WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

Wiss, Janney, Elstner Associates, Inc.
330 Pfingsten Road
Northbrook, Illinois 60062
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www.wje.com

Via Email: kszekely@engplastics.com

3 May 2005

Mr. Ken Szekely
Engineered Plastics, Inc.
300 International Drive, Suite 100
Williamsville, NY 14221

Re: Armor-Deck Structural Composite Plank Load Capacity Calculations
WJE No. 2005.1046

Dear Mr. Szekeley:

Wiss, Janney, Elstner Associates, Inc. (WJE) has recently completed calculations of load capacity for an Armor-Deck structural composite plank utilized in Metra exterior elevated train platforms. The load capacity calculations utilized dimensions obtained from design drawings provided by Engineered Plastics and material properties determined from laboratory tests performed by WJE at our facilities in Northbrook, Illinois. The results of the material property tests are summarized in the attached Table 1. The results of the engineering calculations are summarized in Table 2. The calculations that were performed to derive the load capacity evaluation are attached.

The calculations of load capacity were based upon bending moment diagrams for five different loading configurations shown in Figure 1 and were further based on assumptions of isotropic behavior in the flanges and no contribution of capacity from the webs of the planks. They did not include a shear analysis of the stresses in the webs. These assumptions are considered to be a conservative under-estimate of the load capacity. A more detailed analysis of the flexural capacity, accounting for the anisotropic behavior of the fiber-reinforced plastic (FRP) material would have included the contribution of the webs and would have likely resulted in a higher factor of safety.

The results of the calculations indicate that the planks have a minimum factor of safety of 89 for an applied live load of 125 psf. If you have any questions about the information provided in this letter please feel free to contact us.

Very truly yours,

WISS, JANNEY, ELSTNER ASSOCIATES, INC.

W. Robert Hannen. P.E..
Consultant, Project Manager

Attachments

Ltr Szekely Load Calculations 5-3-05.doc

Table 1 - Results of Material Prperty Tests

Engineered Plastics Material Tests
WJE No. 2005.1046
Tensile Tests per ASTM 638-03

Sample	Thickness (in)	Width (in)	Area (in^2)	Yield Load (lb)		Yield Stress (psi)	Peak Load (lb)	Peak Stress (psi)	Elongation (in)	Δ Load (lb)	Δ elong. (in)	Span (in)
1/4" 1	0.270	0.501	0.135	6237		46107	6850	50639		1000	0.068	4.5
1/4" 2	0.277	0.502	0.139	6740		48470	6740	48470	0.395	3000	0.086	4.5
1/4" 3	0.270	0.501	0.135	6470		47830	6470	47830	0.423	4000	0.129	4.5
1/4" 4	0.273	0.500	0.137	6120		44835	6120	44835	0.393	3000	0.096	4.5
1/4" 5	0.275	0.500	0.138	7450		54182	7450	54182	0.429	3000	0.085	4.5
1/4" 6	0.285	0.499	0.142	6290		44229	6770	47604	0.482	2000	0.085	4.5
Average	**0.275**	**0.501**	**0.138**	**6551**		**47609**	**6733**	**48927**	**0.424**	**2667**	**0.092**	**4.5**
1/8 H 1	0.145	0.503	0.073	533		7301	702	9625		500	0.208	4.5
1/8 H 2	0.141	0.508	0.072	571		7966	642	8963	0.236	200	0.070	4.5
1/8 H 3	0.141	0.500	0.071	618		8761	653	9262	0.255	400	0.145	4.5
1/8 H 4	0.146	0.502	0.073	580		7919	589	8036	0.226	400	0.134	4.5
1/8 H 5	0.137	0.503	0.069	561		8138	645	9360	0.245	400	0.138	4.5
1/8 H 6	0.138	0.501	0.069	545		7884	631	9127	0.264	400	0.140	4.5
Average	**0.141333**	**0.503**	**0.071**	**568**		**7995**	**644**	**9062**	**0.245**	**383**	**0.139**	**4.5**
1/8 V 1	0.130	0.506	0.066			0		0		600	0.121	4.5
1/8 V 2	0.130	0.506	0.066	2502		38036	2502	38036	0.243	1500	0.144	4.5
1/8 V 3	0.123	0.499	0.061	2784		45364	2928	47705	0.270	1000	0.091	4.5
1/8 V 4	0.126	0.501	0.063	2405		38098	2405	38098	0.239	1000	0.098	4.5
1/8 V 5	0.123	0.502	0.062	2746		44473	2746	44473	0.270	1000	0.098	4.5
1/8 V 6	0.124	0.499	0.062	2555		41292	2555	41292	0.289	1000	0.110	4.5
Average	**0.126**	**0.502**	**0.063**	**2598**		**34544**	**2627**	**34934**	**0.262**	**1017**	**0.110**	**4.5**

Flexural Tests per ASTM D790-03				Load at	defl at	Tan Modulus	Peak	Flex Strngth	Deflection	Δ Load	Δ elong.	Span
	d	b	Area	tangent	Tangent	(psi)	Load	(psi)	(in)	(lb)	(in)	(in)
1/4 1	0.236	1.001	0.236	249	0.154	1960700	453	48752	0.156	300	0.169	4
1/4 2	0.242	1.000	0.242	337	0.169	2254401	519	53173	0.263	300	0.141	4
1/4 3	0.237	1.002	0.237	369	0.200	2210879	554	59060	0.347	200	0.107	4
1/4 4	0.240	1.000	0.240	321	0.196	1897421	471	49063	0.328	200	0.122	4
1/4 5	0.247	1.001	0.247	219	0.130	1783842	311	30555	0.241	200	0.119	4
Average	**0.2404**	**1.001**	**0.241**	**299**		**2021448**	**462**	**48121**	**0.267**	**240**	**0.132**	**4.0**
1/4 1-2	0.249	1.000	0.249	316	0.160	2042468	551	53322	0.314	400	0.196	4
1/4 2-2	0.234	1.000	0.234	369	0.200	2301601	605	66294	0.361	300	0.159	4
1/4 3-2	0.245	1.000	0.245	358	0.182	2134381	568	56776	0.322	300	0.147	4
1/4 4-2	0.236	1.001	0.236	471	0.254	2255611	636	68446	0.382	300	0.165	4
1/4 5-2	0.233	1.000	0.233	386	0.228	2145048	582	64322	0.386	300	0.184	4
Average	**0.2394**	**1.000**	**0.239**	**380**		**2175822**	**588**	**61832**	**0.353**	**320**	**0.170**	**4.0**
1/8 H 1	0.134	0.507	0.068	39	0.088	732808	65	21420	0.233			2
1/8 H 2	0.135	0.501	0.068	33	0.062	854960	71	23328	0.216	20	0.040	2
1/8 H 3	0.137	0.501	0.069	26	0.047	861690	63	20099	0.190	20	0.035	2
1/8 H 4	0.133	0.502	0.067	29	0.054	887232	65	21960	0.200	20	0.037	2
Average	**0.13475**	**0.503**	**0.068**	**32**		**834172**	**66**	**21702**	**0.210**	**20**	**0.037**	**2.0**
1/8 V 1	0.130	0.498	0.065	38	0.043	1618209	188	67014	0.251	80	0.089	2
1/8 V 2	0.131	0.503	0.066	55	0.069	1421836	179	62211	0.272	80	0.098	2
1/8 V 3	0.138	0.500	0.069	61	0.080	1171898	177	55766	0.278	80	0.102	2
1/8 V 4	0.131	0.501	0.066	69	0.081	1493365	190	66297	0.255	80	0.096	2
1/8 V 5	0.132	0.505	0.067	74	0.100	1281572	165	56256	0.259	80	0.107	2
Average	**0.1324**	**0.501**	**0.066**	**59**		**1397376**	**180**	**61508**	**0.263**	**80**	**0.099**	**2.0**

Table 2 - Results of Load Calculations			
	Calculated Tensile Stress (psi)	Tested Ultimate Stress (psi)	Factor of Safety
Load Case	Flange	Flange	Flange
1	343	48,927	143
2	452	48,927	108
3	209	48,927	234
4	209	48,927	234
5	552	48,927	89

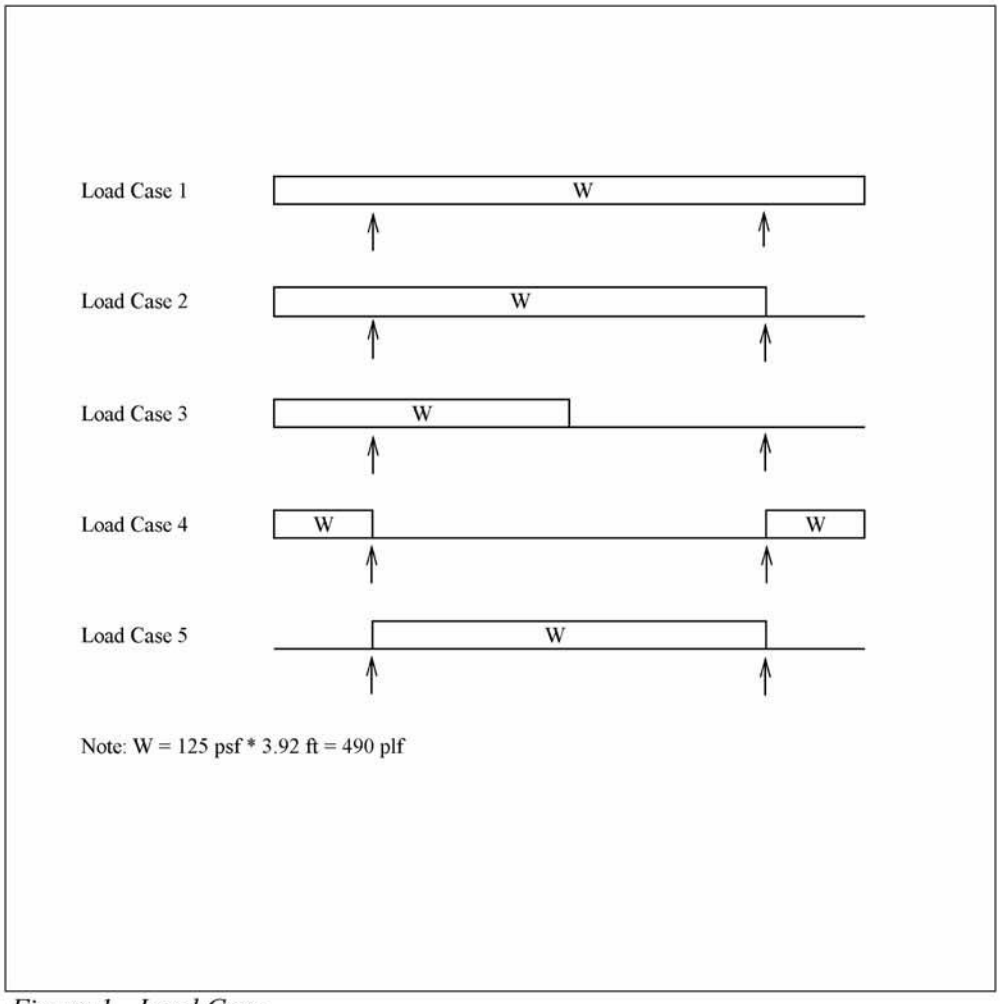


Figure 1 - Load Case

WJE	Wiss, Janney, Elstner Associates, Inc. 330 Pfingsten Road, Northbrook, IL 60062	MADE BY KWH	SHEET NUMBER 1 OF 6
		CHECKED BY	PROJ. NUMBER 2005.1042
		DATE 4/22/05	

CROSS-SECTIONAL PROPERTIES (SEE DWG. NO. AD-3123-4868M-BRYNO3)

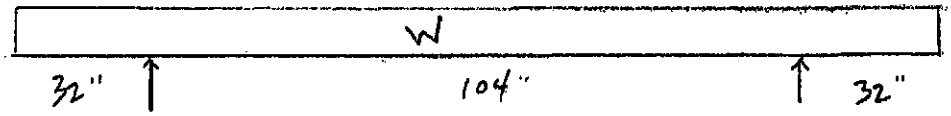
- MOMENT OF INERTIA
  - IGNORE SMALL DAP FOR ADJACENT PLATFORMS
  - IGNORE CONTRIBUTION OF WEB TO STIFFNESS (ONLY ACCOUNT FOR FLANGES) TO BE CONSERVATIVE

$$I = (2)\left[(1/12)(4\text{"})(1/4\text{"})^3 + (4\text{"})(1/4\text{"})(4/2 + 1/8\text{"})^2 \right] = 400 \text{ in}^4$$

- MOMENT CALCULATIONS FOR VARIOUS LOADINGS

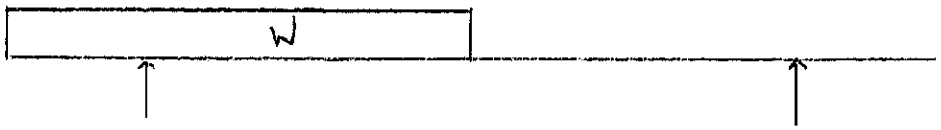
  $w = 125$ PSF (LL) $\quad W = (125)(3.92') = 490$ PLF $= 0.04083$ K/IN

LOAD CASE 1



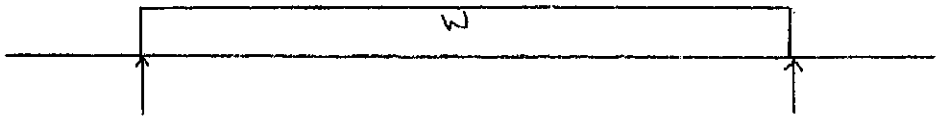
LOAD CASE 2

LOAD CASE 3



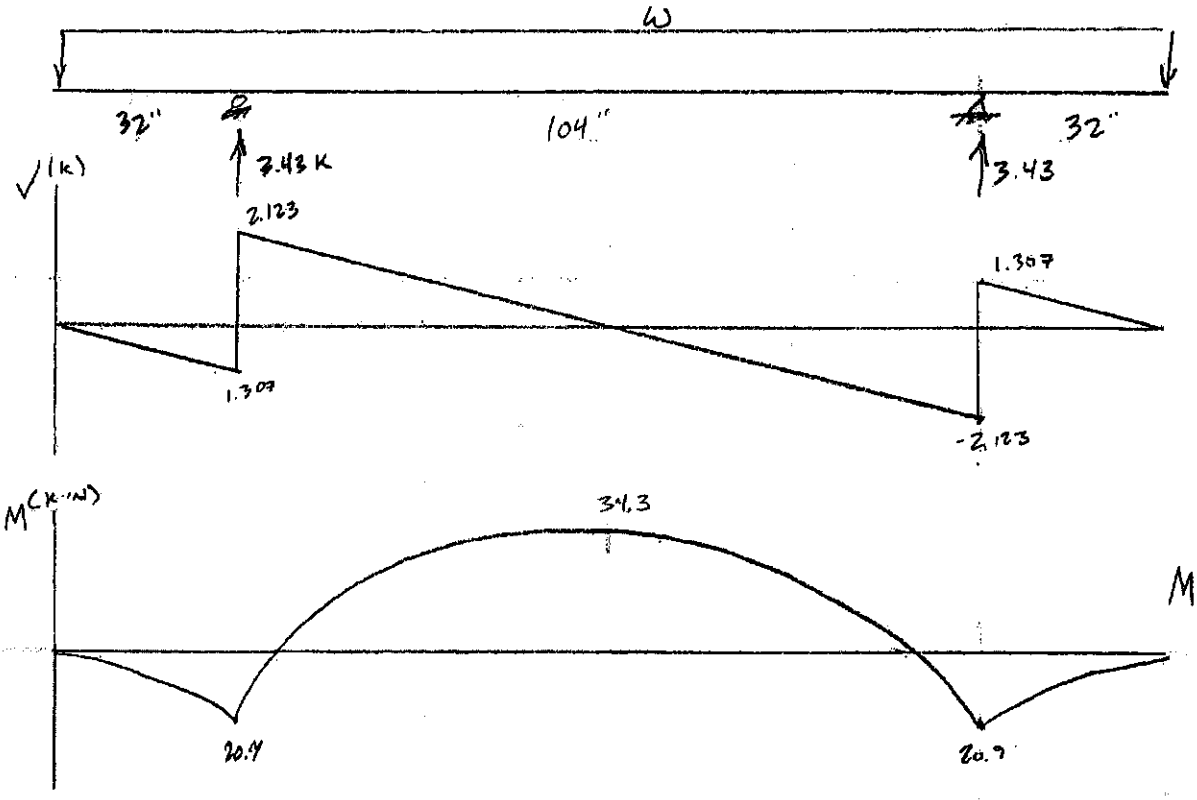
LOAD CASE 4

LOAD CASE 5



WJE	Wiss, Janney, Elstner Associates, Inc. 330 Pfingsten Road, Northbrook, IL 60062	MADE BY KWH	SHEET NUMBER 2 OF 6
		CHECKED BY	PROJ. NUMBER
		DATE 4/22/05	2005.1046

LOAD CASE 1: $w = 490\ PLF = 40.83\ PLI = 0.04083\ K/IN$



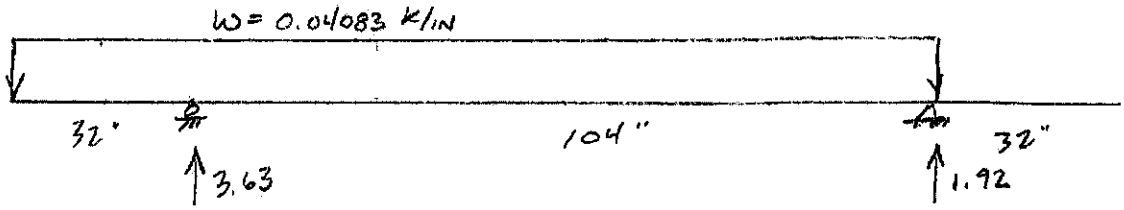
$V_{MAX} = 2.123\ K$

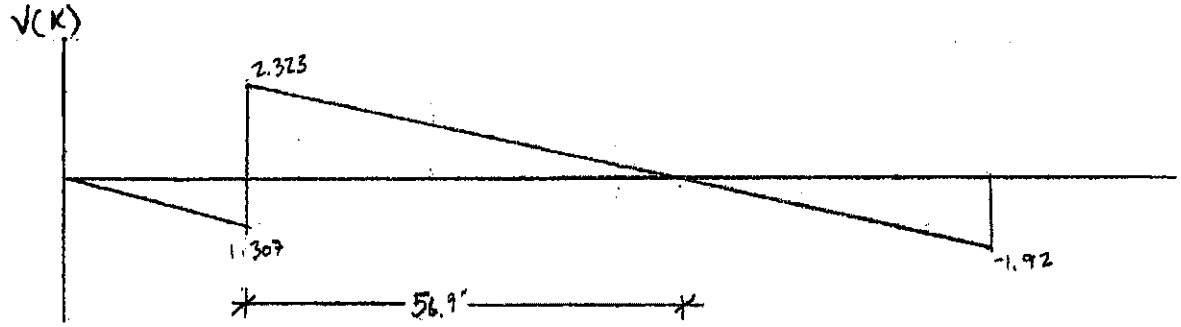
$M_{MAX} = 34.3\ K \cdot IN$

$$\sigma_F = \frac{Mc}{I} = \frac{(34.3)(4)}{400} = 343\ PSI$$

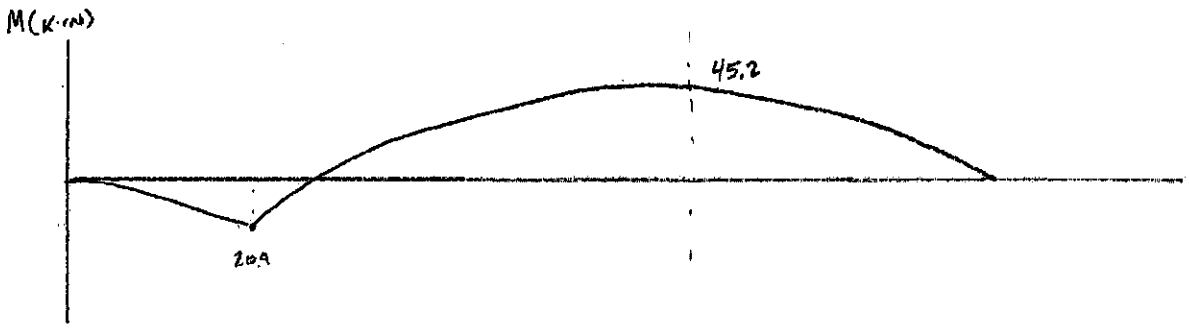
WJE	Wiss, Janney, Elstner Associates, Inc. 330 Pfingsten Road, Northbrook, IL 60062	MADE BY KWH	SHEET NUMBER 3 OF 6
		CHECKED BY	PROJ. NUMBER
		DATE 4/22/05	2005.1646

LOAD CASE 2:





$V_{MAX} = 2.323$ K

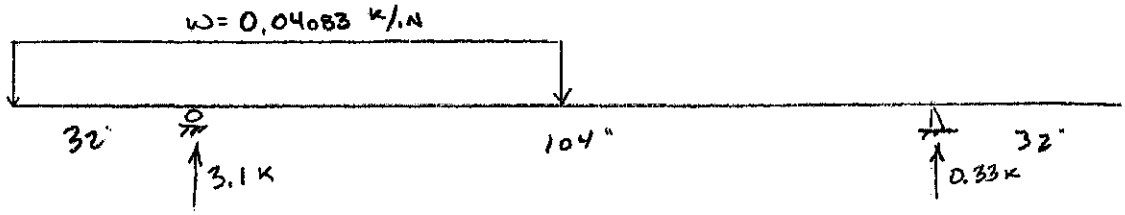


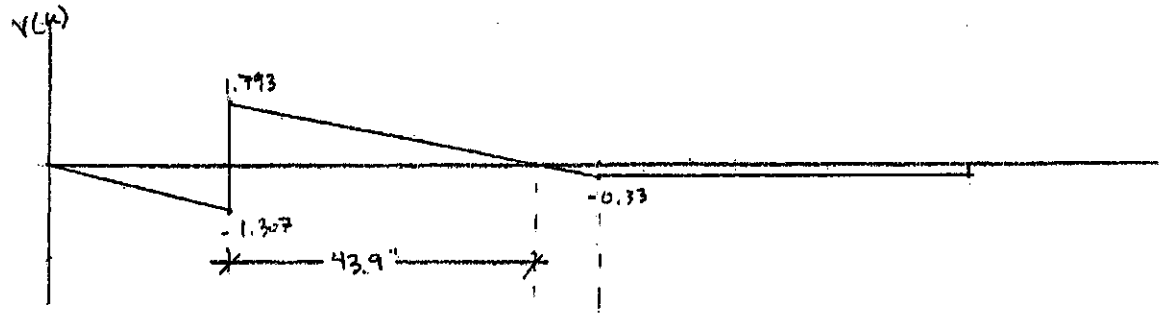
$M_{MAX} = 45.2$ K·IN

$$\sigma = \frac{(45.2)(4)}{400} = 452 \text{ PSI}$$

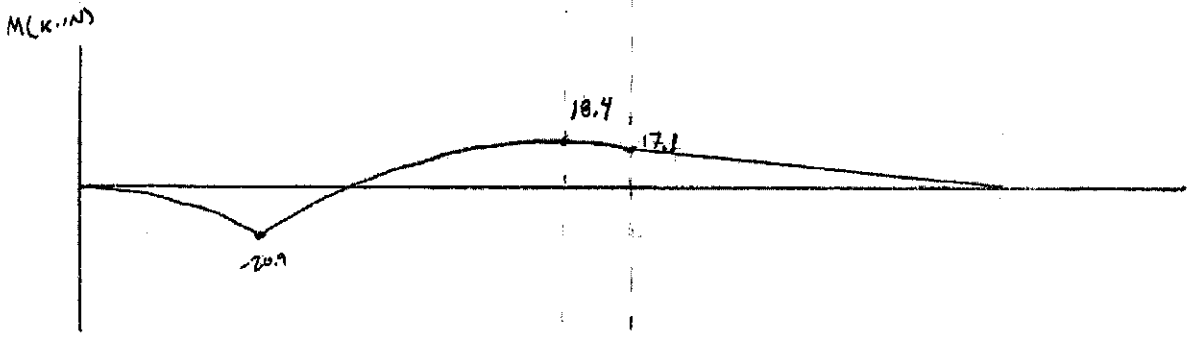
WJE	Wiss, Janney, Elstner Associates, Inc. 330 Pfingsten Road, Northbrook, IL 60062	MADE BY KWH	SHEET NUMBER 4 OF 6
		CHECKED BY	PROJ. NUMBER 2005.104
		DATE 4/22/05	

LOAD CASE 3:





$V_{MAX} = 1.793$ K

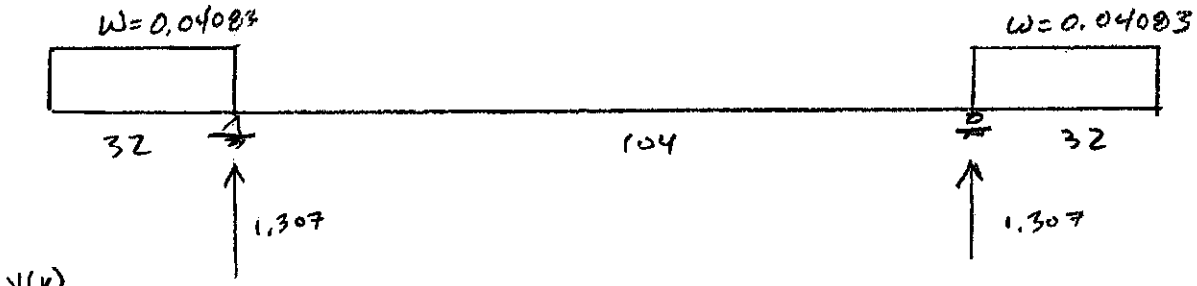


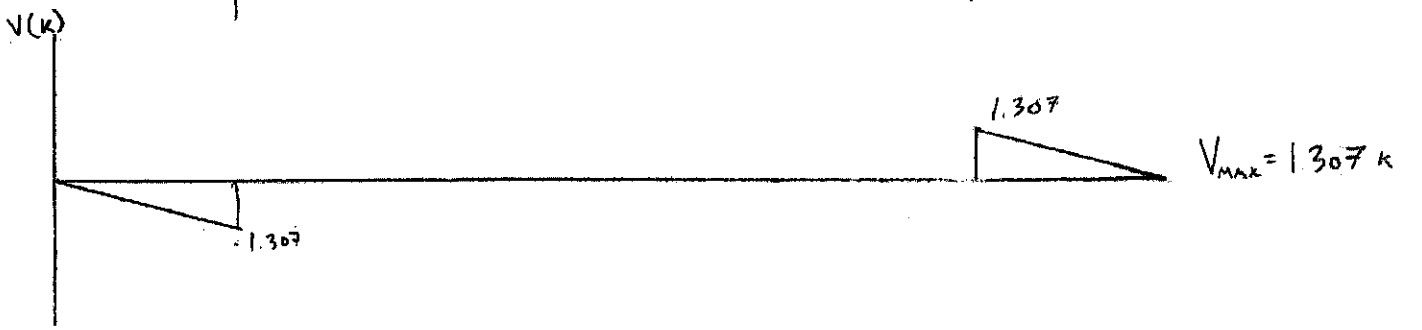
$M_{MAX} = 20.9$ K·IN

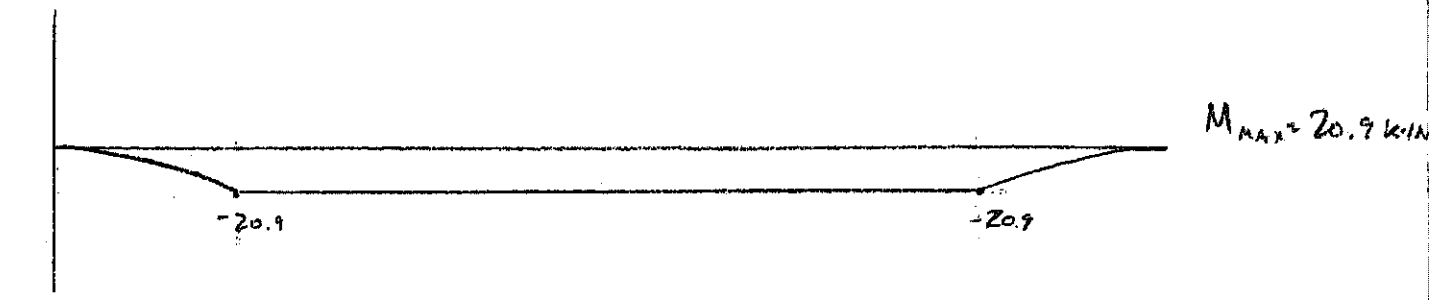
$$\sigma = \frac{(20.9)(4)}{400} = 209 \text{ PSI}$$

WJE	Wiss, Janney, Elstner Associates, Inc. 330 Pfingsten Road, Northbrook, IL 60062	MADE BY KWH	SHEET NUMBER 5 of 6
		CHECKED BY	PROJ. NUMBER 05.1046
		DATE 4/22/05	

LOAD CASE 4:



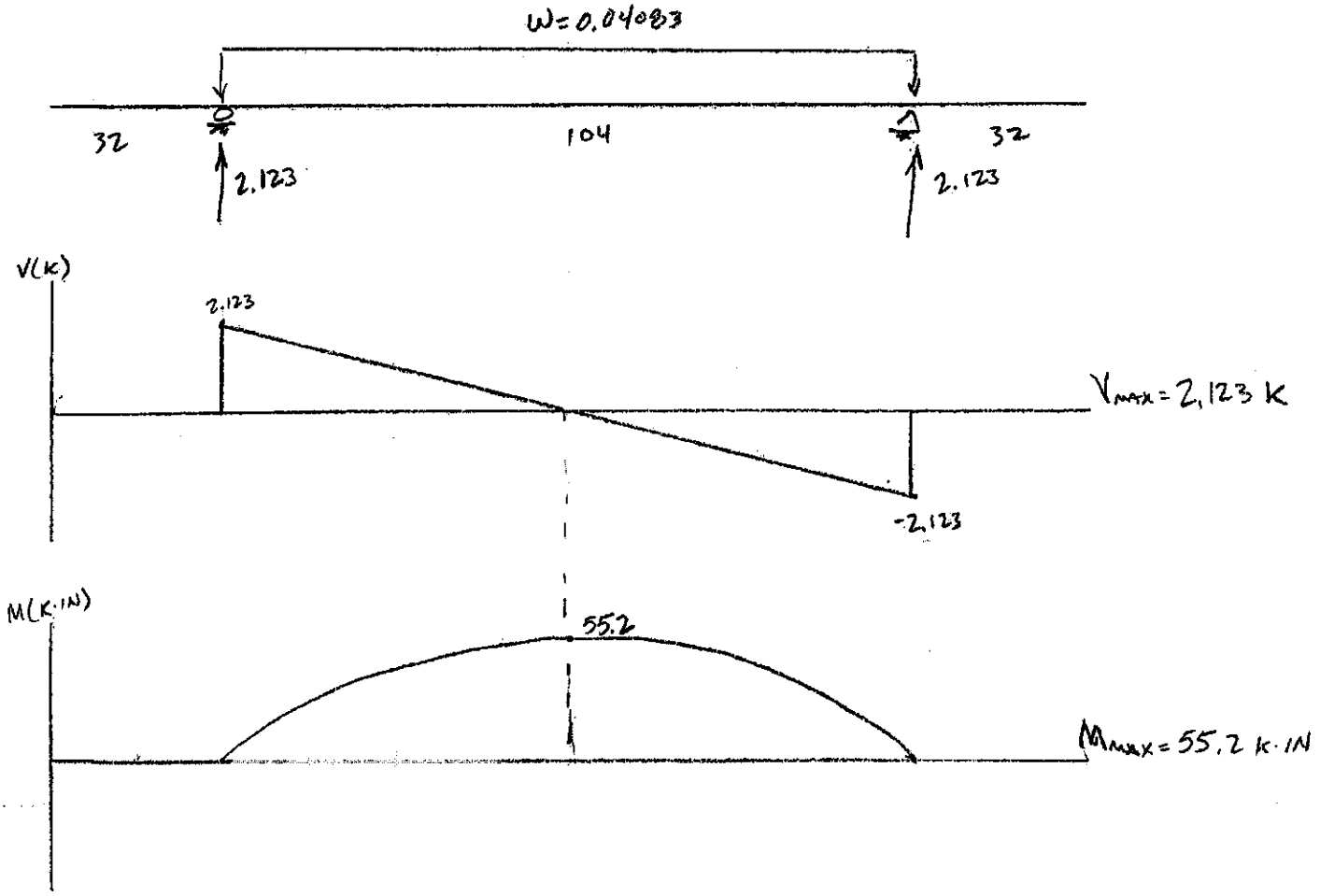




$$\sigma = \frac{(20.9)(4)}{400} = 209 \text{ PSI}$$

WJE	Wiss, Janney, Elstner Associates, Inc. 330 Pfingsten Road, Northbrook, IL 60062	MADE BY KVH	SHEET NUMBER 6 OF 6
		CHECKED BY	PROJ. NUMBER 2005.1046
		DATE 4/22/05	

LOAD CASE 5:

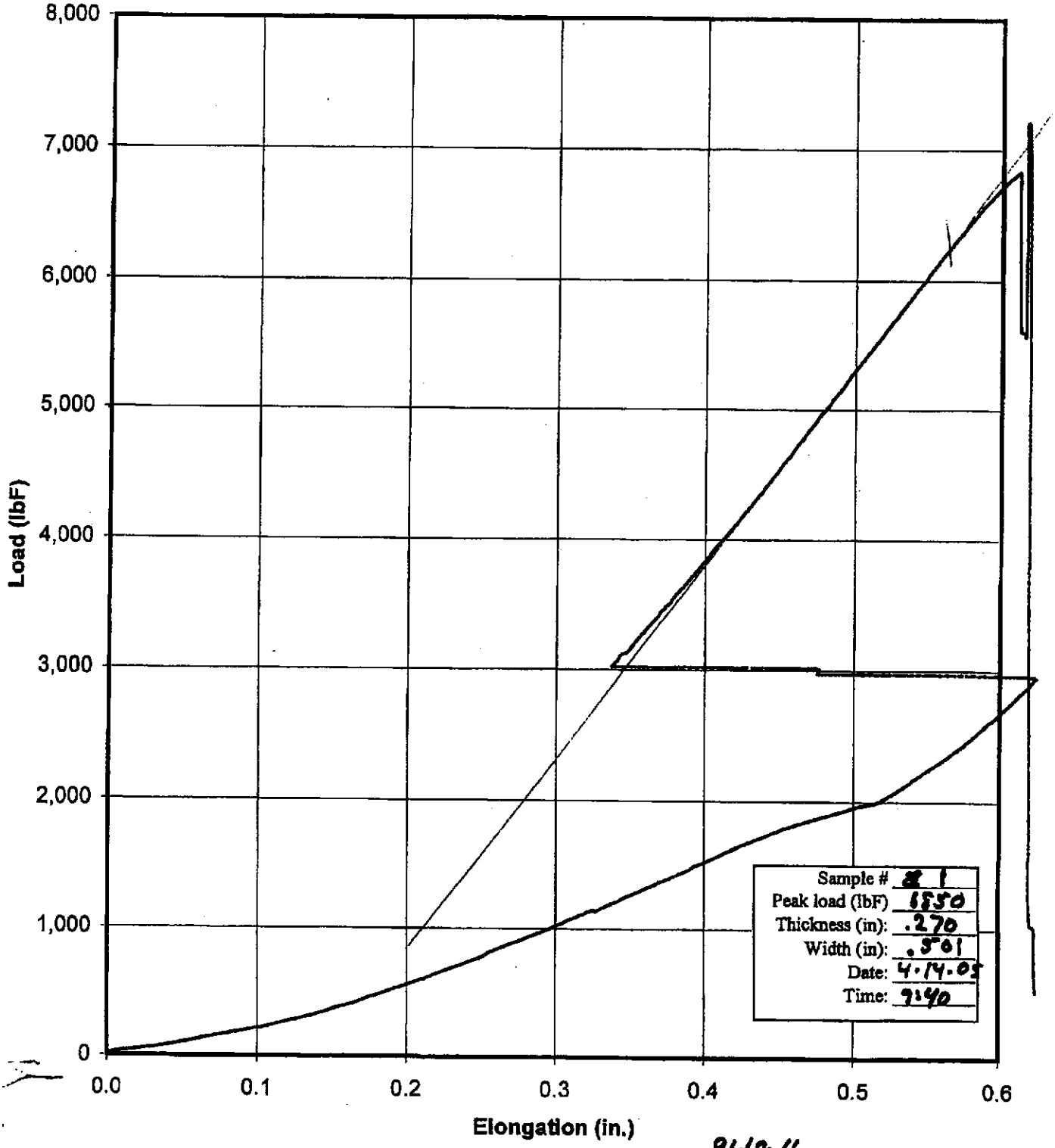


$$\sigma = \frac{(55.2)(4)}{400} = 552 \text{ PSI}$$

Initial Test to Set

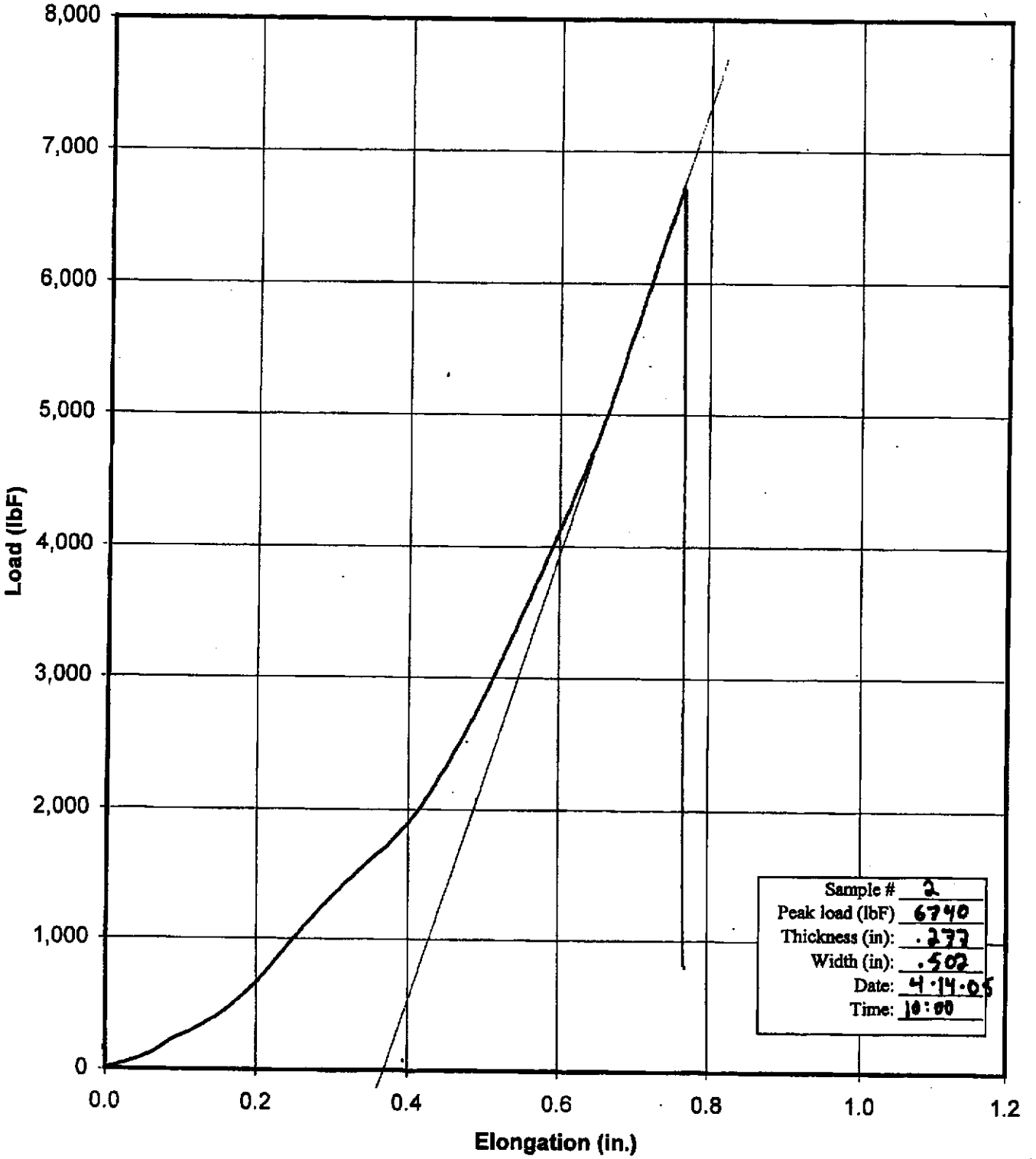
Plot Scale

Engineered Plastics, Inc.
Armor-Deck Structural Composites
Tensile testing - 1/4" thick sample



.948"
elong.

Engineered Plastics, Inc.
Armor-Deck Structural Composites
Tensile testing - 1/4" thick sample



Engineered Plastics, Inc.
Armor-Deck Structural Composites
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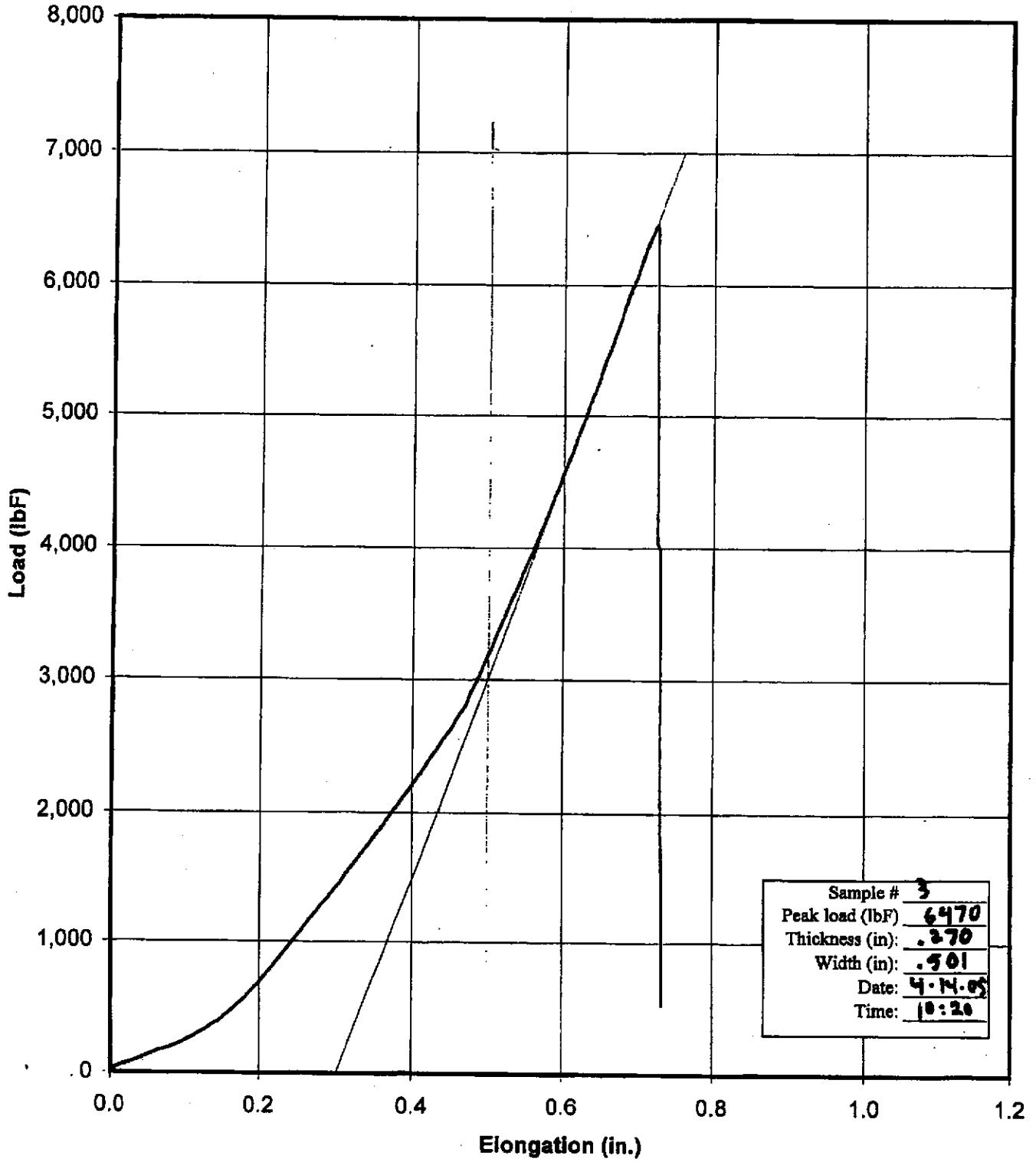

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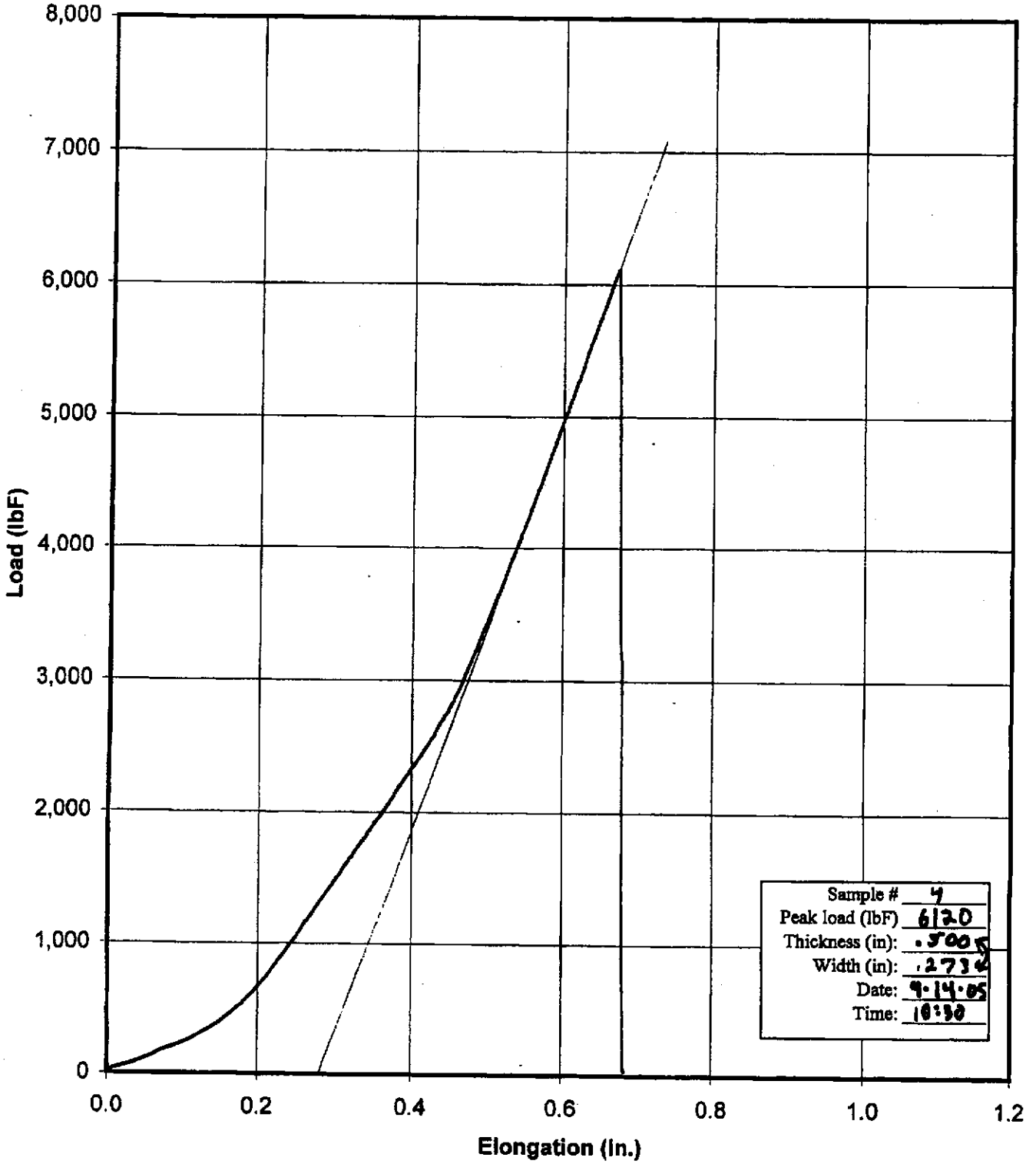

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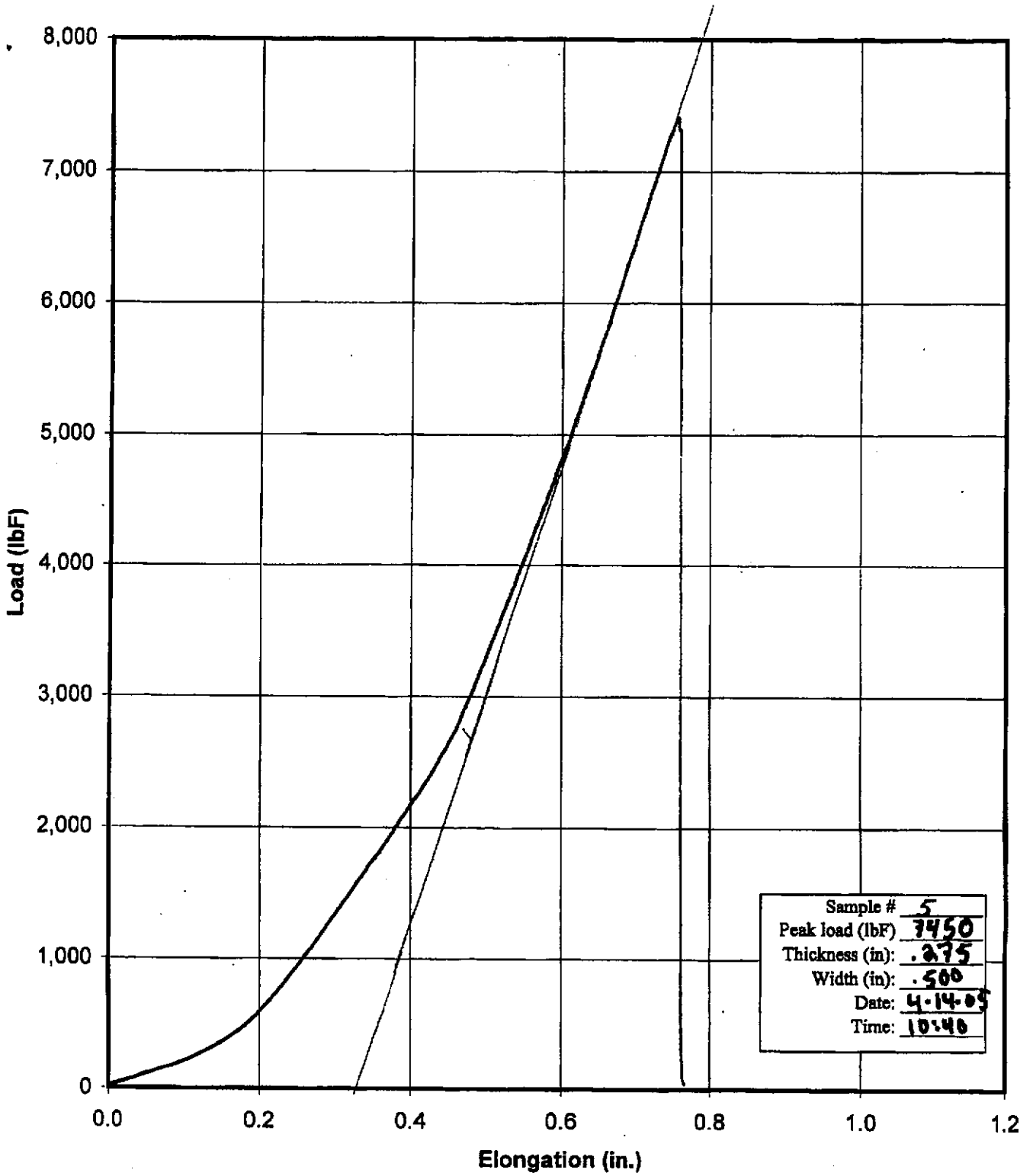
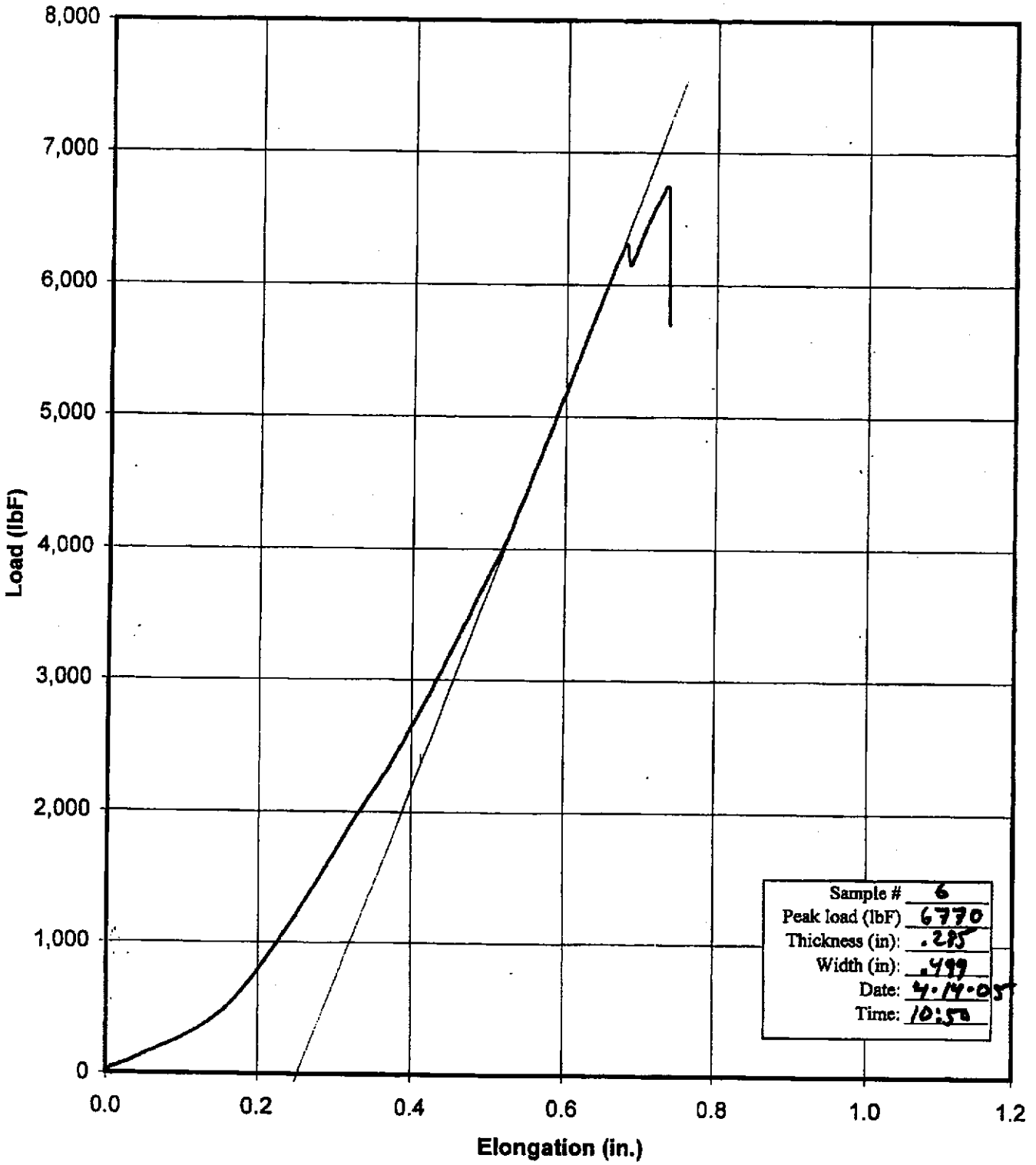
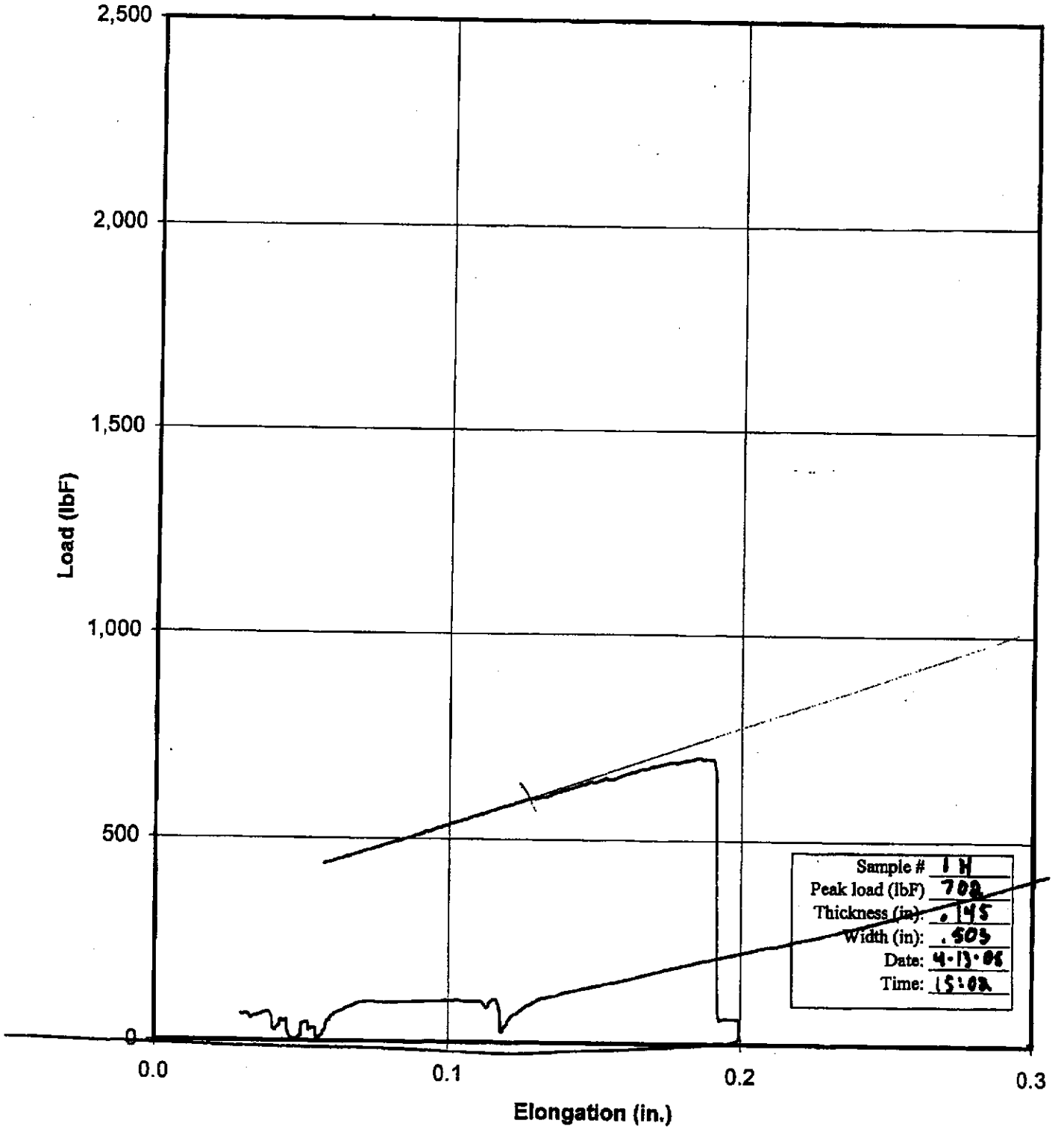
Tensile testing - 1/4" thick sample



Engineered Plastics, Inc.
Armor-Deck Structural Composites
Tensile testing - 1/4" thick sample



Engineered Plastics, Inc.
Armor-Deck Structural Composites
Tensile testing - 1/8" thick sample



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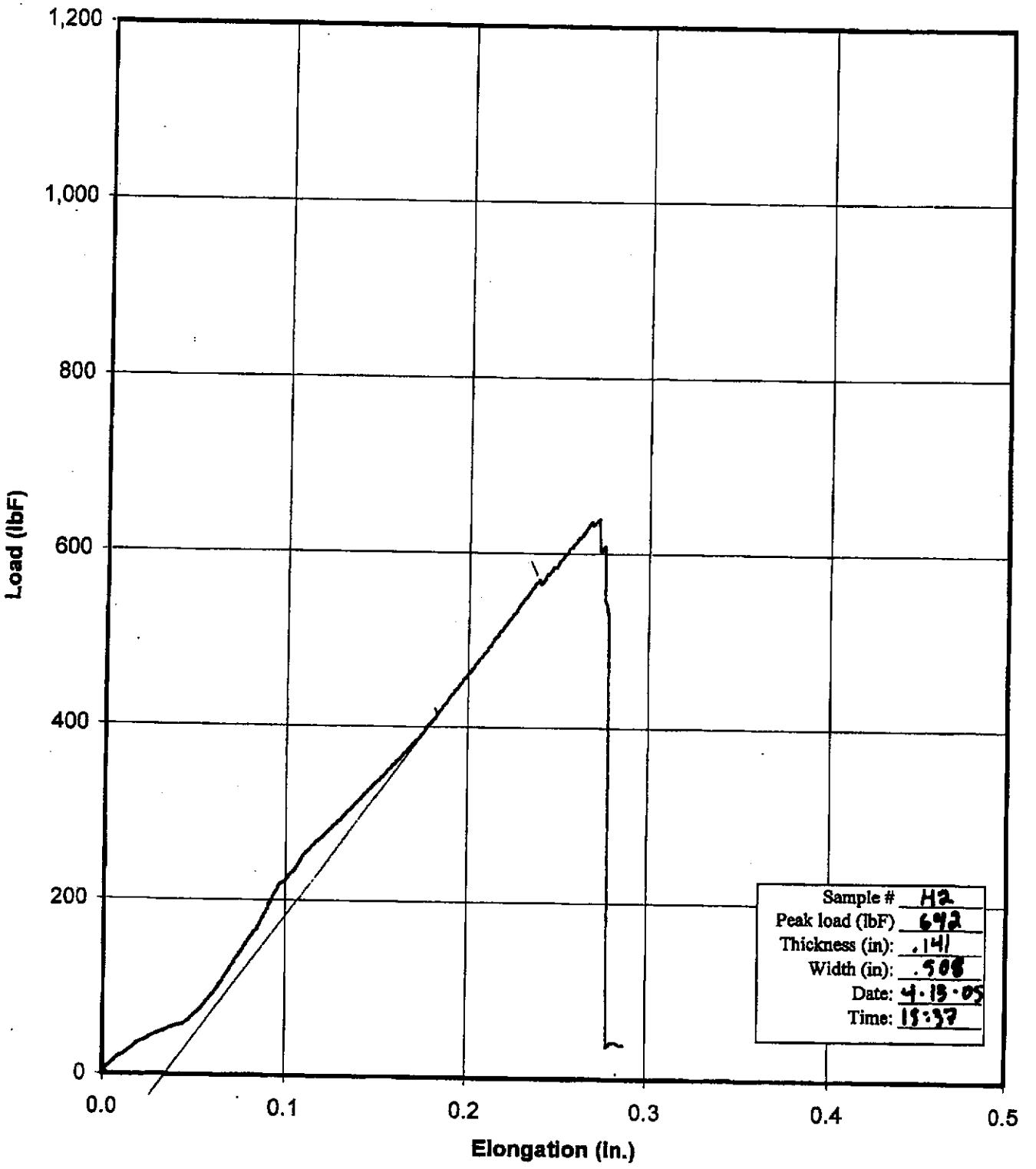
Armor-Deck Structural Composites
Tensile testing - 1/8" thick sample



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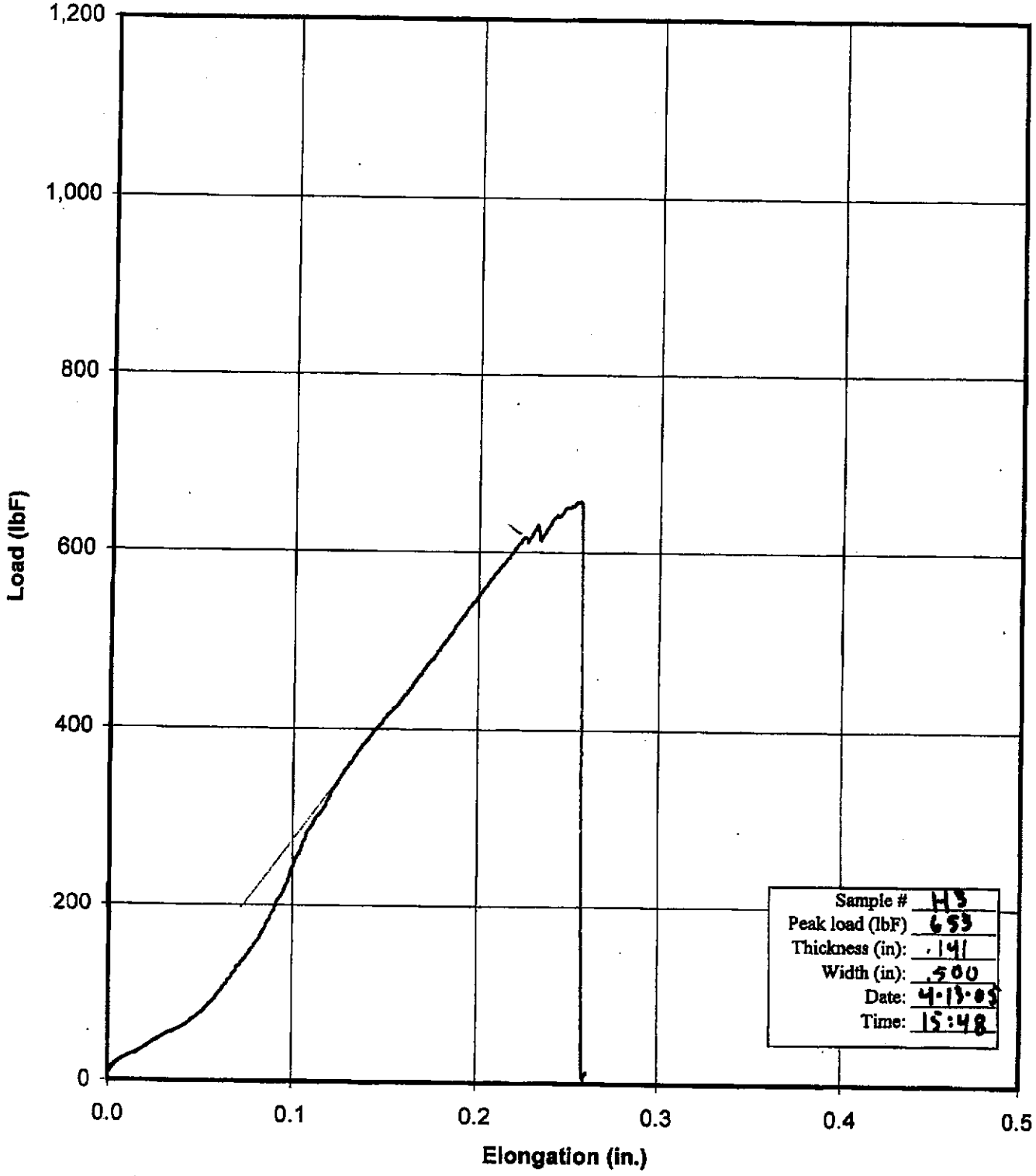
Armor-Deck Structural Composites
Tensile testing - 1/8" thick sample



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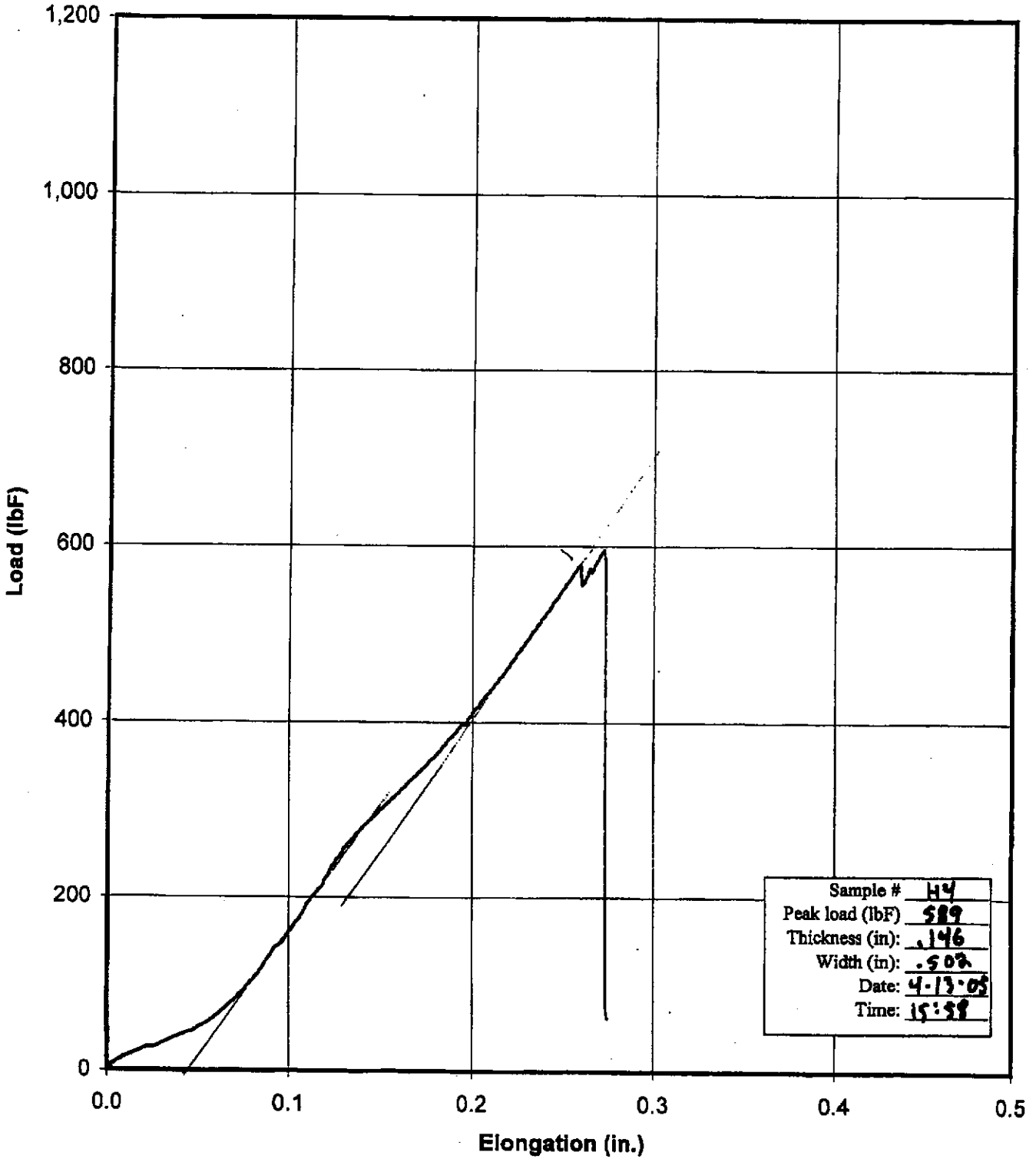

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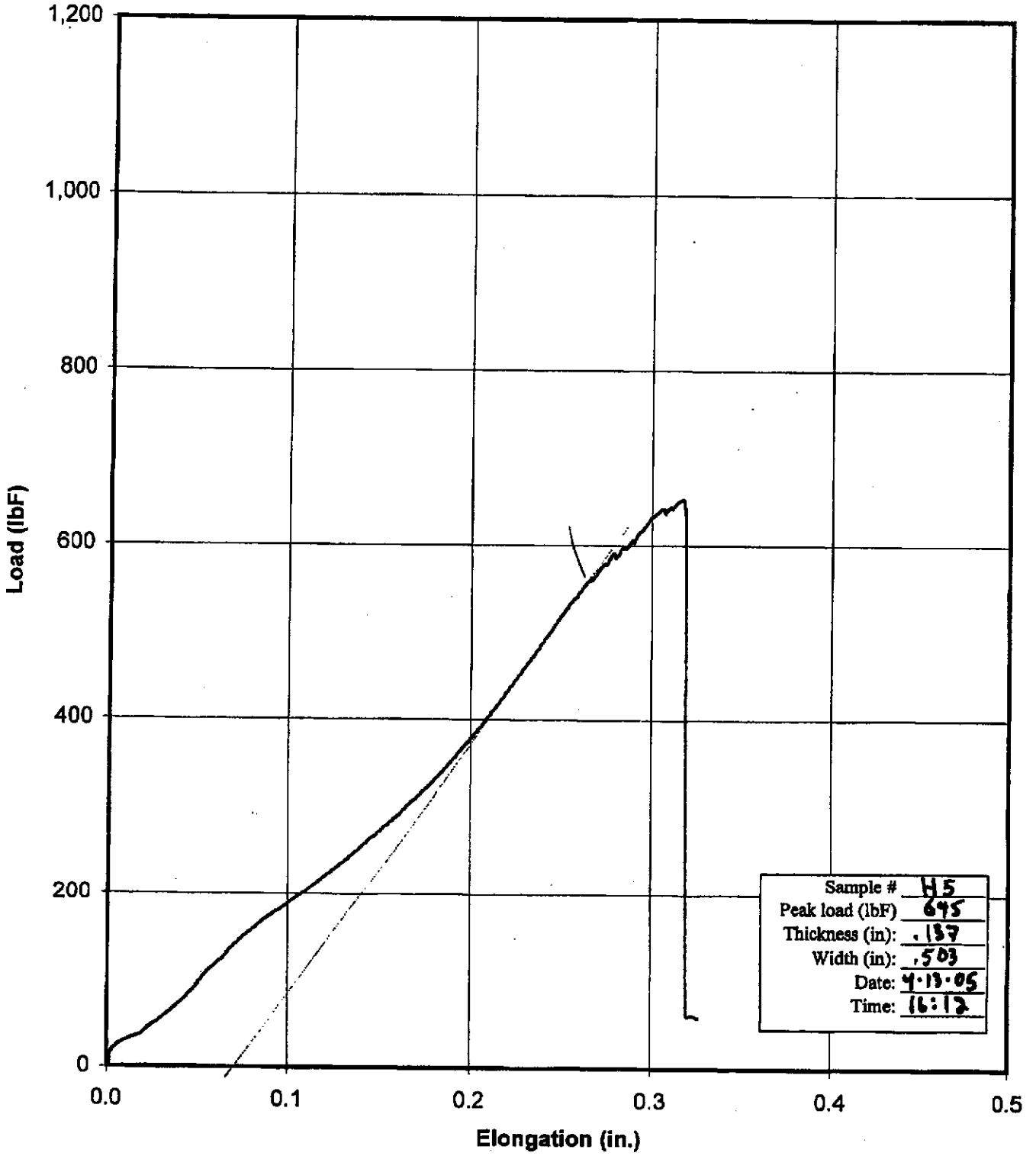
Armor-Deck Structural Composites
Tensile testing - 1/8" thick sample



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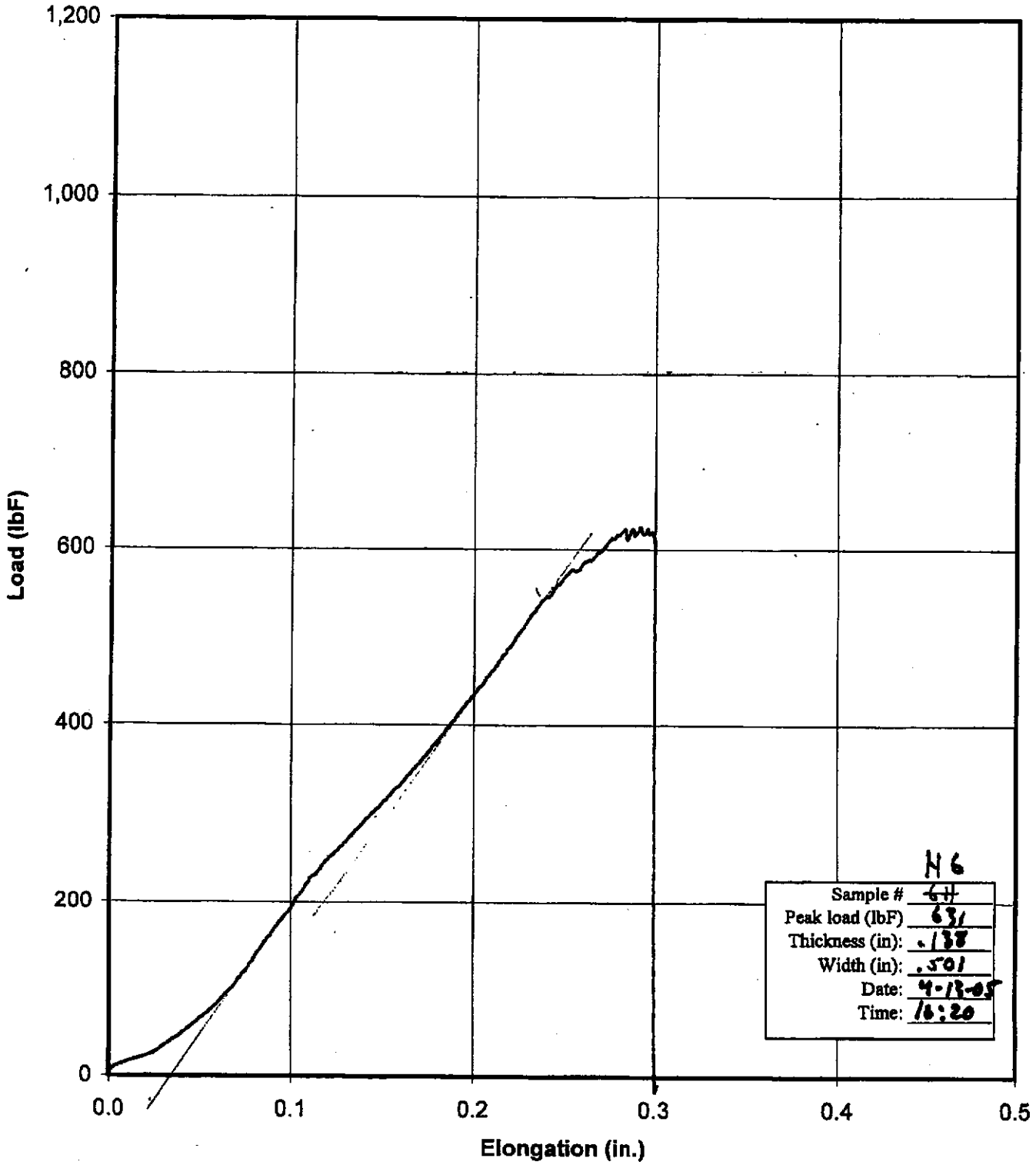
Armor-Deck Structural Composites
Tensile testing - 1/8" thick sample



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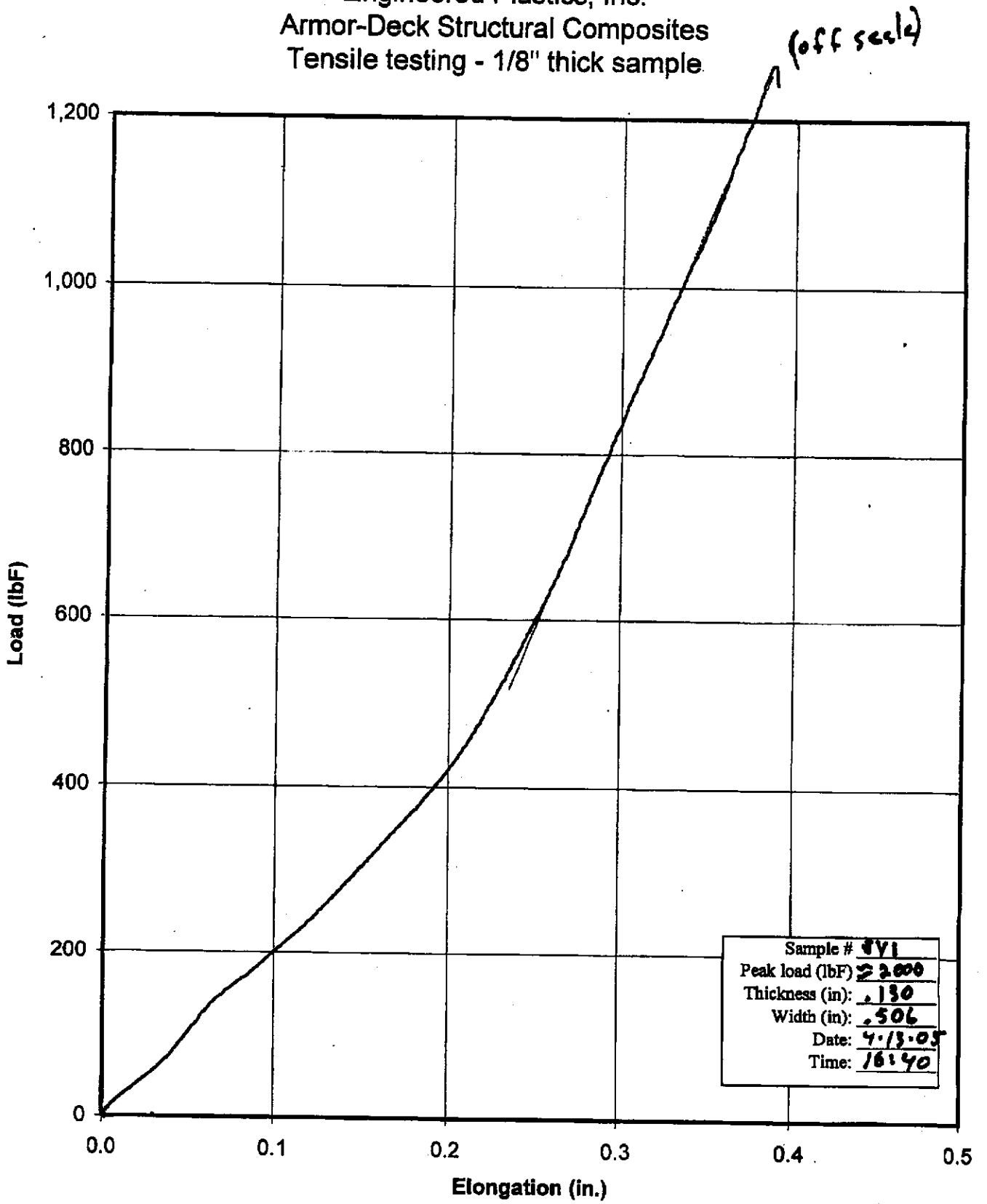

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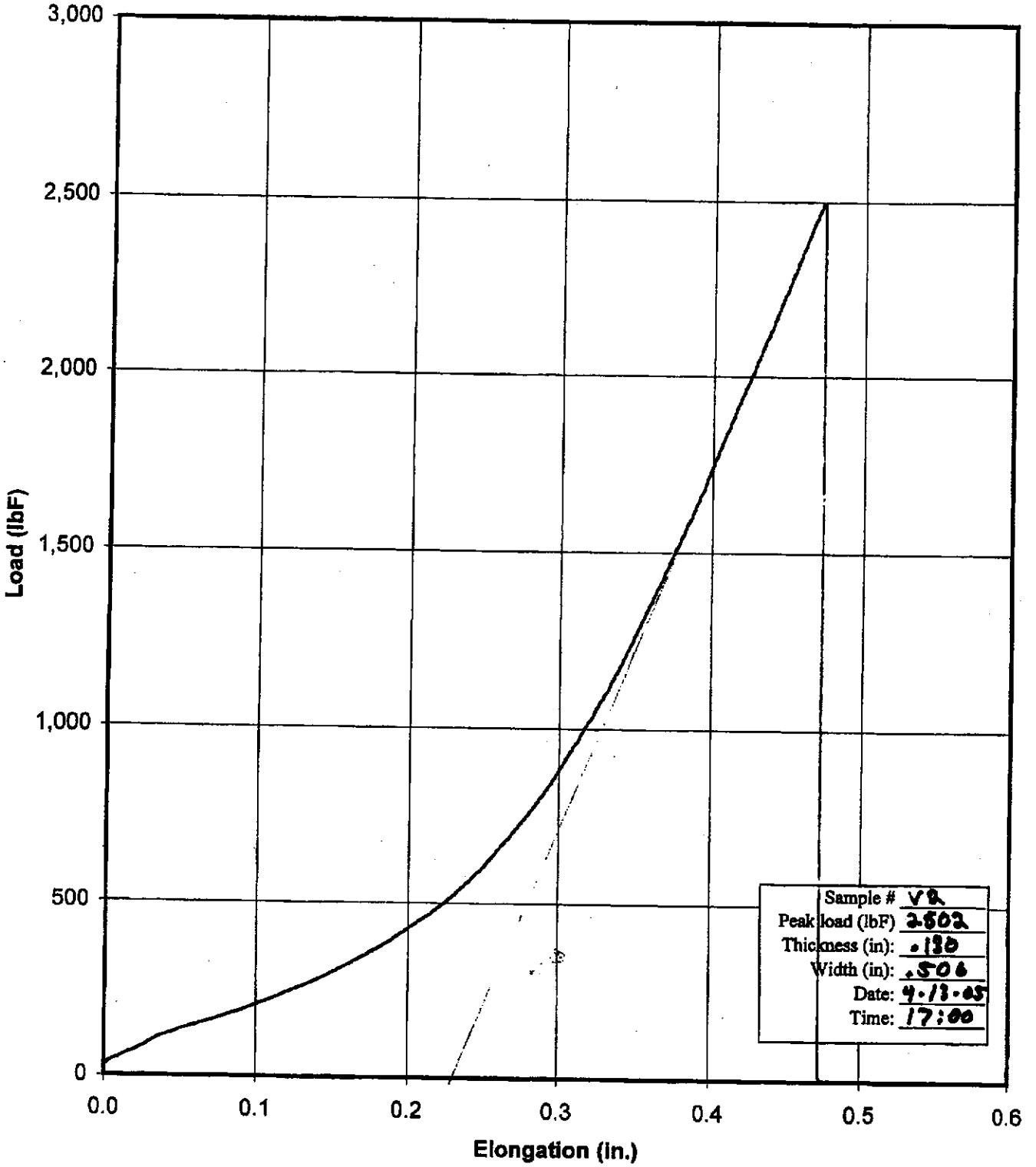

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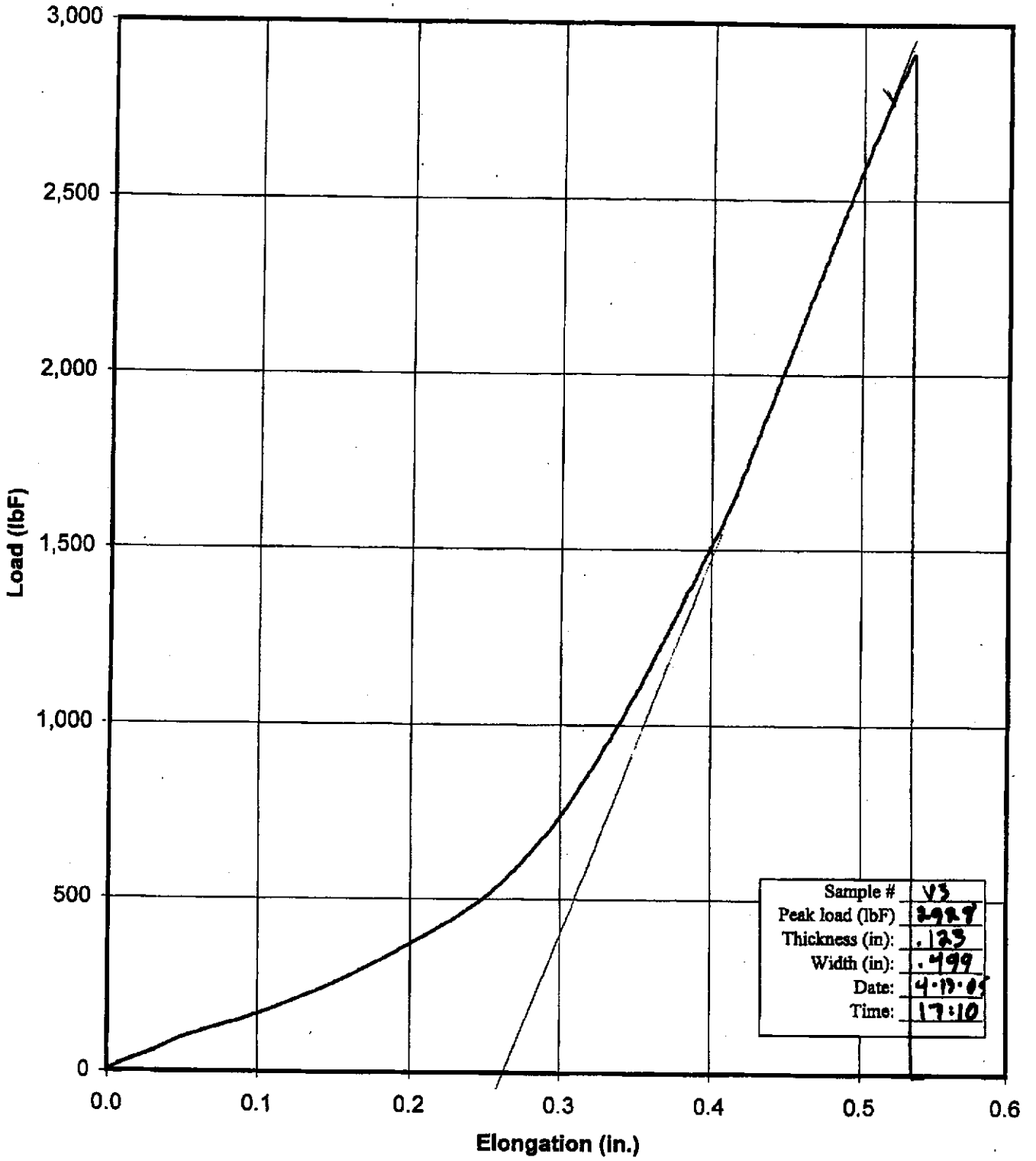
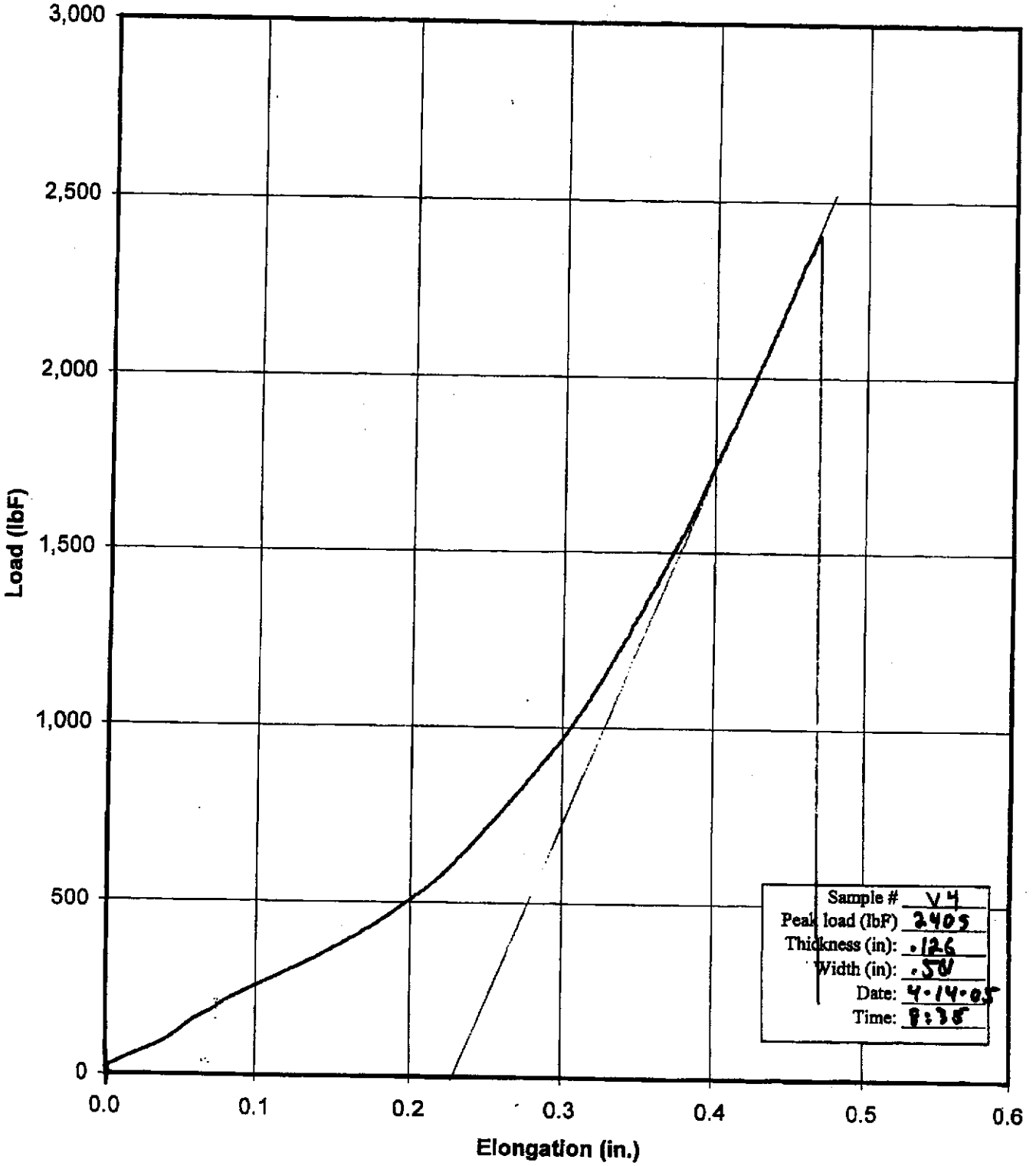
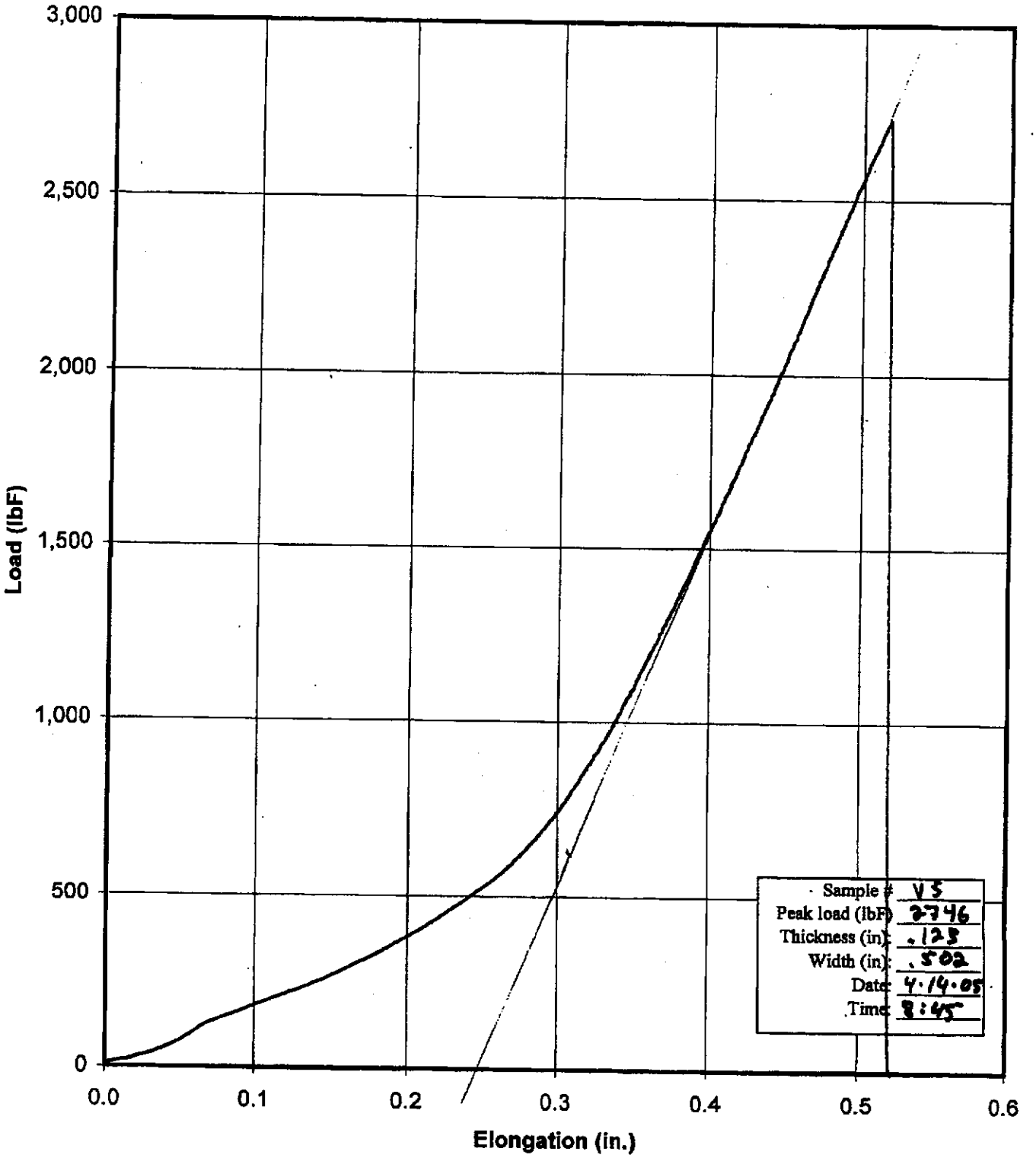
Armor-Deck Structural Composites
Tensile testing - 1/8" thick sample



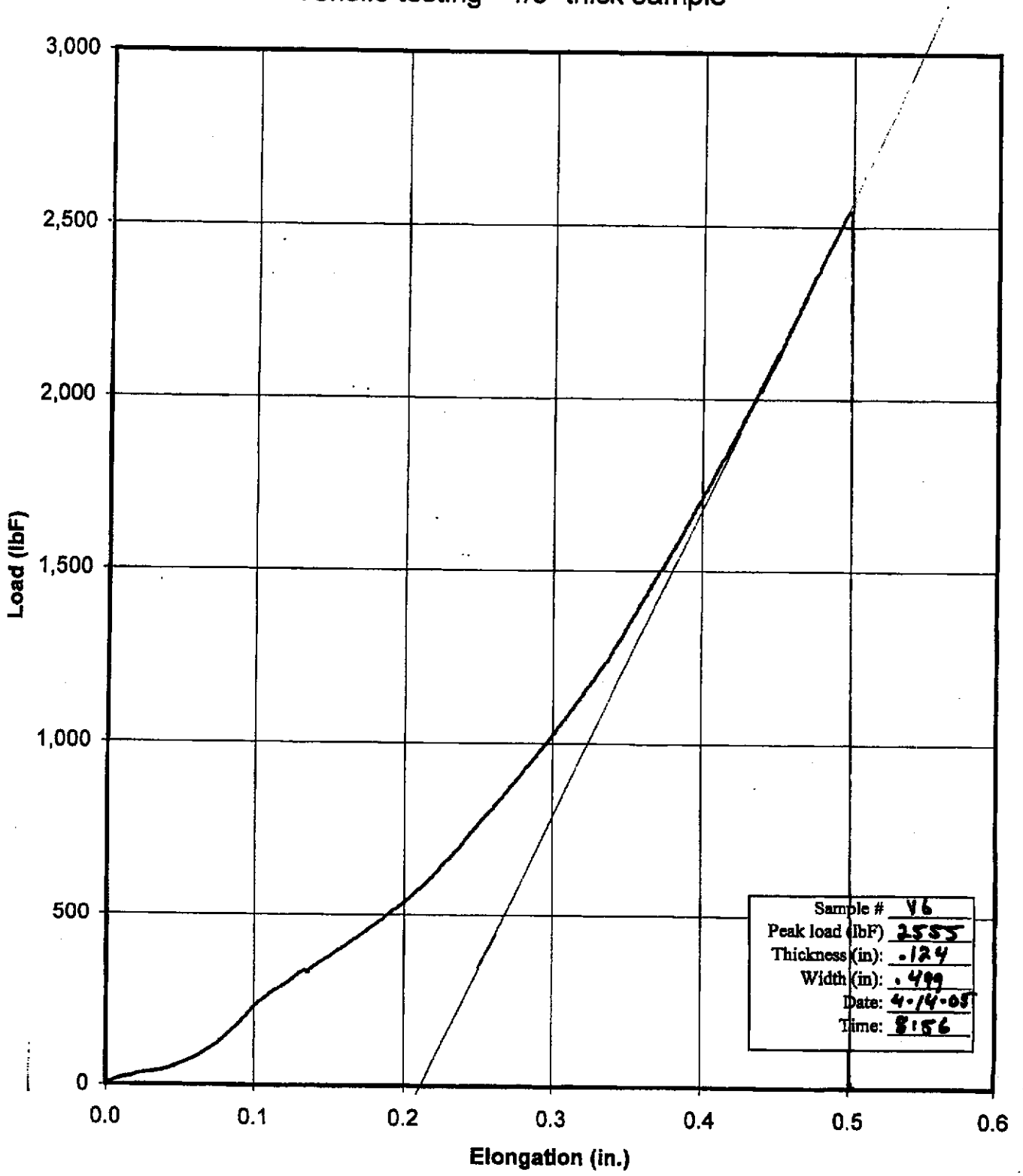
Engineered Plastics, Inc.
Armor-Deck Structural Composites
Tensile testing - 1/8" thick sample



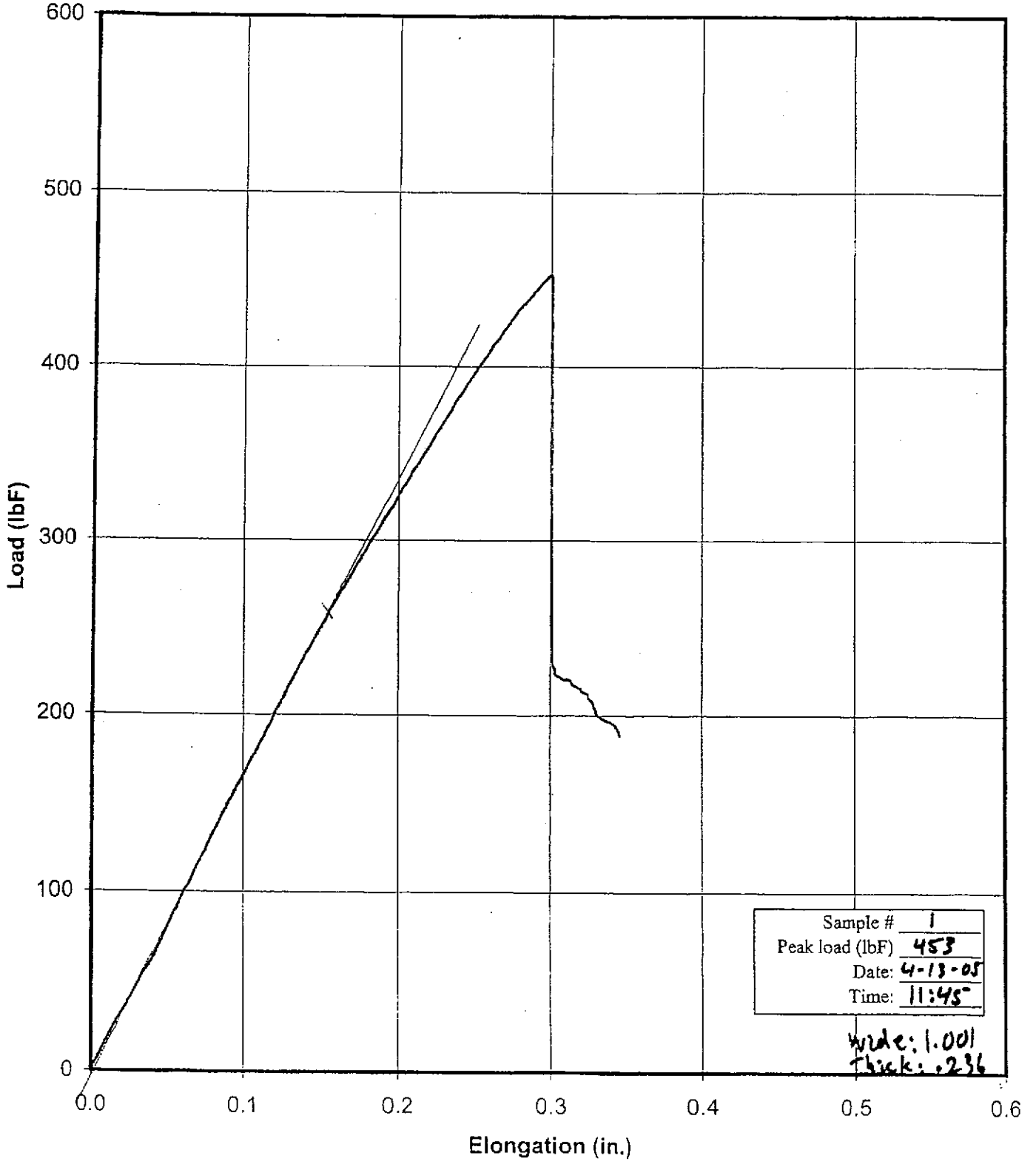
Engineered Plastics, Inc.
Armor-Deck Structural Composites
Tensile testing - 1/8" thick sample



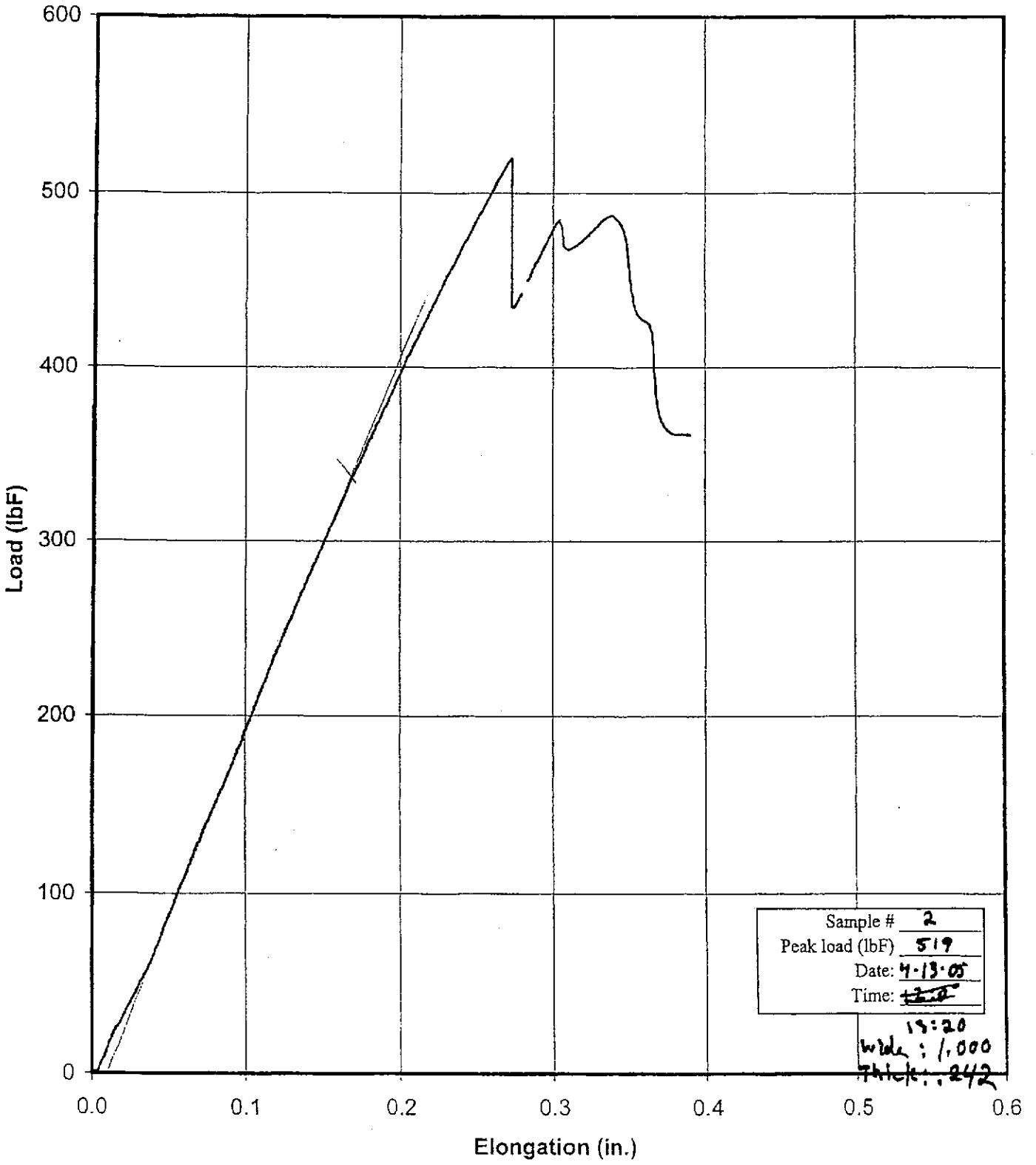
Engineered Plastics, Inc.
Armor-Deck Structural Composites
Tensile testing - 1/8" thick sample



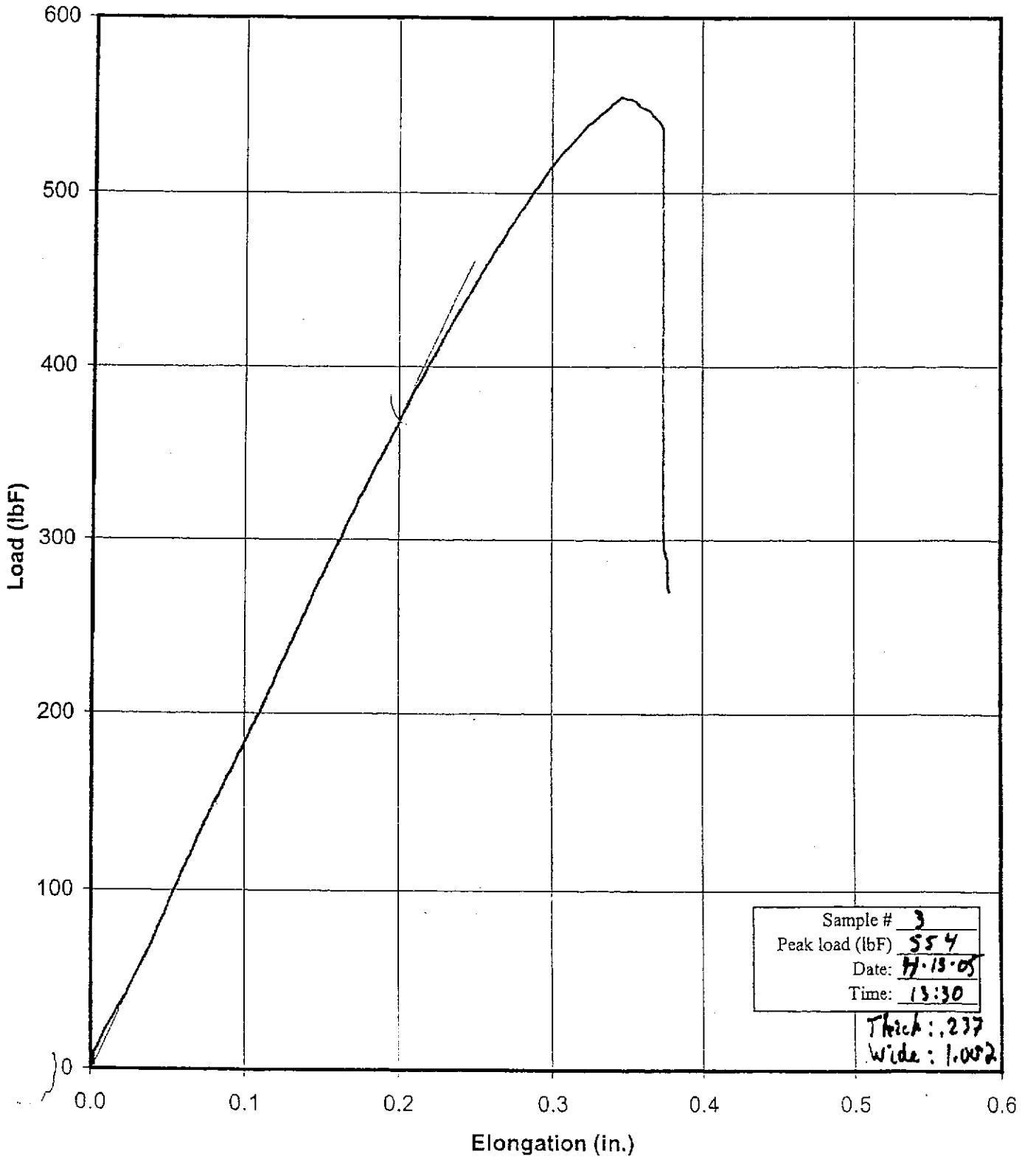
Engineered Plastics, Inc.
Armor-Deck Structural Composites
Flexural testing - 1/4" thick sample



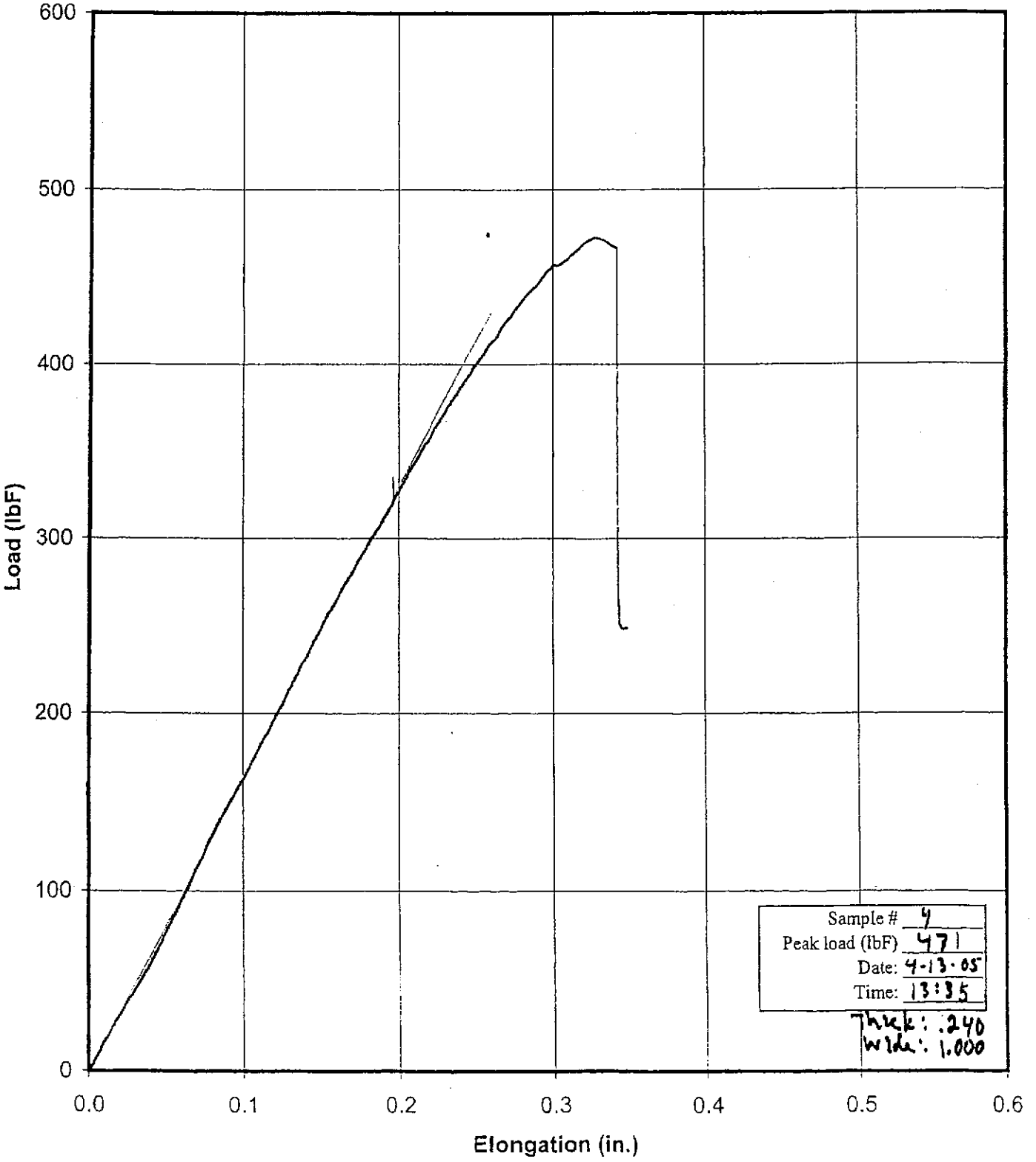
Engineered Plastics, Inc.
Armor-Deck Structural Composites
Flexural testing - 1/4" thick sample



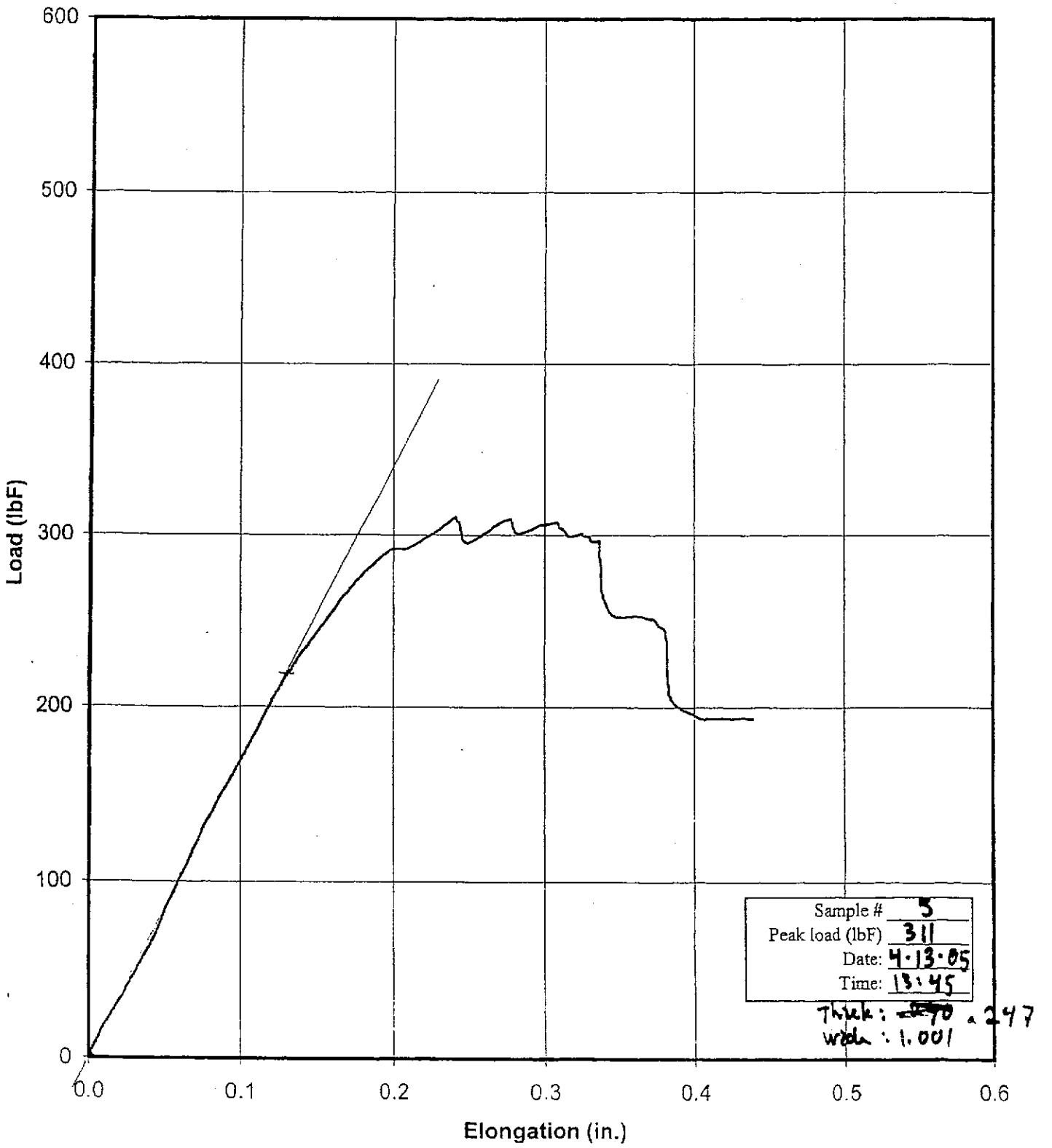
Engineered Plastics, Inc.
Armor-Deck Structural Composites
Flexural testing - 1/4" thick sample



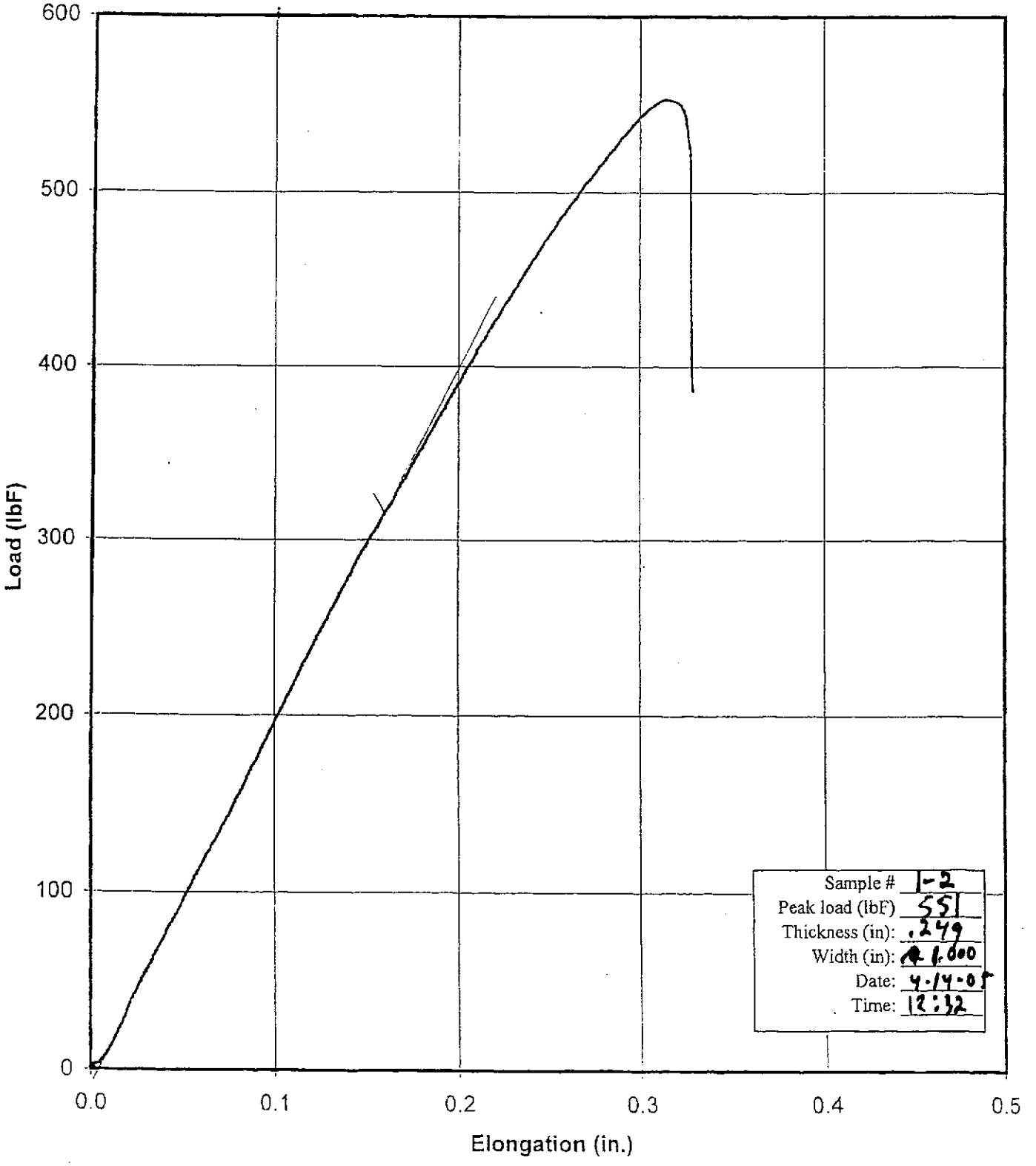
Engineered Plastics, Inc.
Armor-Deck Structural Composites
Flexural testing - 1/4" thick sample



Engineered Plastics, Inc.
Armor-Deck Structural Composites
Flexural testing - 1/4" thick sample



Engineered Plastics, Inc.
Armor-Deck Structural Composites
Flexural testing - 1/4" thick sample



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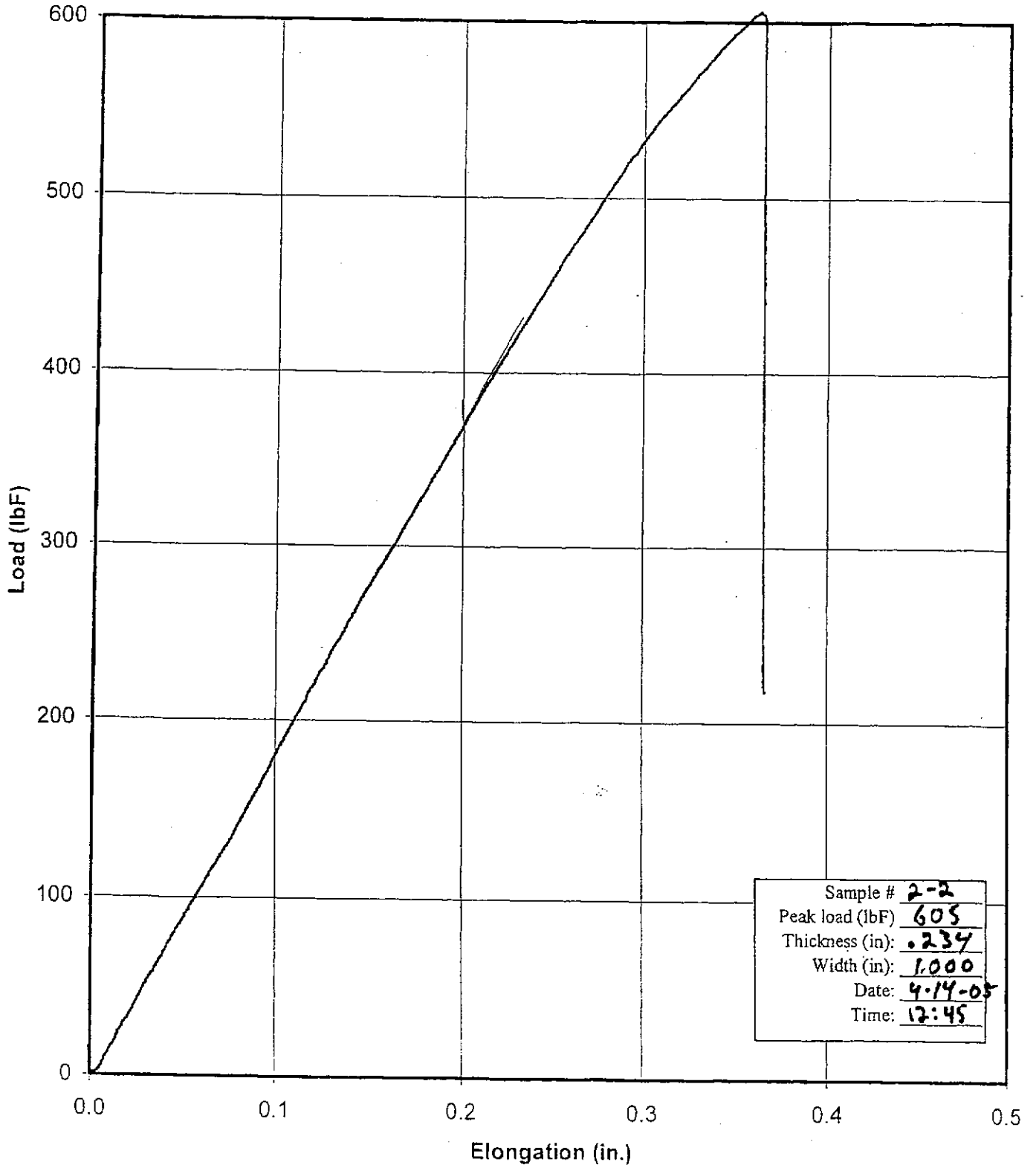
Armor-Deck Structural Composites
Flexural testing - 1/4" thick sample



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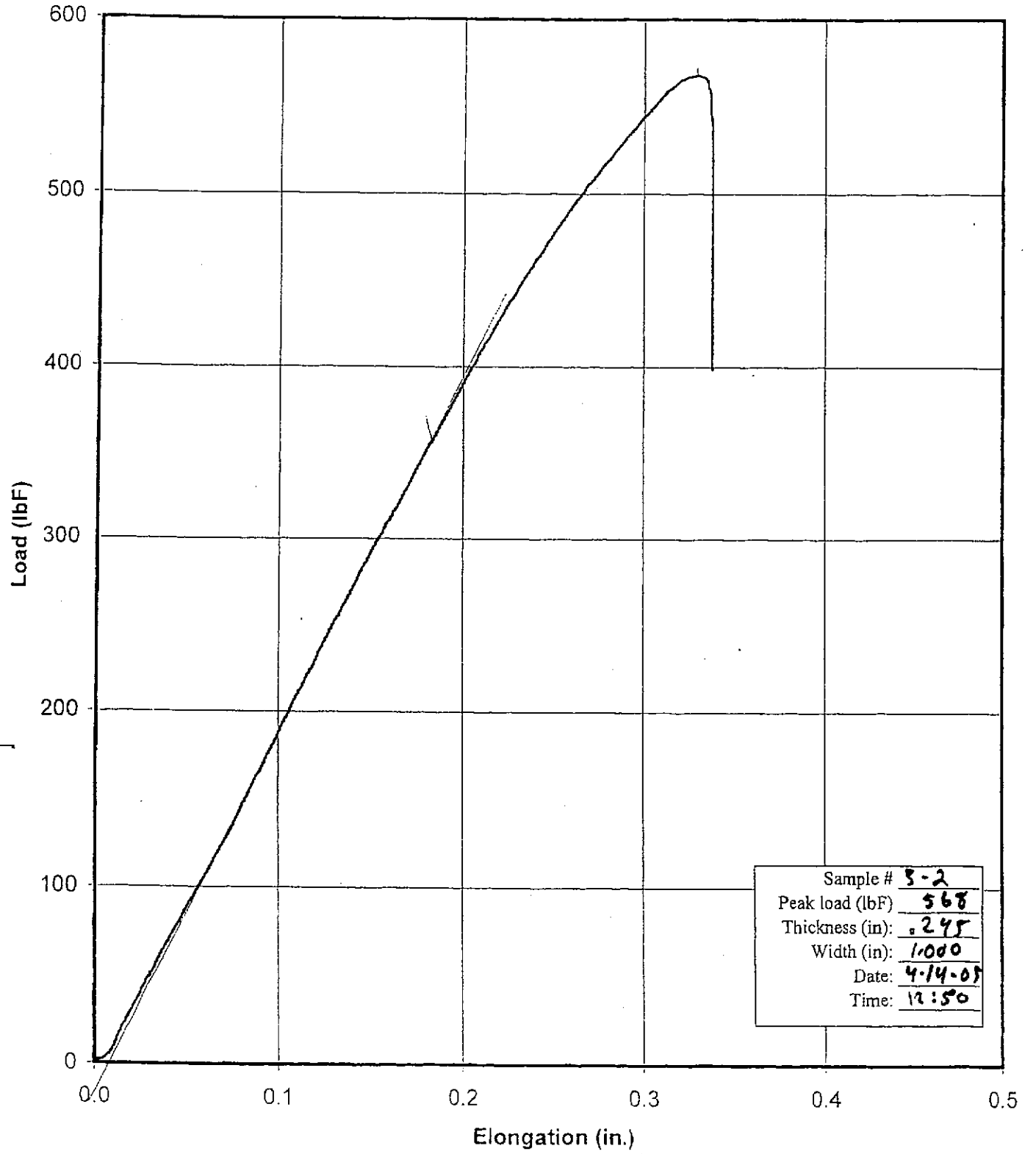
Armor-Deck Structural Composites
Flexural testing - 1/4" thick sample



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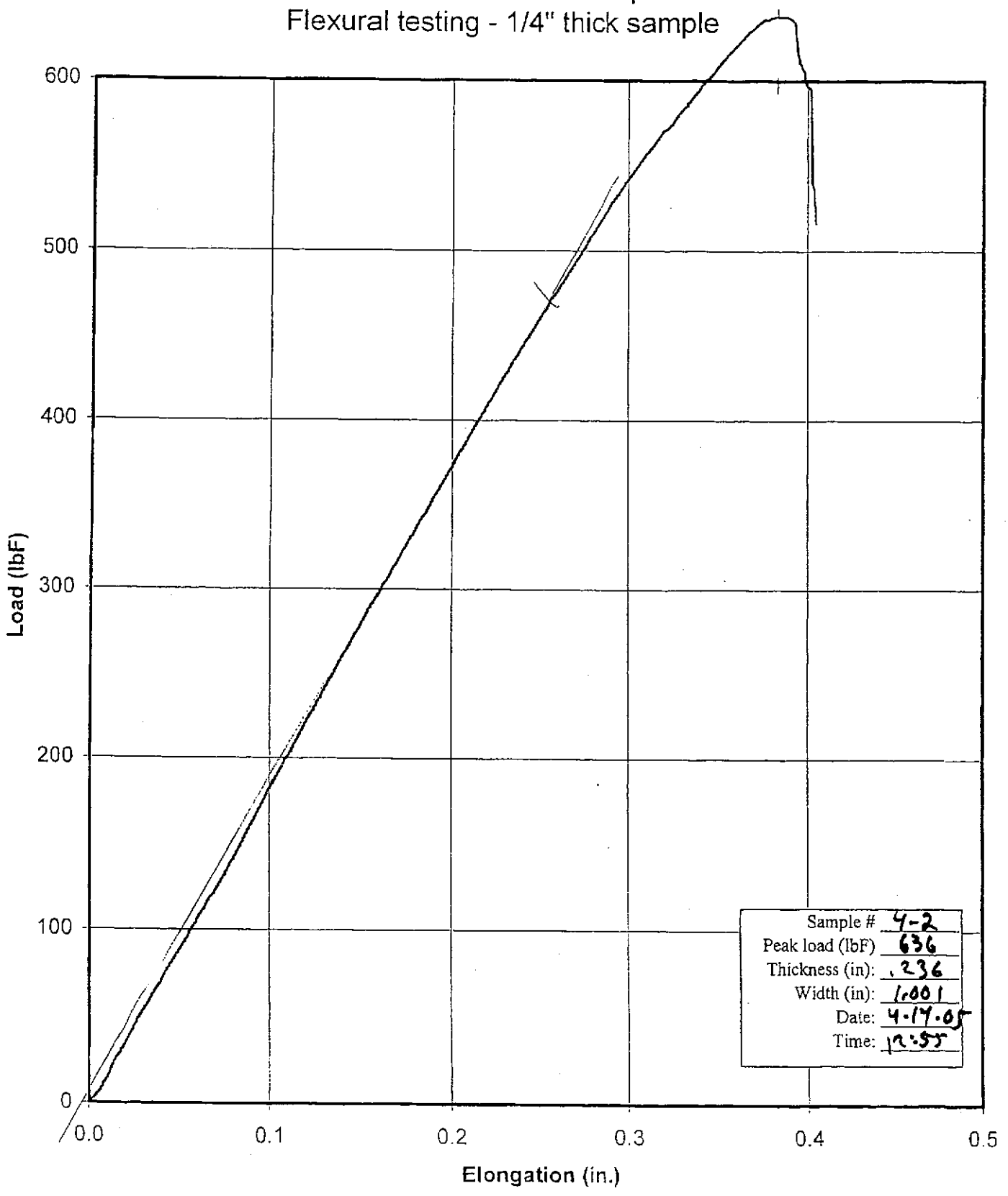
Flexural testing - 1/4" thick sample



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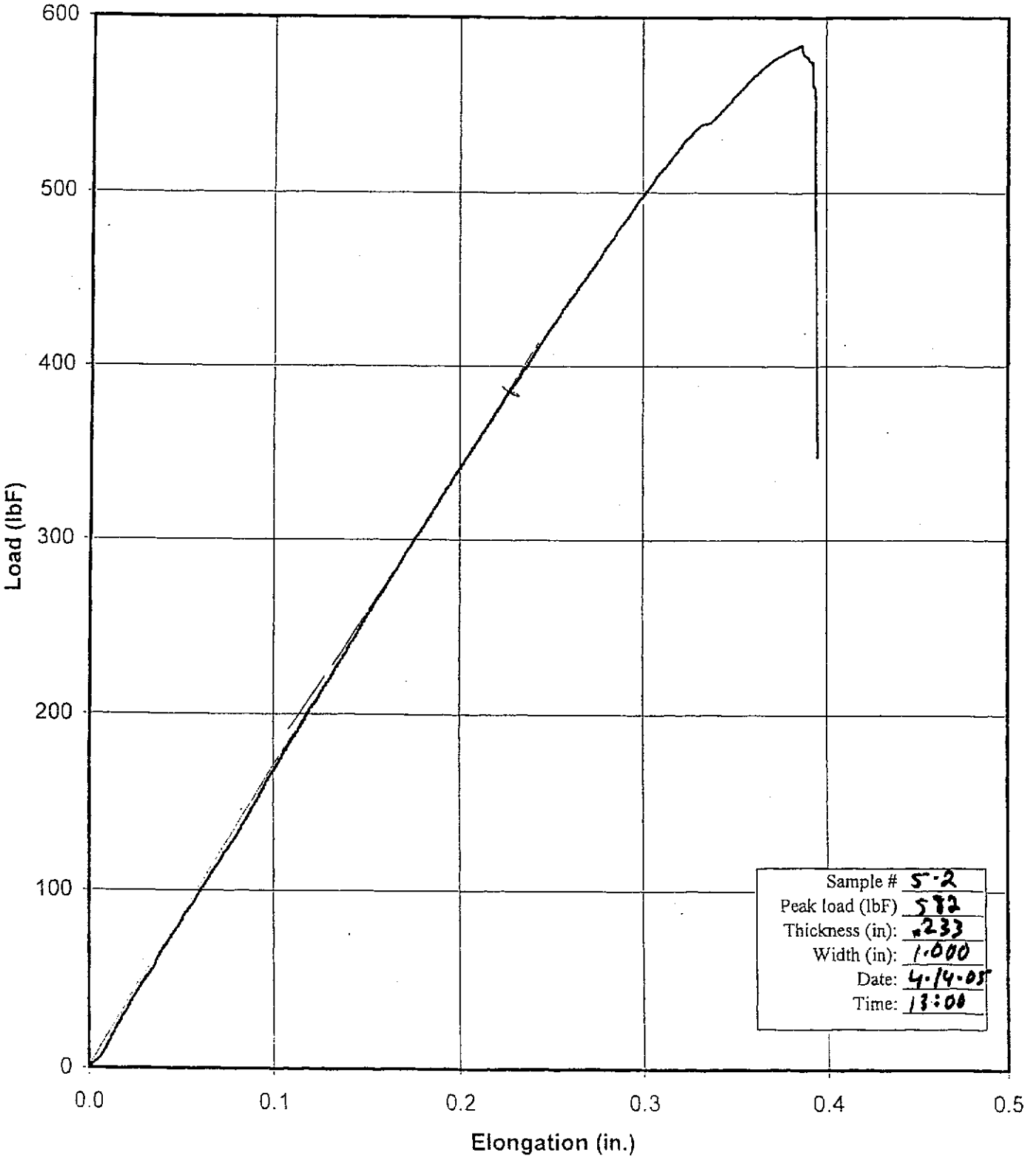
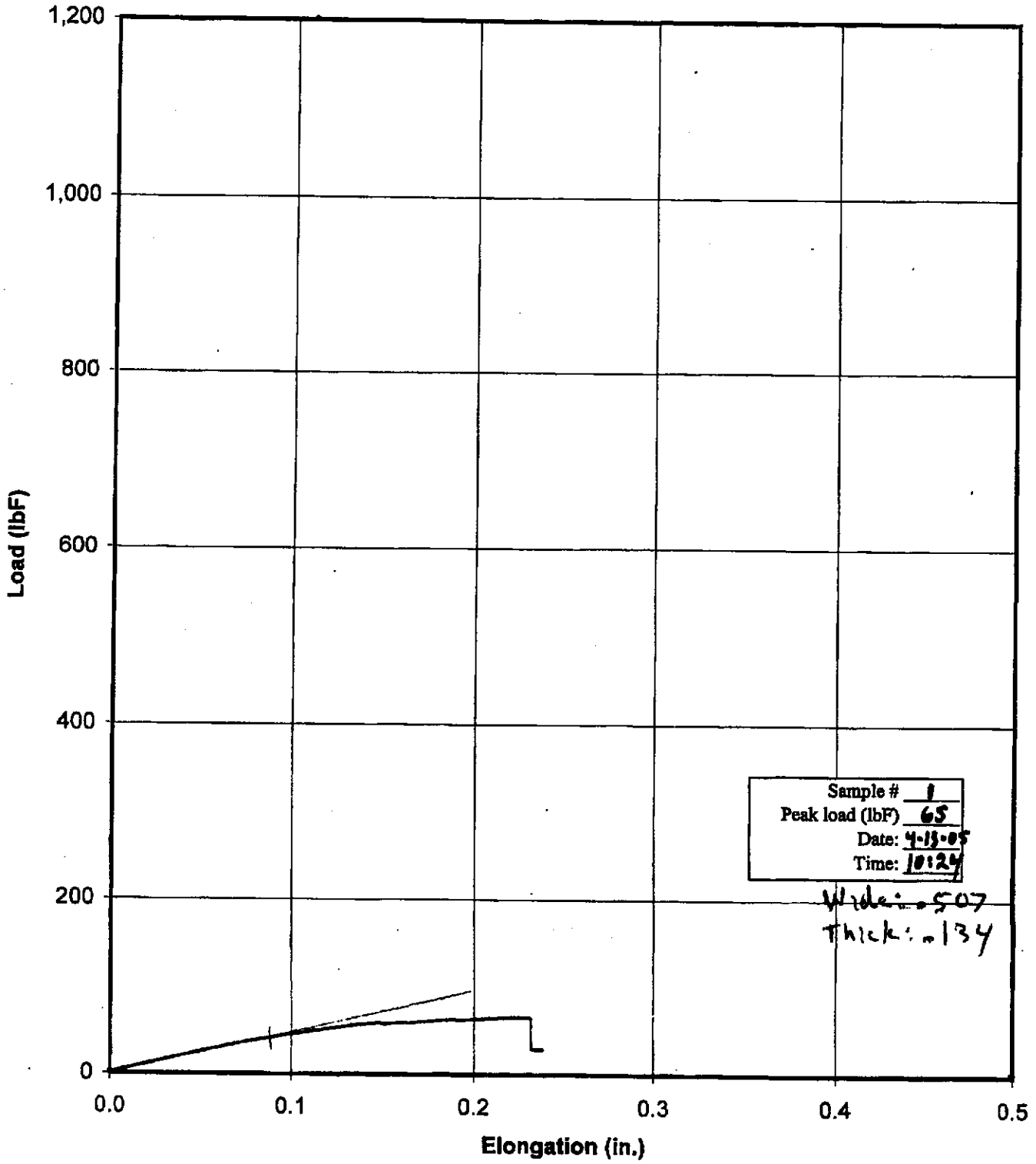
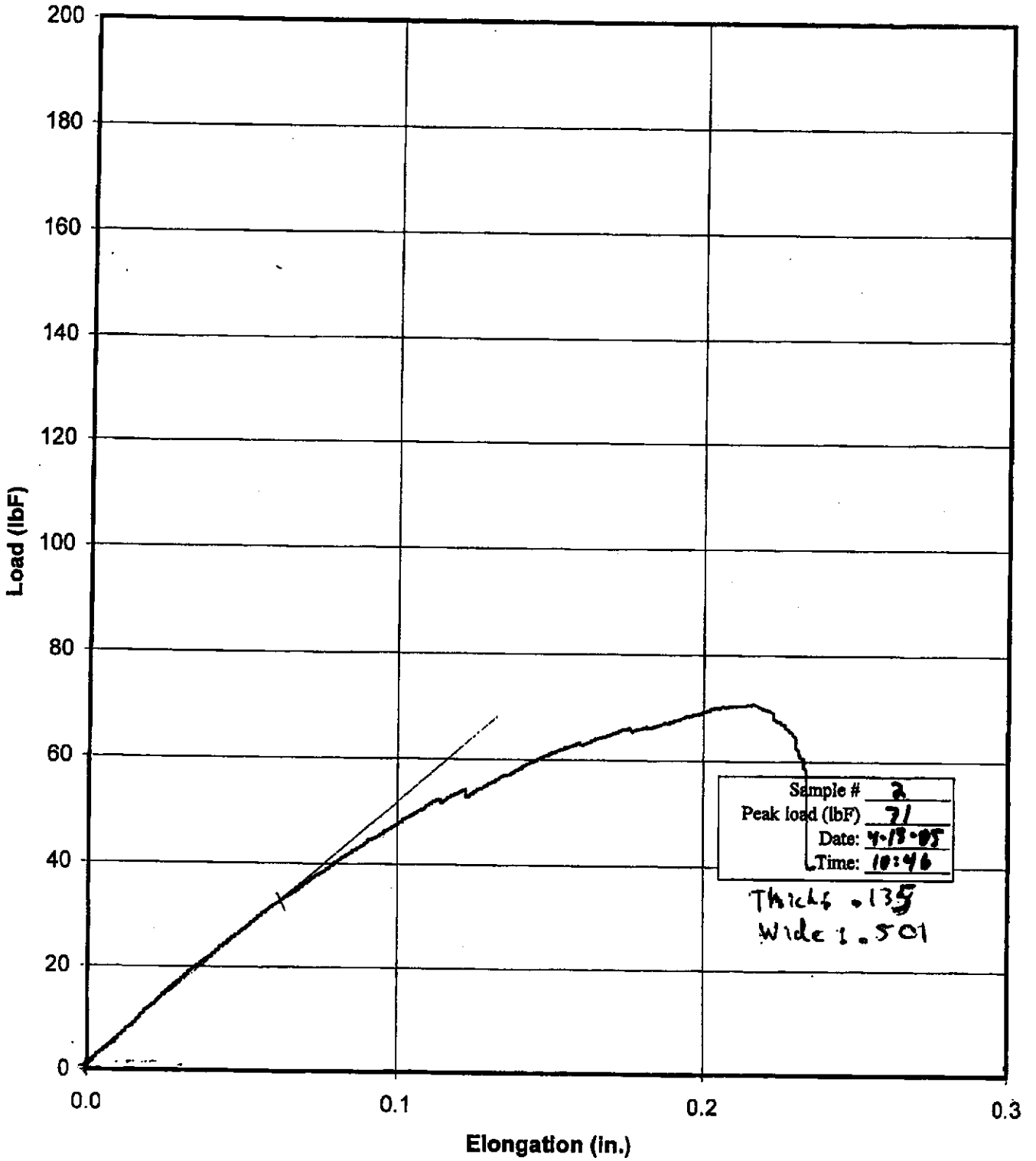
Flexural testing - 1/4" thick sample



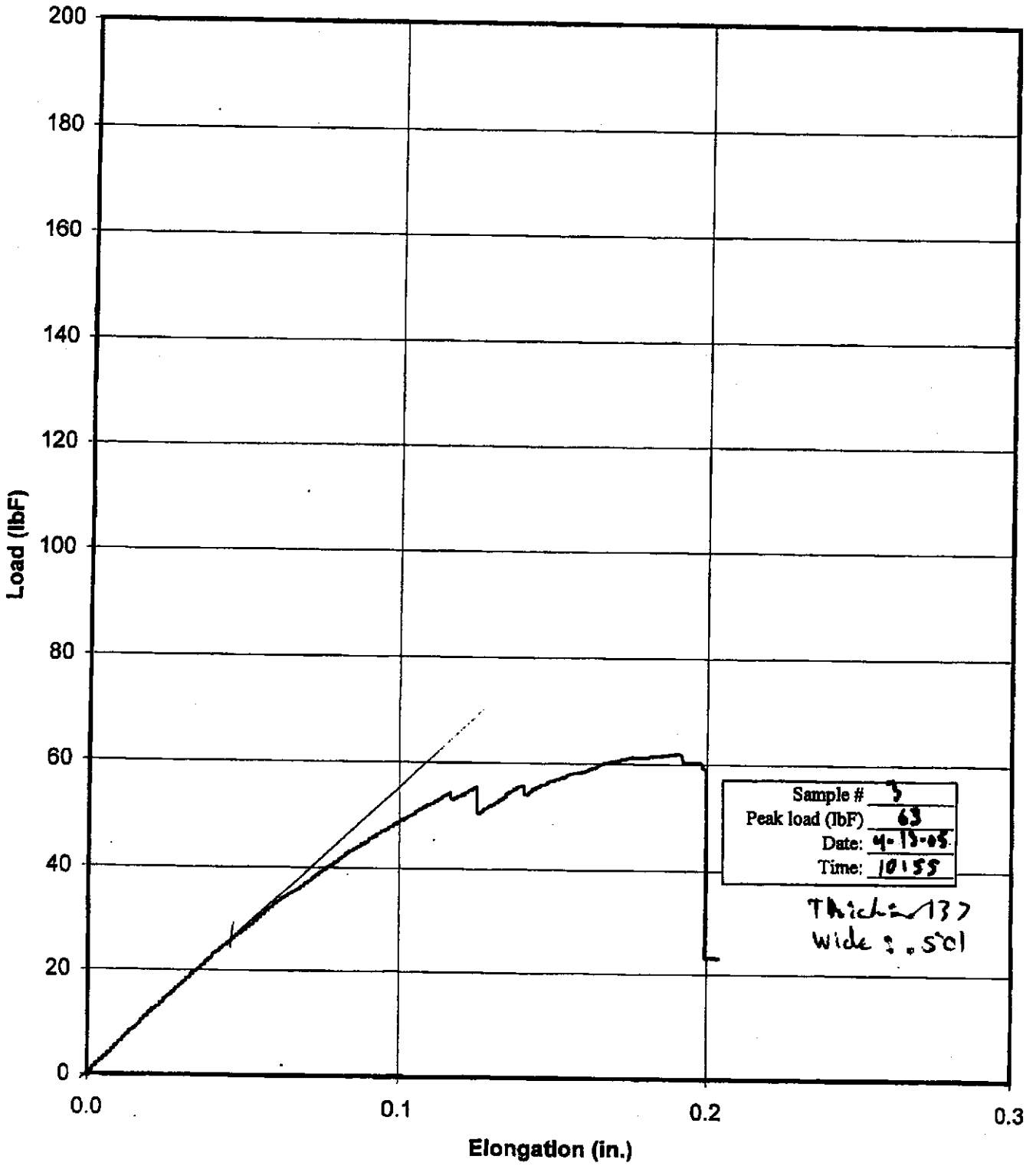
Engineered Plastics, Inc.
Armor-Deck Structural Composites
Flexural testing - 1/8" thick sample



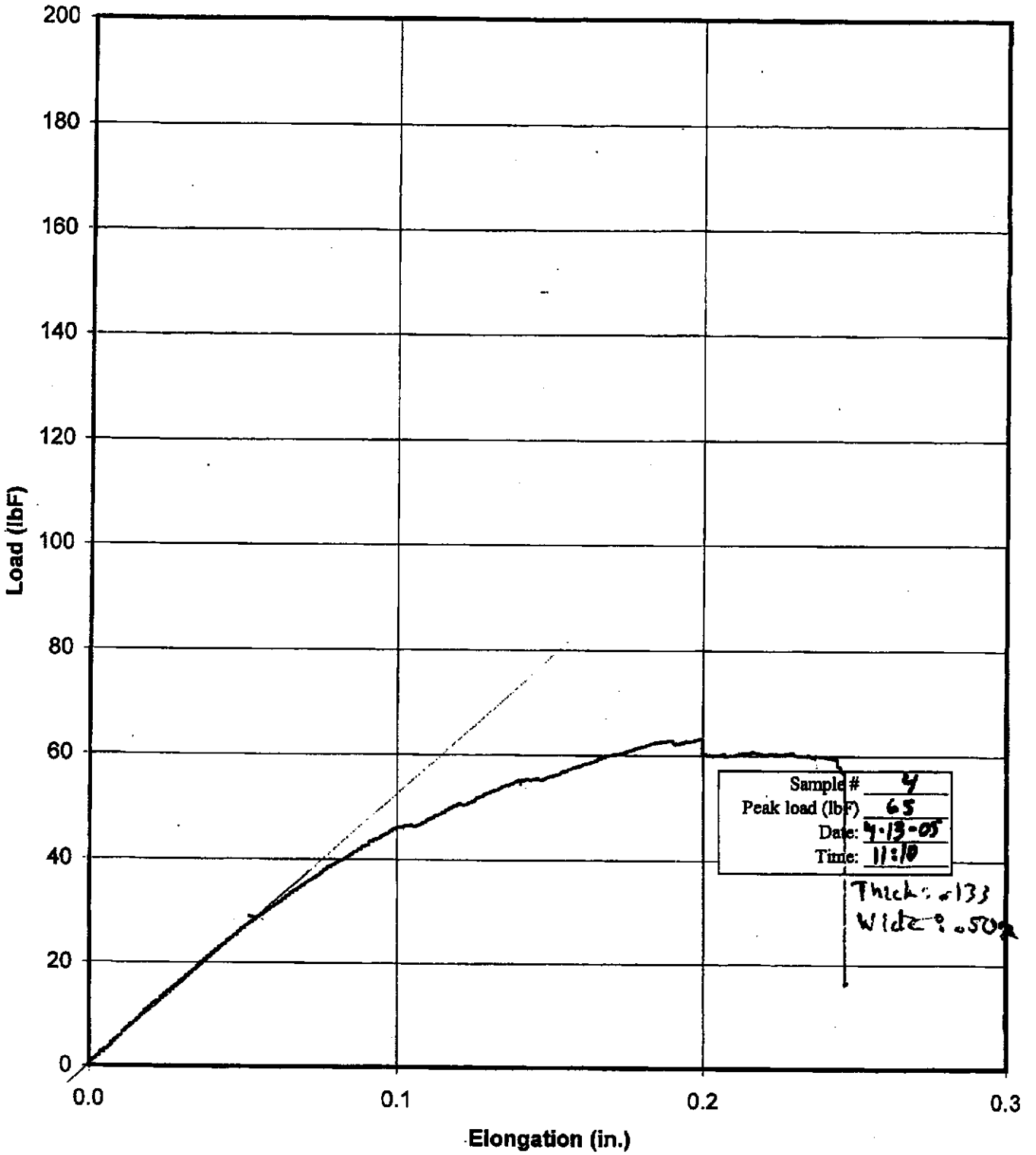
Engineered Plastics, Inc.
Armor-Deck Structural Composites
Flexural testing - 1/8" thick sample



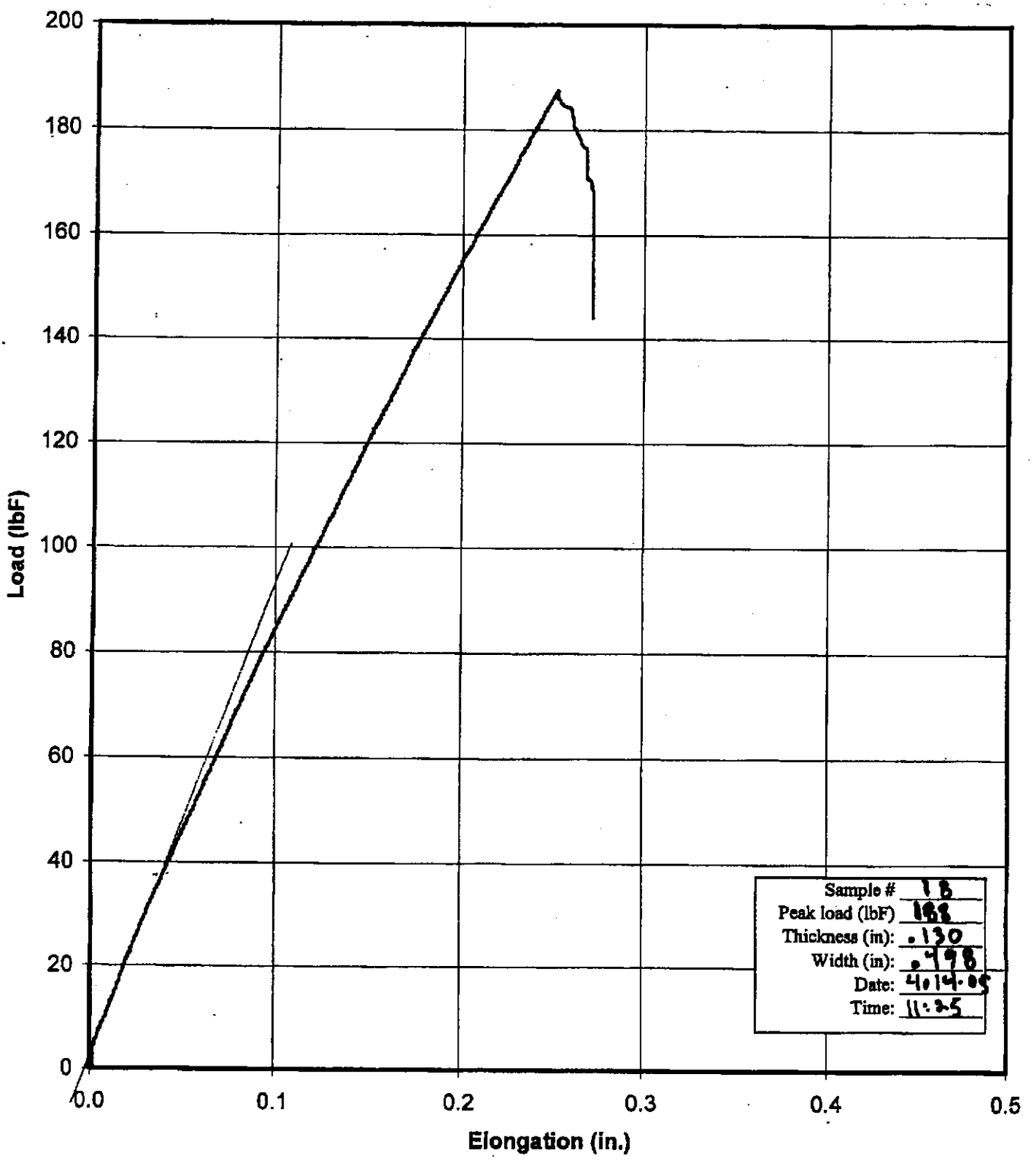
Engineered Plastics, Inc.
Armor-Deck Structural Composites
Flexural testing - 1/8" thick sample



Engineered Plastics, Inc.
Armor-Deck Structural Composites
Flexural testing - 1/8" thick sample



Engineered Plastics, Inc.
Armor-Deck Structural Composites
Flexural testing - 1/8" thick sample



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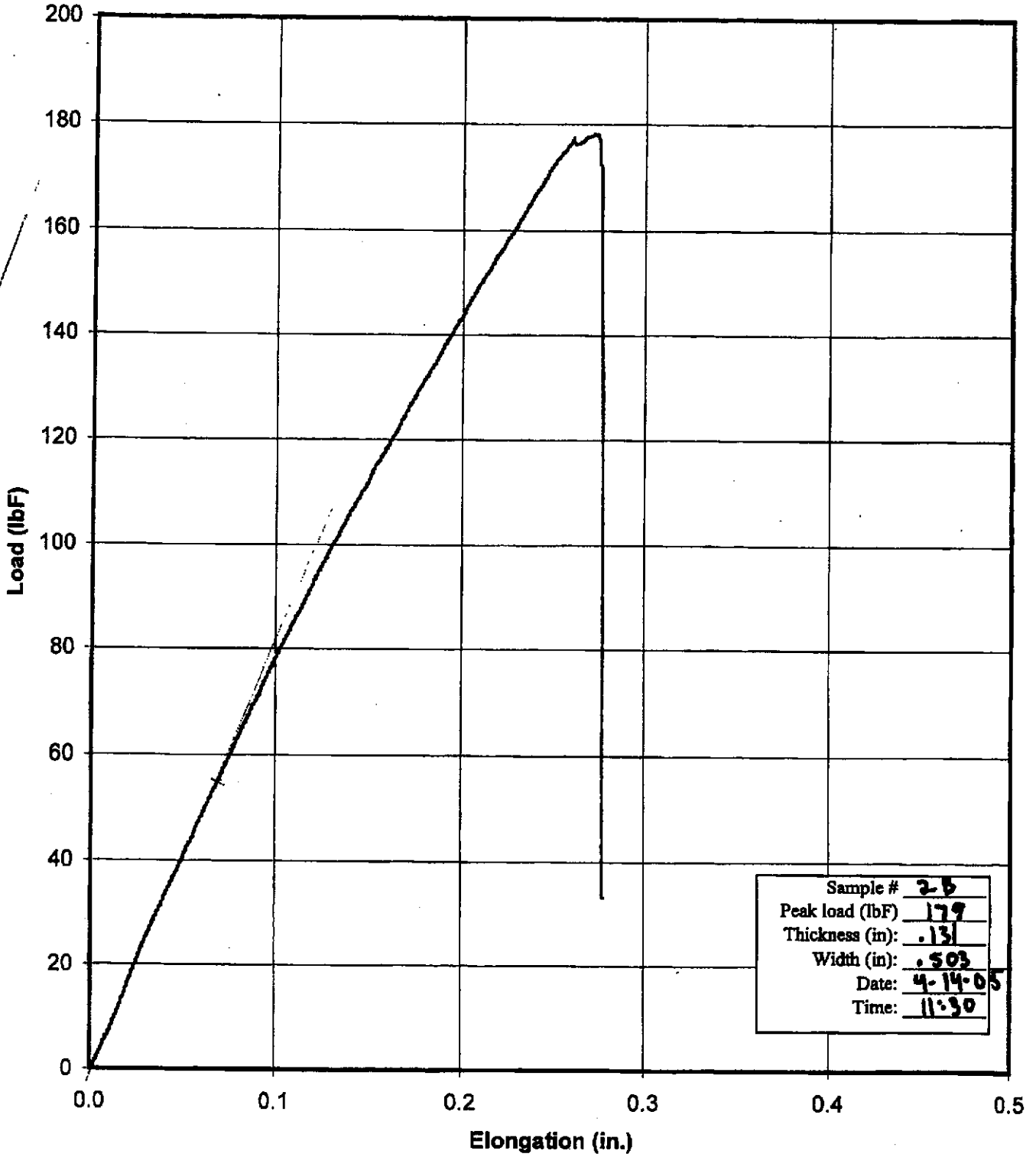
Flexural testing - 1/8" thick sample



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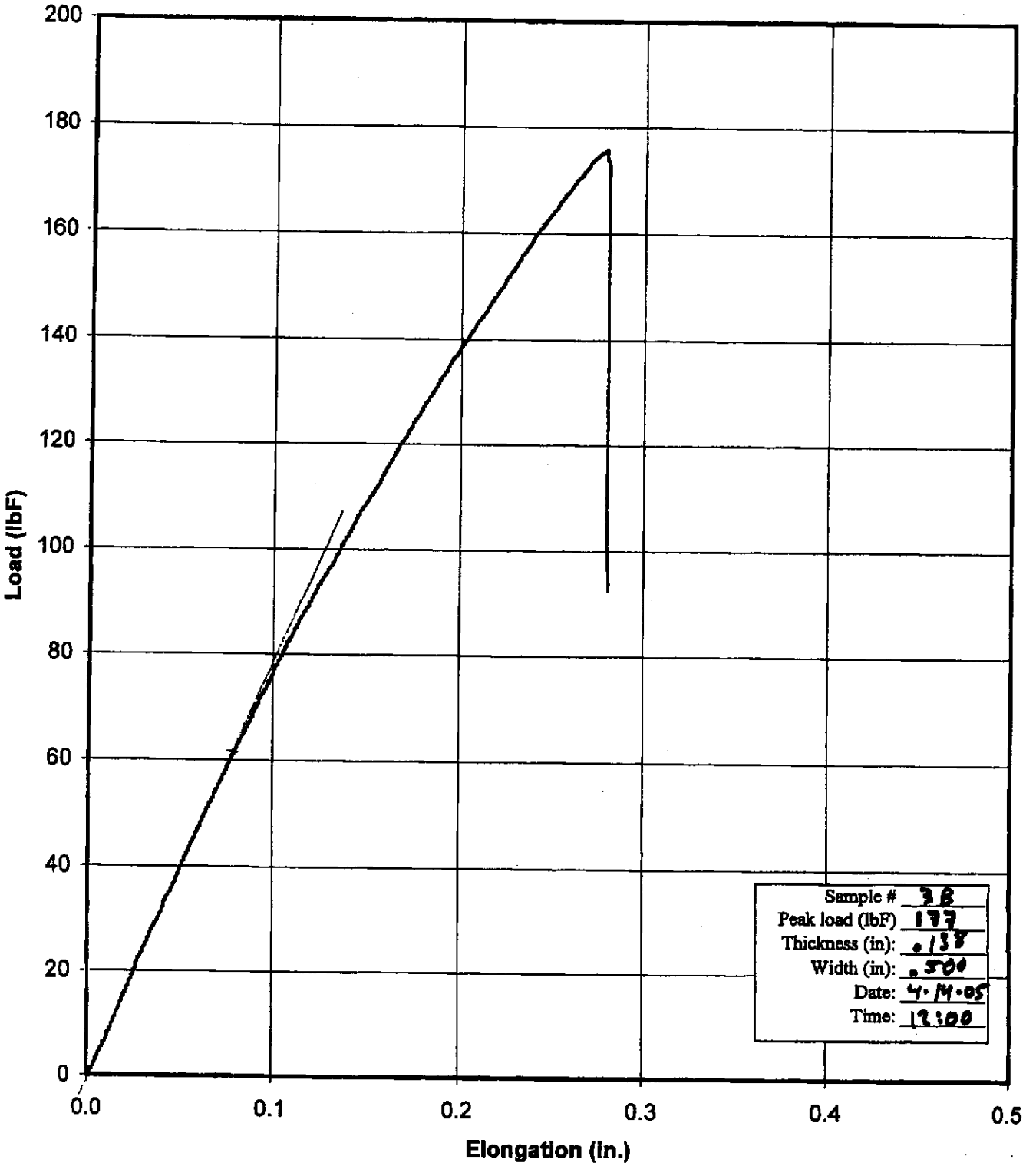

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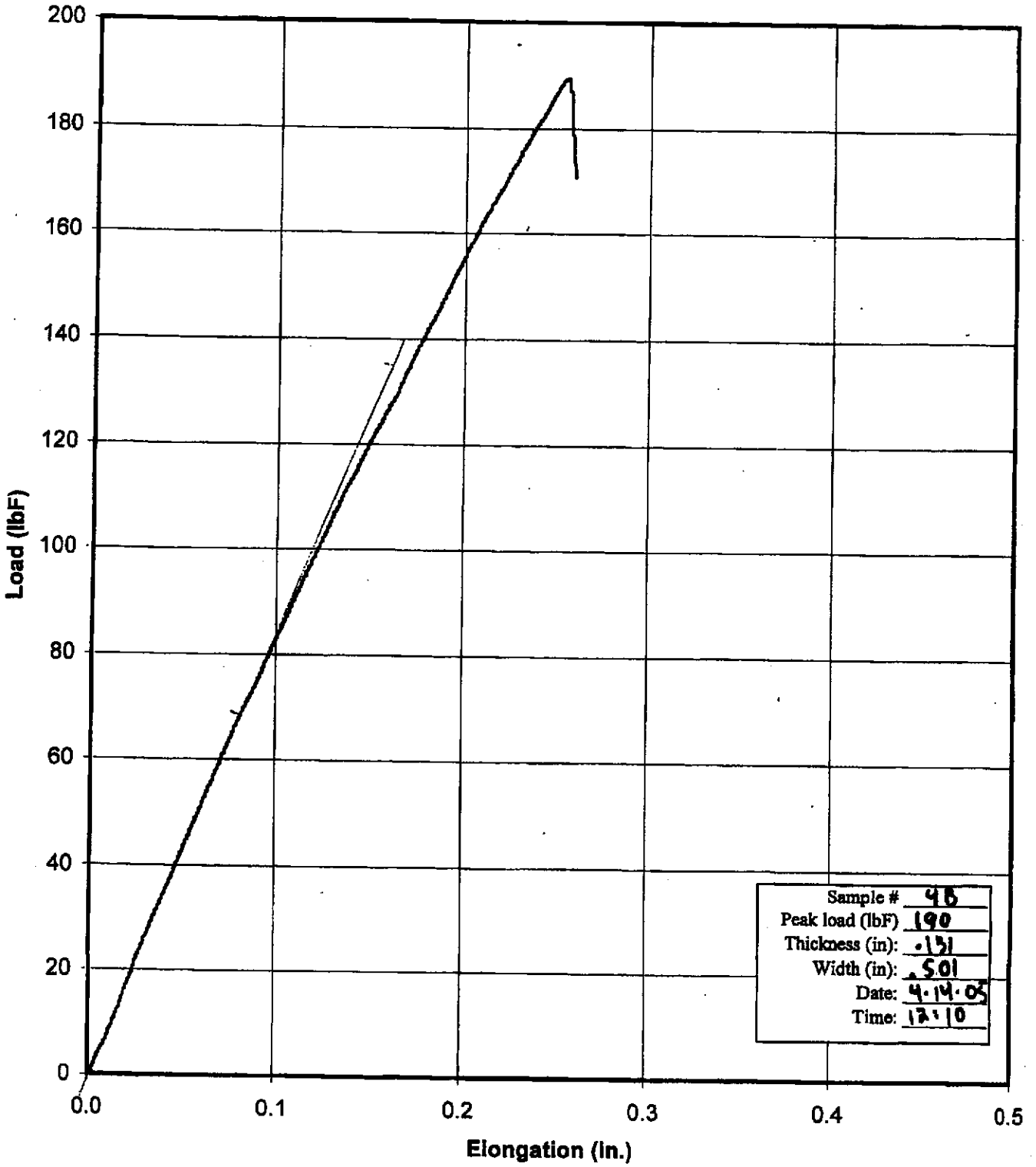

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