	Impact Face Material	Height of Hammer To Break Glass CM.
81	5.74	1 Kg	Polyamide	12
82	"	"	"	10
83	"	"	"	20
84	"	"	"	11
85	"	"	"	11
86	"	"	Steel	11
87	"	"	"	16
88	"	"	"	14
89	"	"	"	18
90	"	"	"	17
91	2.69	250 g	Polyamide	12
92	"	"	"	22
93	"	"	"	12
94	"	"	"	10
95	"	"	"	15
96	"	"	Steel	11
97	"	"	"	10
98	"	"	"	12
99	"	"	"	8
100	"	"	"	9
101	4.95	"	Polyamide	44
102	"	"	"	104
103	"	"	"	22
104	"	"	"	20
105	"	"	"	122
106	"	"	Steel	48
107	"	"	"	53
108	"	"	"	24
109	"	"	"	44
110	"	"	"	40
111	5.74	"	Polyamide	115
112	"	"	"	104
113	"	"	"	77
114	"	"	"	122
115	"	"	"	40
116	"	"	Steel	40
117	"	"	"	36
118	"	"	"	40
119	"	"	"	36
120	"	"	"	44

TABLE 2

SUMMARY OF IMPACT TESTS ON GLASS PLATES

Glass Thickness MM.	Weight of Impact Mass	Impact Face Material	Height of Impact Mass To Break Glass CM		
			Min.	Average	Max.
2.69	250 g	Steel	10.0	11.9	19.0
4.95	250 g	Steel	28.0	44.2	64.0
5.74	250 g	Steel	36.0	38.6	44.0
2.69	250 g	Polyamide	10.0	15.9	22.0
4.95	250 g	Polyamide	20.0	54.3	122.0
5.74	250 g	Polyamide	30.0	82.2	122.0
2.69	1 Kg	Steel	3.0	5.8	10.0
4.95	1 Kg	Steel	6.0	13.8	24.0
5.74	1 Kg	Steel	11.0	17.9	24.0
2.69	1 Kg	Polyamide	5.5	6.3	10.0
4.95	1 Kg	Polyamide	9.0	15.0	33.0
5.74	1 Kg	Polyamide	10.0	20.0	33.0

Figure 1: Height of Drop Required for a 250 gram Hammer With a Steel Impact Face to Break Flat Glass Plates

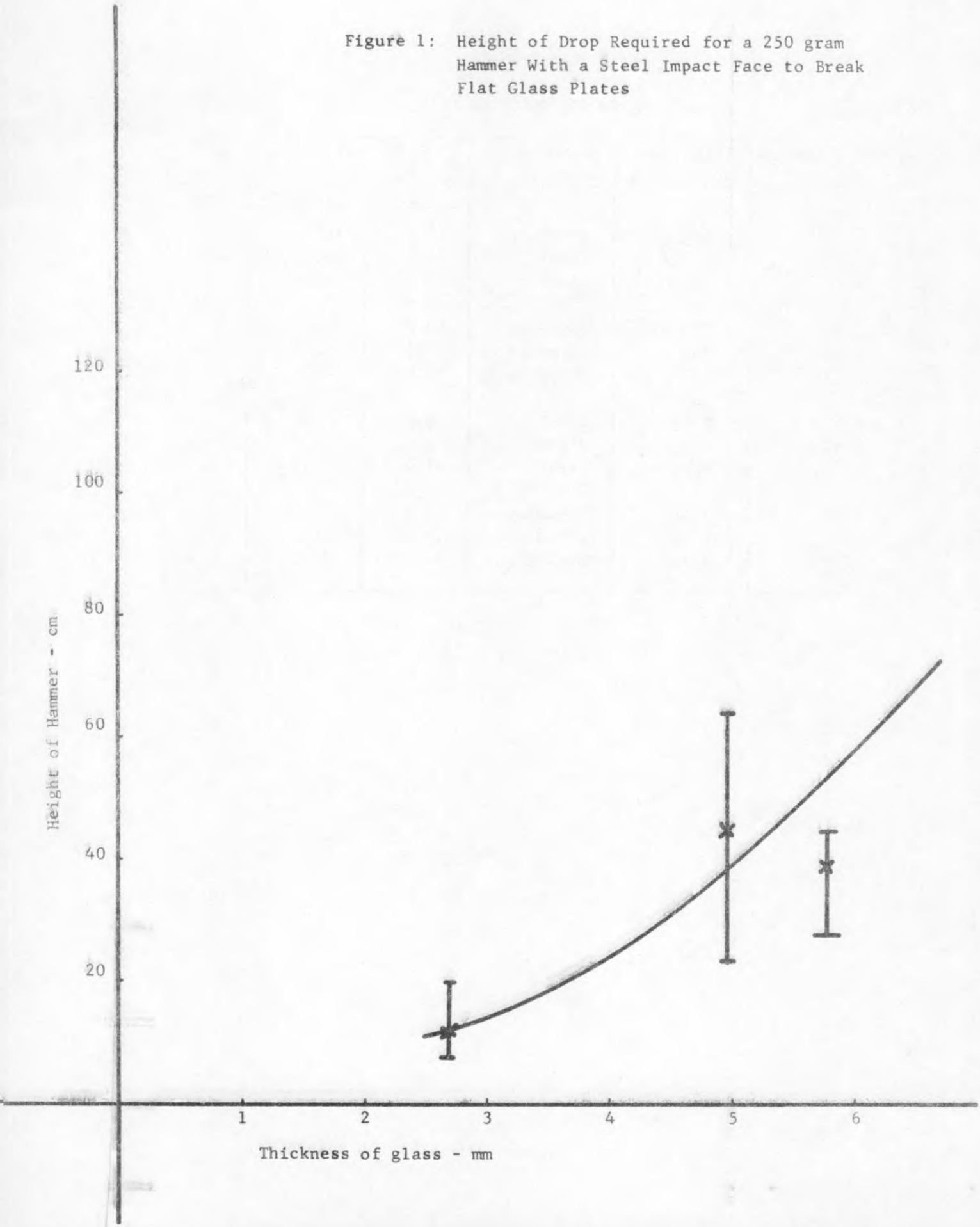

Figure 2: Height of Drop Required For a 250 gram Hammer With a Polyamide Impact Face to Break Flat Glass Plates

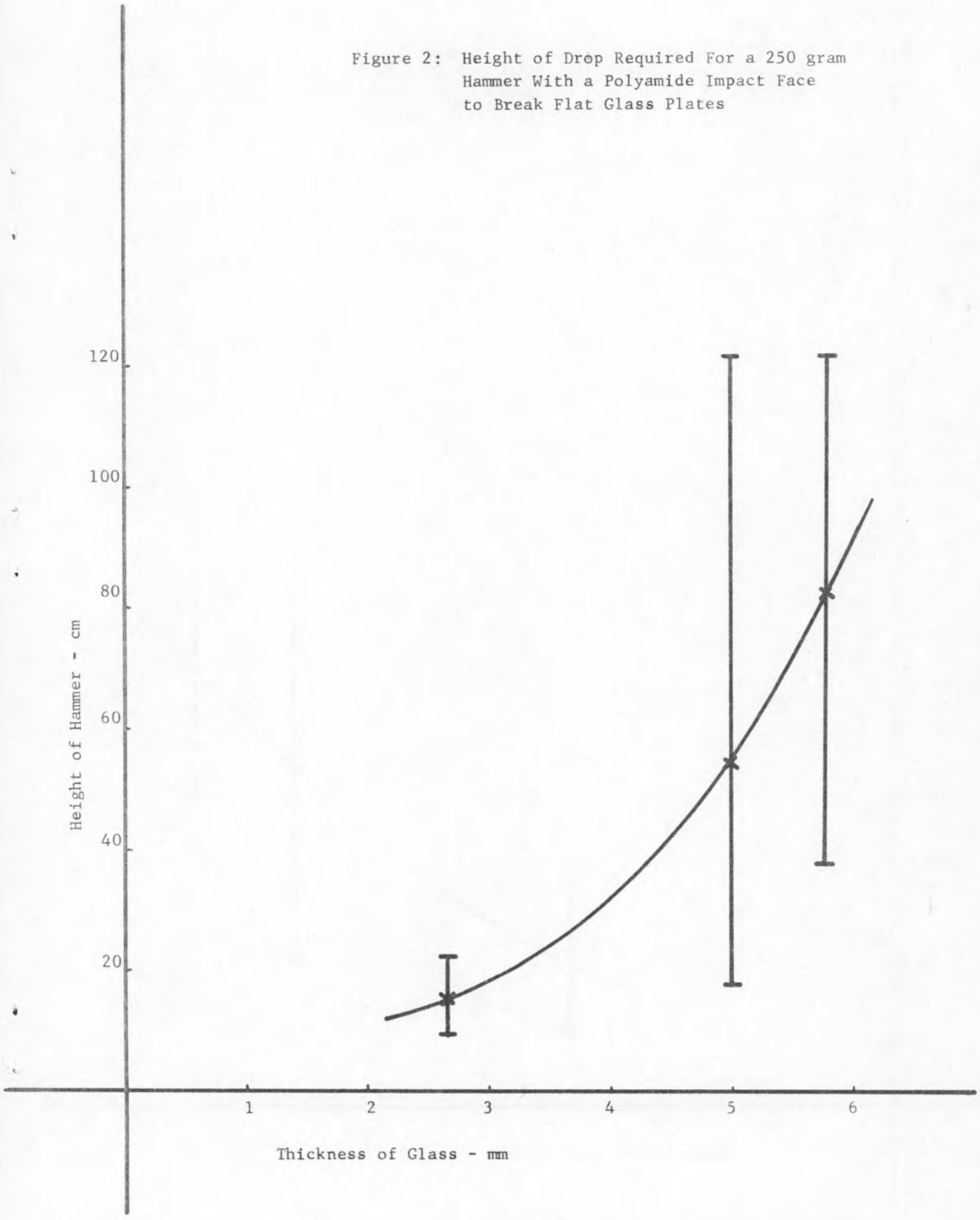

Figure 3: Height of Drop Required For a 1 Kilogram Hammer With a Steel Impact Face to Ereak Flat Glass Plates

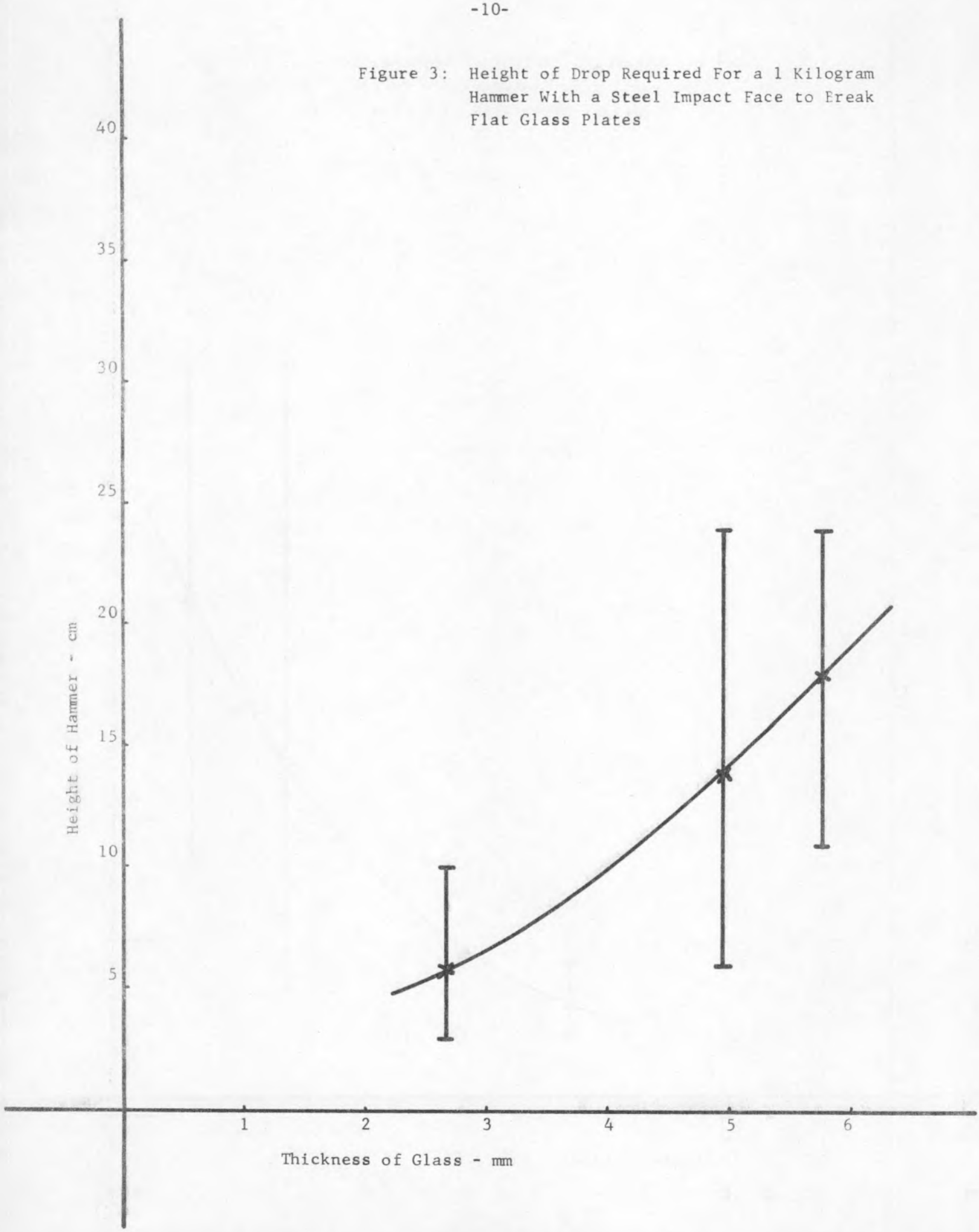

Figure 4: Height of Drop Required for a 1 Kilogram Hammer With a Polyamide Impact Face to Break Flat Glass Plates