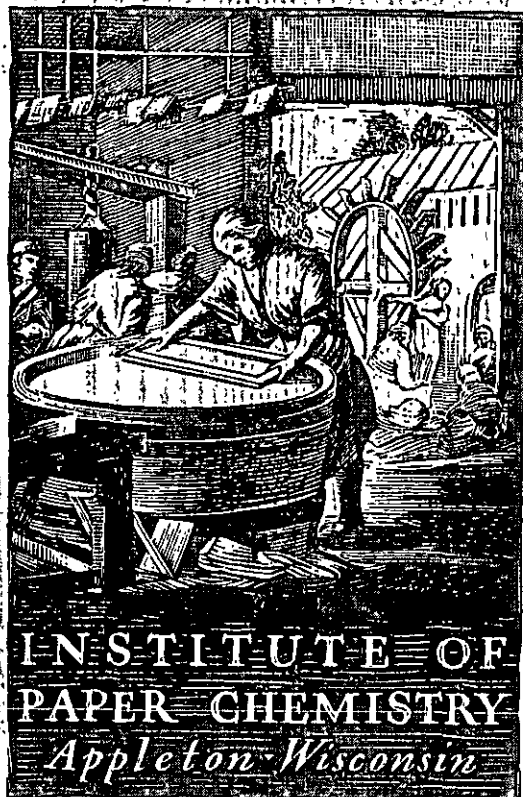


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## CONTINUOUS EVALUATION OF CORRUGATING MEDIUM

✓ Project 1108-17

Summary Report

to

FOURDRINIER KRAFT BOARD INSTITUTE, INC.

October 1, 1956

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

Continuous Evaluation

of

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This study---the Continuous Evaluation of Corrugating Medium---was initiated by the Fourdrinier Kraft Board Institute on October 1, 1955 and has now been in progress for twelve months. The test results obtained during this first year of the study are the subject of this report and are summarized herein.

Rolls of corrugating medium have been submitted for evaluation from thirteen different paper machines during this inaugural year. The number of rolls submitted from each of these machines for each of the twelve first-year periods, the total number of rolls evaluated during each period, and the average number of rolls submitted for evaluation from each machine per period are given in Table I. It may be noted in Table I that the total number of samples submitted reached a maximum of 90 during the fourth period as compared to a total of 33 during the first period. Currently the total number of rolls being evaluated each month is in the 60-70 range. During the first twelve months of the study, the total number of rolls submitted for evaluation was 819.

Each roll of corrugating medium submitted for this study was evaluated for basis weight, caliper, Concora flat crush, H. and D. flat crush (single-faced board), and runability. The Concora medium test results were calculated on the basis of pounds of load per unit area rather than on the basis of the formula suggested by the Concora manufacturer and are reported as Concora flat crush test results. Runability was measured by corrugating each roll under standardized conditions on the Institute's

TABLE I  
TABULATION BY PERIODS OF THE NUMBER OF ROLLS OF CORRUGATING  
MEDIUM SUBMITTED FROM EACH MACHINE

Machines	Periods												Av.
	1	2	3	4	5	6	7	8	9	10	11	12	
A	4	9	5	10	8	10	7	3	7	2	5	7	6.4
B	6	8	8	9	8	8	9	9	5	2	6	6	7.0
C	5	8	8	9	8	7	8	8	6	7	--	--	6.2
D	2	2	4	8	4	2	6	4	4	6	11	4	4.8
E	--	5	7	10	8	6	10	7	5	7	6	4	6.2
F	--	1	1	--	--	--	--	--	--	--	--	1	0.2
G	--	1	7	10	8	9	8	7	7	3	5	8	6.1
H	--	1	1	1	--	--	--	--	--	1	1	1	0.5
I	4	7	9	9	9	8	10	7	9	8	3	7	7.5
J	6	8	7	8	9	9	7	9	8	8	9	8	8.0
K	6	8	8	7	9	8	6	8	8	7	9	7	7.6
L	--	--	2	--	--	2	--	1	2	2	--	2	0.9
M	--	2	6	9	7	9	7	9	6	8	11	8	6.8
Total	33	60	73	90	78	78	78	72	67	61	66	63	68.2

corrugator into A-flute board at a given speed. This speed was 450 feet per minute for periods one through nine and has been 600 feet per minute for subsequent periods. If unsatisfactory runability occurred at the maximum speed, the corrugator was slowed down in increments of 25 feet per minute until satisfactory runability was obtained--i.e., no ruptured flutes.

The current F.K.I. averages for basis weight, caliper, Concora flat crush, and single-face flat crush are summarized in Table II for the first twelve periods and presented graphically in Figure 1. From an inspection of these results, the following observations would seem to be pertinent:

1. Basis weight has maintained a relatively constant level near 27.0 pounds.
2. Caliper has decreased somewhat from a high of 10.7 points during the third and fourth periods to a low of 10.1 points during the twelfth period.
3. Concora flat crush results were relatively constant during the first six periods. However, since then, a steady increase has been evident.
4. Single-face flat crush results were also relatively constant during the first six periods. Like the Concora flat crush results, the single-face flat crush results have shown a rather steady increase during periods 7 through 12.

The current machine averages obtained on the rolls of corrugating medium submitted from the production of each paper machine have been summarized for the first twelve periods in individual tables and corresponding

TABLE II

TABULATION OF CURRENT F.K.I. AVERAGES BY PERIODS

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	26.6	10.4	33.2	33.0
2	26.8	10.4	31.3	32.4
3	27.1	10.7	31.1	31.7
4	27.3	10.7	32.8	33.1
5	27.0	10.5	33.1	33.7
6	27.2	10.4	31.8	33.9
7	27.2	10.2	31.6	35.1
8	27.2	10.2	33.0	34.8
9	27.0	10.2	34.4	34.7
10	26.8	10.2	33.4	35.3
11	27.0	10.2	36.0	36.4
12	27.3	10.1	35.5	37.5

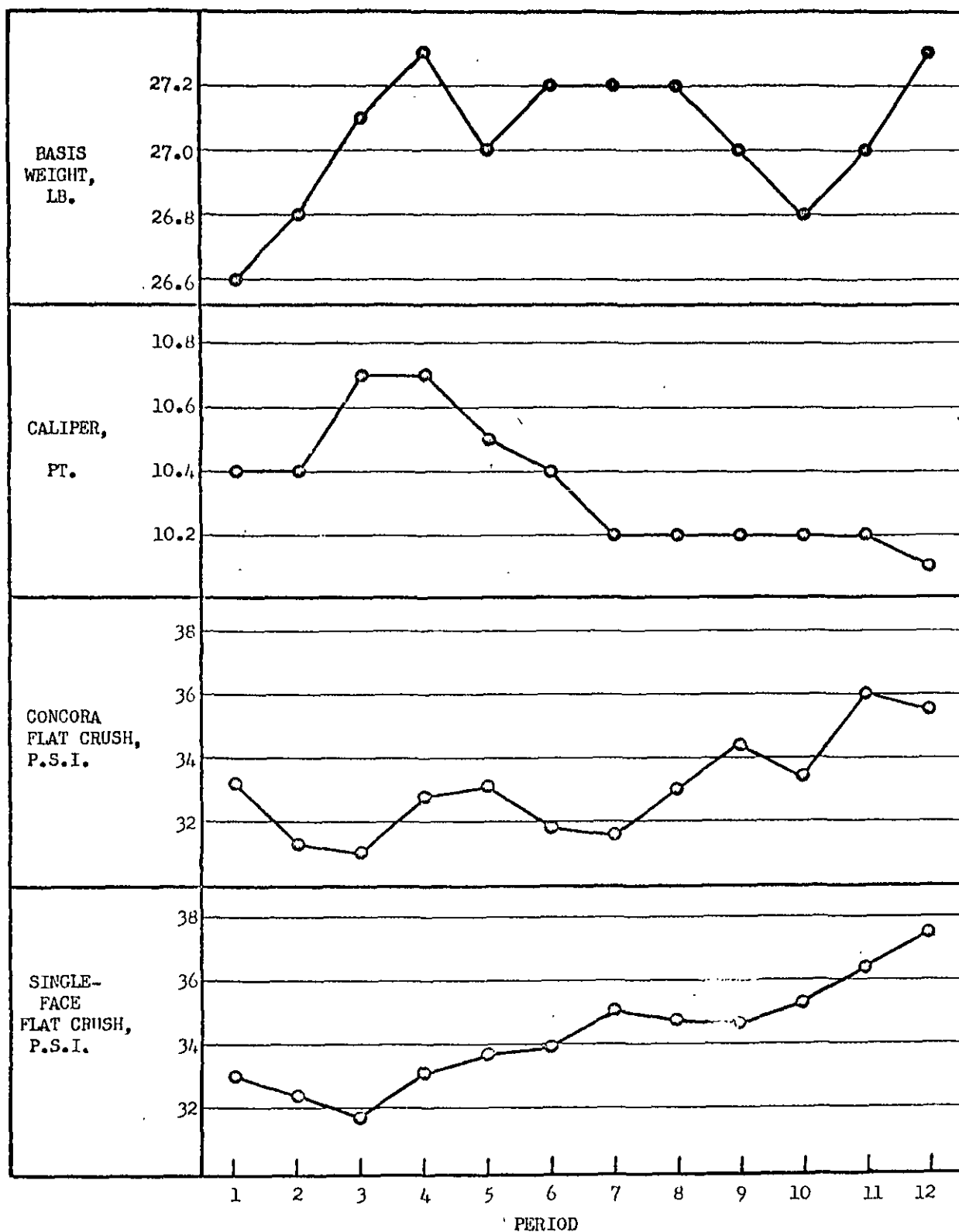


Figure 1. Comparison of Current F.K.I. Averages by Periods

figures which are presented and discussed in alphabetical order on the pages of this report that follow. In considering these results from period to period, the reader should bear in mind that some of the current machine averages are based on the results for a greater number of rolls of corrugating medium than are some others, and this has an influence on how reliably a given average reflects the quality of product which a particular machine is producing. For example, if the average for period 1 is based on the testing of 2 rolls and that for period 2 on the testing of 8 rolls, it would be concluded that the average for period 2 was more reliable in representing the true quality level for that particular machine, other factors being equal. This fact is mentioned to emphasize the importance of testing an adequate number of rolls in order to obtain a reliable indication of quality.

Table III presents the current averages by periods for Machine A. These results are presented graphically in Figure 2. It may be noted from a consideration of these results that basis weight averages for Machine A have generally been slightly above 26 pounds and maintained that level for the twelve month period of this report. Caliper averages reached maximum levels during the third and fourth periods. Since that time, caliper averages have remained near the 9-point level. Both Concora flat crush and single-face flat crush maintained averages near 32 p.s.i. until recently. A definite increase in the magnitude of these two tests has been evident for the two most recent periods.

The current averages for Machine B are given in Table IV and presented graphically in Figure 3. An inspection of these results reveals



TABLE III

TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE A

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	26.3	9.3	31.4	32.5
2	26.3	9.4	31.0	32.7
3	26.3	9.9	32.2	32.3
4	26.1	9.8	31.5	32.5
5	26.4	9.1	32.6	33.2
6	26.1	8.8	30.3	32.7
7	25.8	8.8	28.8	31.9
8	26.6	8.9	32.8	34.2
9	26.2	9.1	32.8	32.9
10	27.0	9.2	31.2	33.1
11	26.4	9.0	36.0	37.4
12	26.5	9.1	33.5	35.6

TABLE IV

TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE B

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	26.6	10.8	34.4	32.5
2	26.6	10.4	32.5	32.6
3	26.6	10.5	33.3	33.6
4	26.9	10.8	35.9	34.4
5	26.5	10.7	34.1	34.6
6	26.6	10.6	33.2	33.9
7	26.9	10.6	33.0	35.1
8	26.7	10.6	33.7	35.5
9	26.9	10.5	36.5	35.8
10	27.0	11.0	35.4	34.4
11	26.6	10.6	36.6	36.2
12	26.9	10.5	35.2	35.8

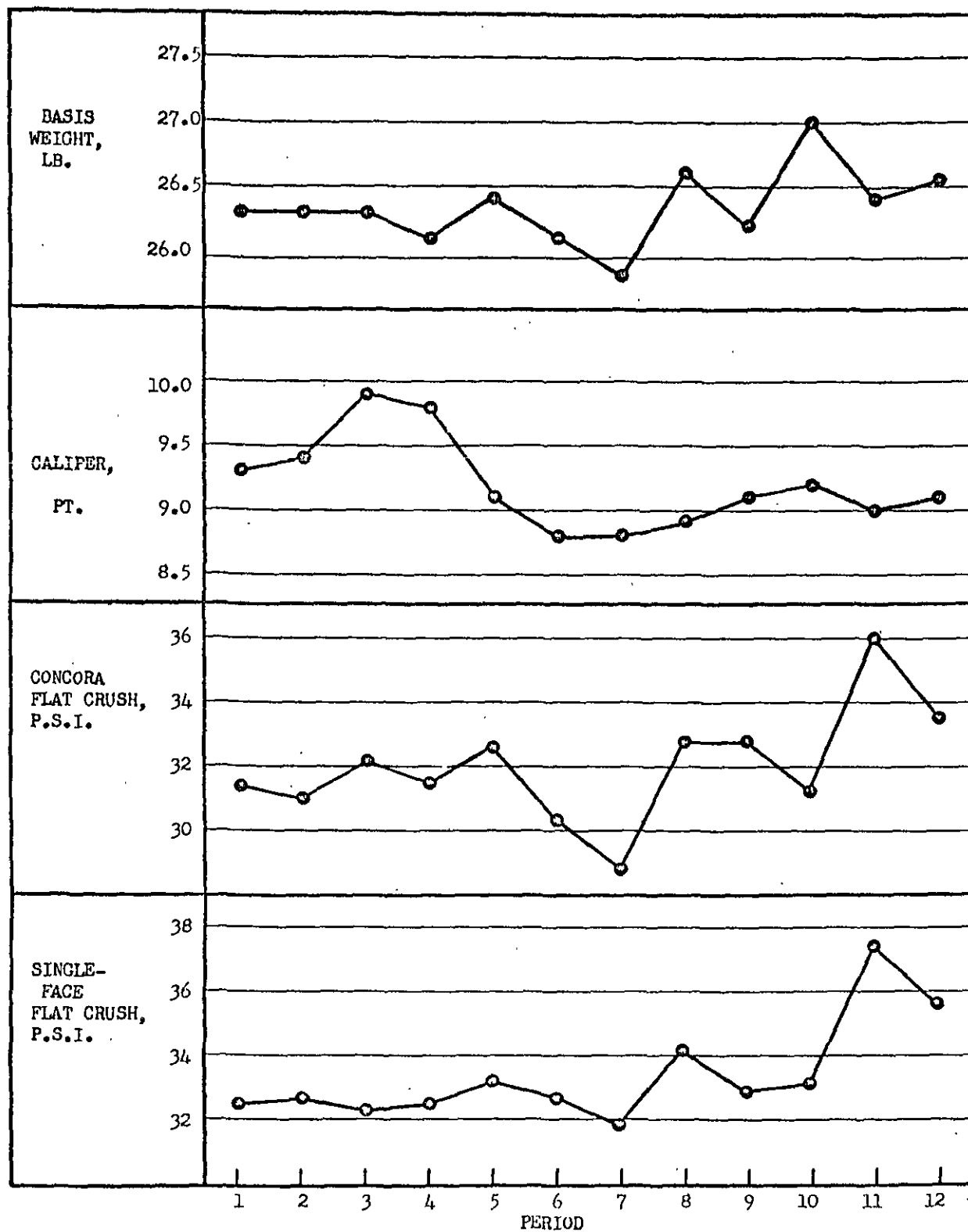


Figure 2. Comparison of Current Averages by Periods for Machine A

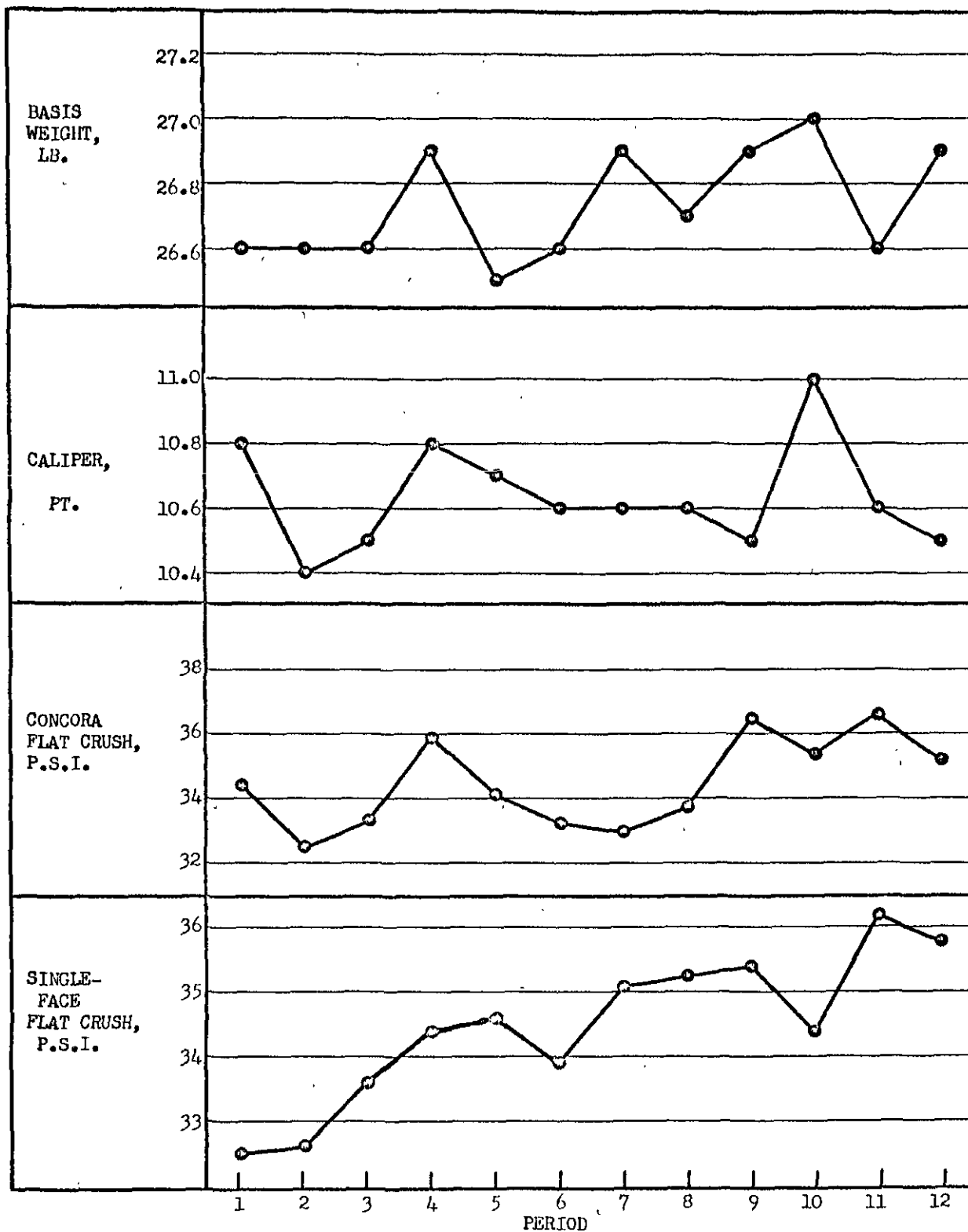


Figure 3. Comparison of Current Averages by Periods for Machine B.

that basis weight averages for the twelve-month period of this report have varied only from 26.5 to 27.0 pounds. Similarly, caliper averages have varied from 10.4 to 11.0 points. In neither case is a definitive trend evident. Both Concora flat crush and single-face flat crush have been maintaining stronger levels for the last six months than they did for the first six months.

The current averages for Machine C are shown in Table V and given graphic presentation in Figure 4. It may be observed in Figure 4 that basis weight averages exhibited no definite trends for the ten periods during which rolls were submitted. Similarly, caliper averages showed no specific trends. Both Concora flat crush and single-face flat crush are currently maintaining higher levels than they were at the start of this study. The trend to higher values is especially evident in the single-face flat crush test averages for the ten periods.

Given in Table VI are the current averages for Machine D. These averages are shown in graphical form in Figure 5. A review of these results shows that basis weight averages are currently somewhat lower than they were during the first six months of this study. This is also true for the caliper averages. Contrary to the general trend, the Concora and single-face flat crush averages for Machine D have maintained lower levels during the second half of this first year of the study than they did during the first half.

In Figure 6 the current averages for Machine E are presented graphically. These averages are compiled in Table VII. From these results it may be seen that basis weight averages have maintained a level near 28

TABLE V  
TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE C

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	26.3	10.4	31.8	30.7
2	26.1	10.4	31.0	31.1
3	26.9	10.3	31.4	31.7
4	26.5	10.5	32.5	32.3
5	26.9	10.4	34.0	34.2
6	26.8	10.5	33.4	33.8
7	26.6	10.1	32.3	34.7
8	26.3	10.2	33.1	34.4
9	26.6	10.8	35.5	34.7
10	26.2	11.5	33.3	35.1
11	--	--	--	--
12	--	--	--	--

TABLE VI

TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE D

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	27.1	10.1	38.5	35.0
2	27.3	10.2	31.8	34.8
3	28.8	9.8	33.7	35.6
4	28.9	9.8	34.0	36.2
5	28.2	10.1	34.9	38.0
6	28.5	10.1	33.0	39.6
7	27.6	10.1	26.1	30.2
8	27.1	9.6	26.4	28.7
9	28.0	9.0	31.3	33.1
10	27.0	9.1	28.7	32.5
11	26.8	9.4	30.1	31.5
12	26.6	9.3	27.0	28.9

TABLE VII  
TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE E

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	--	--	--	--
2	27.7	10.3	27.6	27.4
3	29.0	10.8	30.3	30.3
4	29.1	10.9	28.5	29.1
5	27.8	10.5	28.6	29.9
6	28.2	11.0	24.6	26.9
7	28.3	10.7	24.2	28.1
8	28.5	10.5	28.2	31.6
9	28.0	10.7	28.2	29.9
10	27.6	10.2	29.9	32.2
11	28.0	10.2	30.6	32.5
12	28.8	10.0	38.8	41.0



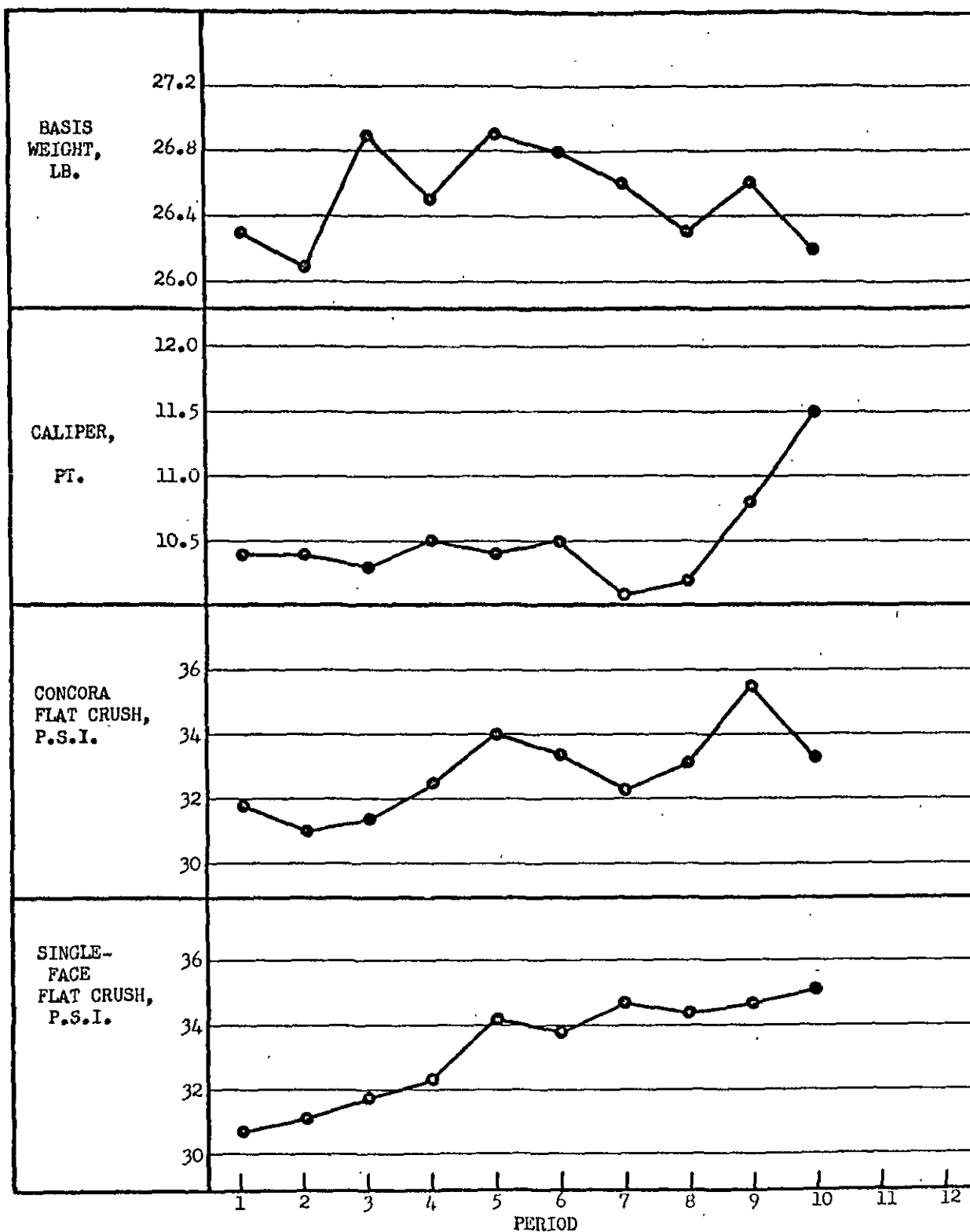


Figure 4. Comparison of Current Averages by Periods for Machine C.

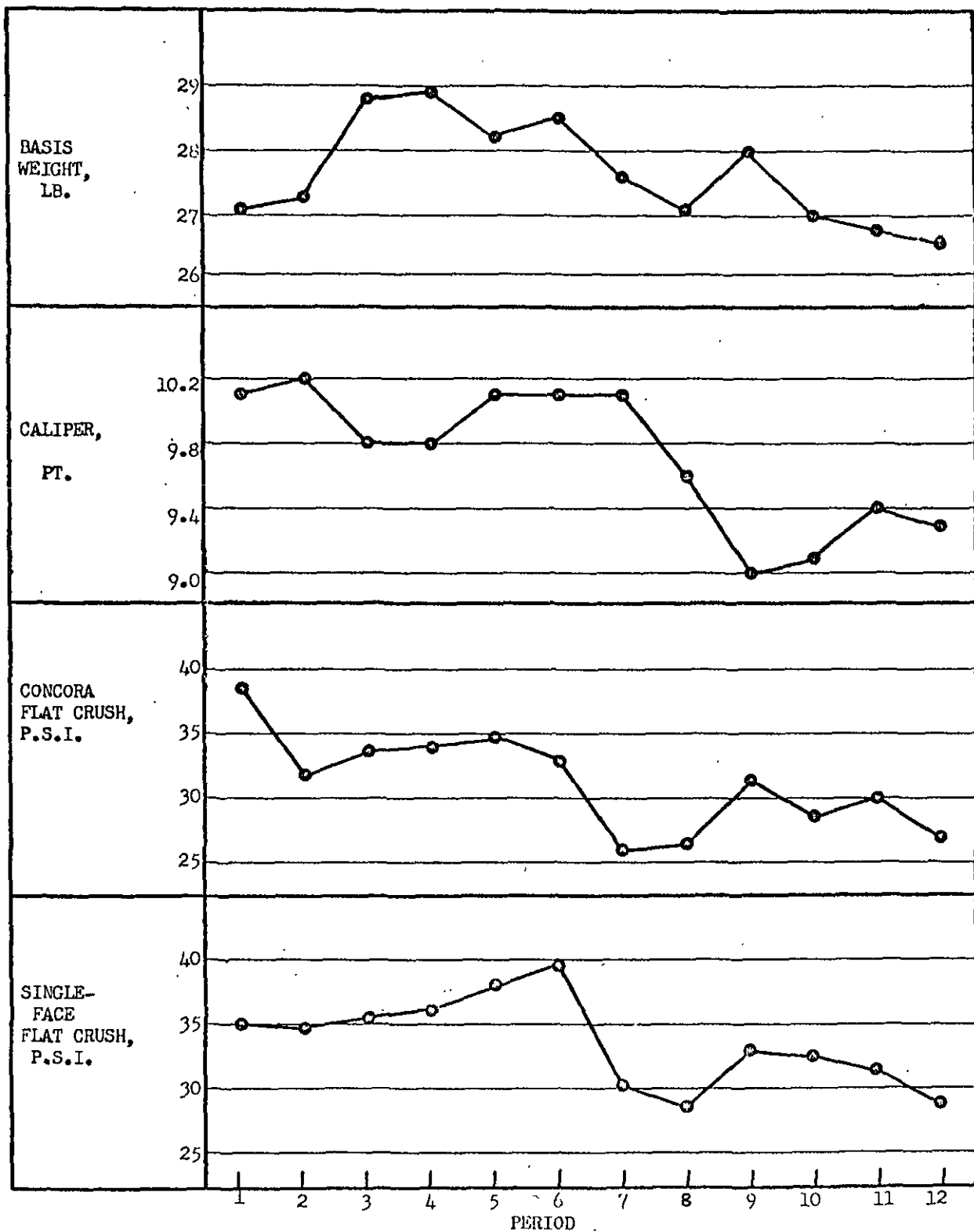


Figure 5. Comparison of Current Averages by Periods for Machine D.

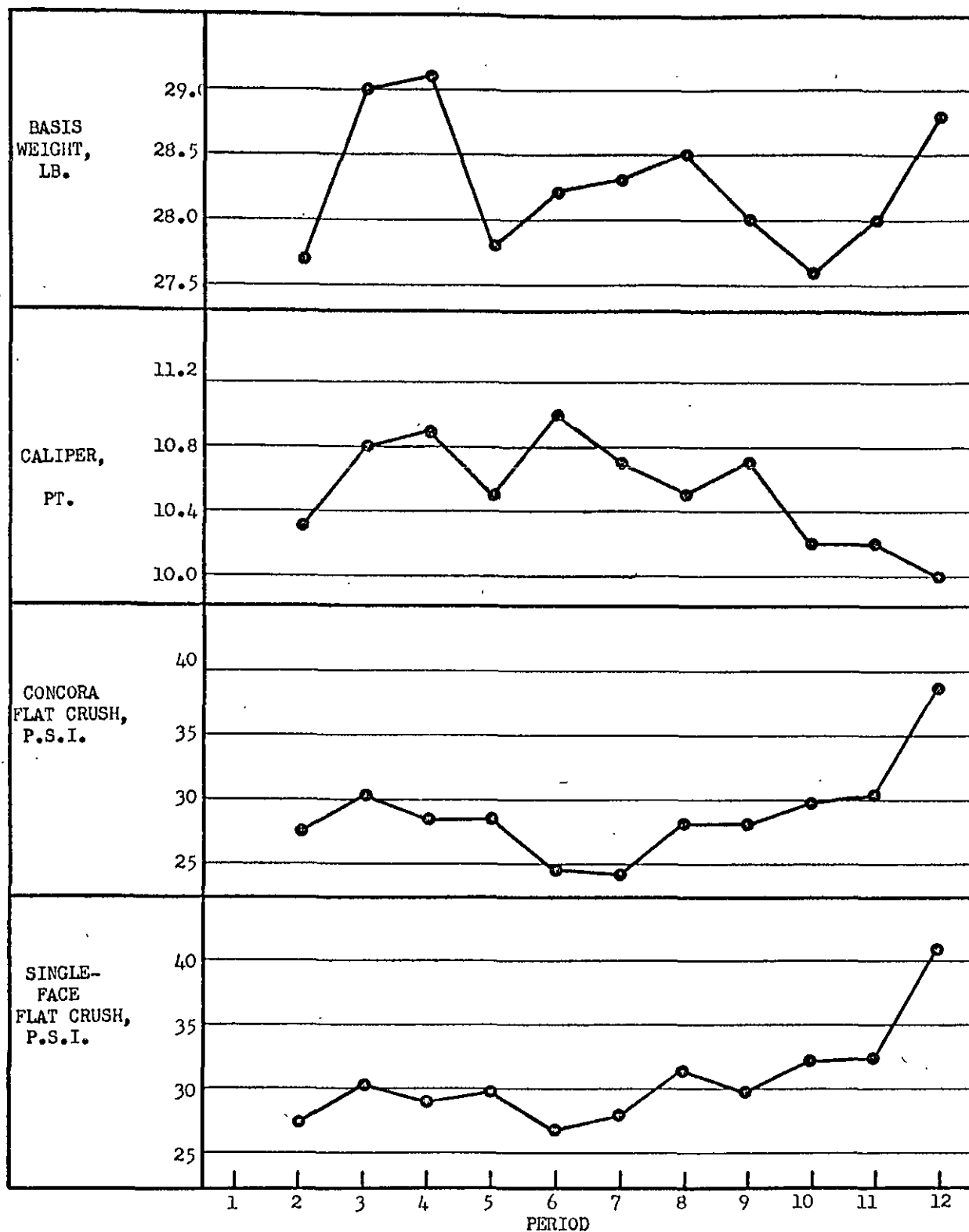


Figure 6. Comparison of Current Averages by Periods for Machine E.

pounds. Caliper averages are currently lower than they were during the first nine months of the twelve months covered by this report. Both Concora and single-face flat crush are currently at their highest level-- a very sudden and substantial increase being evident during the twelfth period.

The current averages for Machine F are presented in Table VIII and shown in graphic form in Figure 7. It may be noted that data are available for only three of the twelve periods and, subsequently, any trends noted would be based on much fewer data than in the case of most other machines. With this in mind, it may be seen that basis weight is higher, caliper lower, and Concora and single-face flat crush both much higher than they were during the initial periods.

From an inspection of the current averages given in Table IX for Machine G and graphically presented in Figure 8, it may be noted that basis weight averages have maintained a level near 29 pounds. Caliper averages currently appear to be maintaining a somewhat higher level than they did during the first six months. Concora and single-face flat crush have maintained levels slightly above 30 p.s.i. during most of the first year of this study.

Shown in Table X are the current averages for Machine H. These averages are presented graphically in Figure 9, where it may be noted that no definite trends are evident for basis weight or caliper. Both Concora and single-face flat crush currently are maintaining higher levels than they did during the initial periods of this study.

TABLE VIII

TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE F

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	--	--	--	--
2	28.3	11.0	26.3	25.4
3	27.4	10.9	21.8	22.4
4	--	--	--	--
5	--	--	--	--
6	--	--	--	--
7	--	--	--	--
8	--	--	--	--
9	--	--	--	--
10	--	--	--	--
11	--	--	--	--
12	29.2	10.0	43.0	40.5

TABLE IX  
TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE G

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	---	---	---	---
2	27.5	10.6	29.0	31.5
3	29.2	10.9	28.4	31.7
4	29.3	10.9	30.2	32.1
5	29.0	10.9	30.8	32.2
6	29.2	10.9	30.9	33.4
7	29.3	11.0	30.8	35.3
8	29.6	11.4	30.0	32.3
9	28.8	11.0	32.2	33.0
10	27.7	10.9	27.7	31.4
11	28.7	11.2	30.4	31.6
12	29.0	11.4	30.9	33.9

TABLE X

TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE H

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	--	--	--	--
2	26.0	11.4	34.0	35.2
3	26.2	12.2	34.1	34.1
4	27.3	12.0	35.9	35.7
5	--	--	--	--
6	--	--	--	--
7	--	--	--	--
8	--	--	--	--
9	--	--	--	--
10	25.4	9.8	33.8	40.4
11	26.5	11.3	41.8	42.5
12	26.9	11.5	38.8	42.2

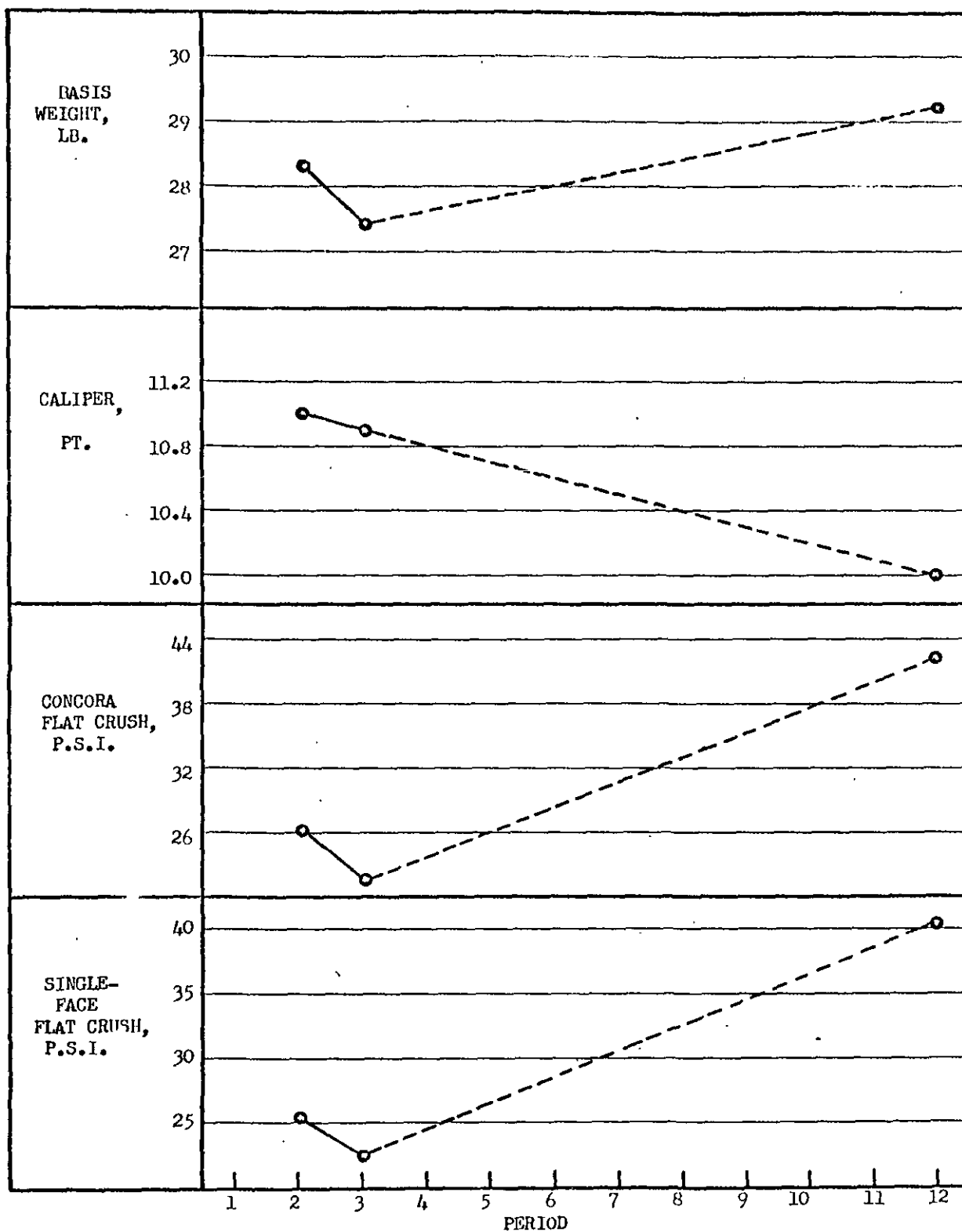


Figure 7. Comparison of Current Averages by Periods for Machine F.



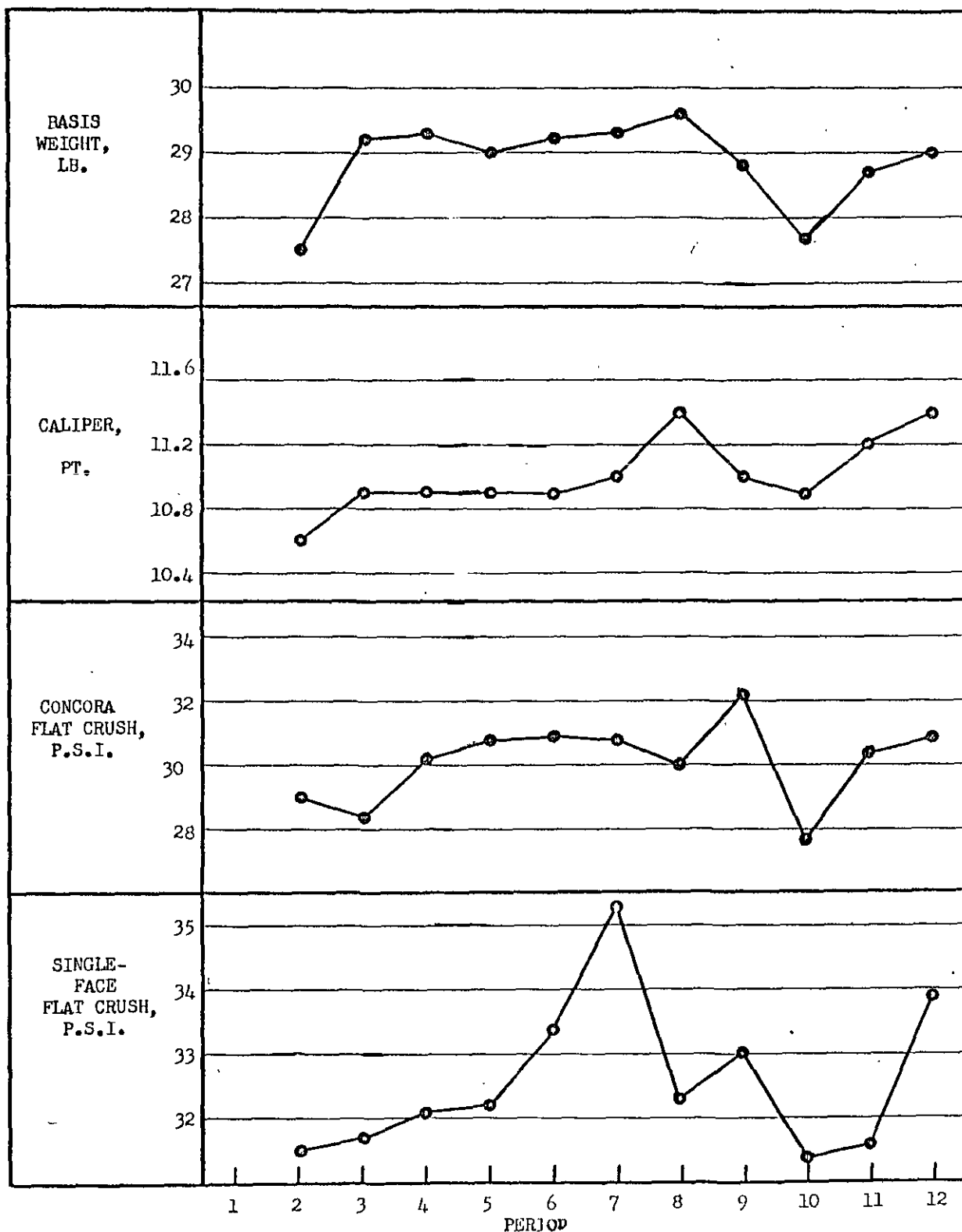


Figure 8. Comparison of Current Averages by Periods for Machine G.

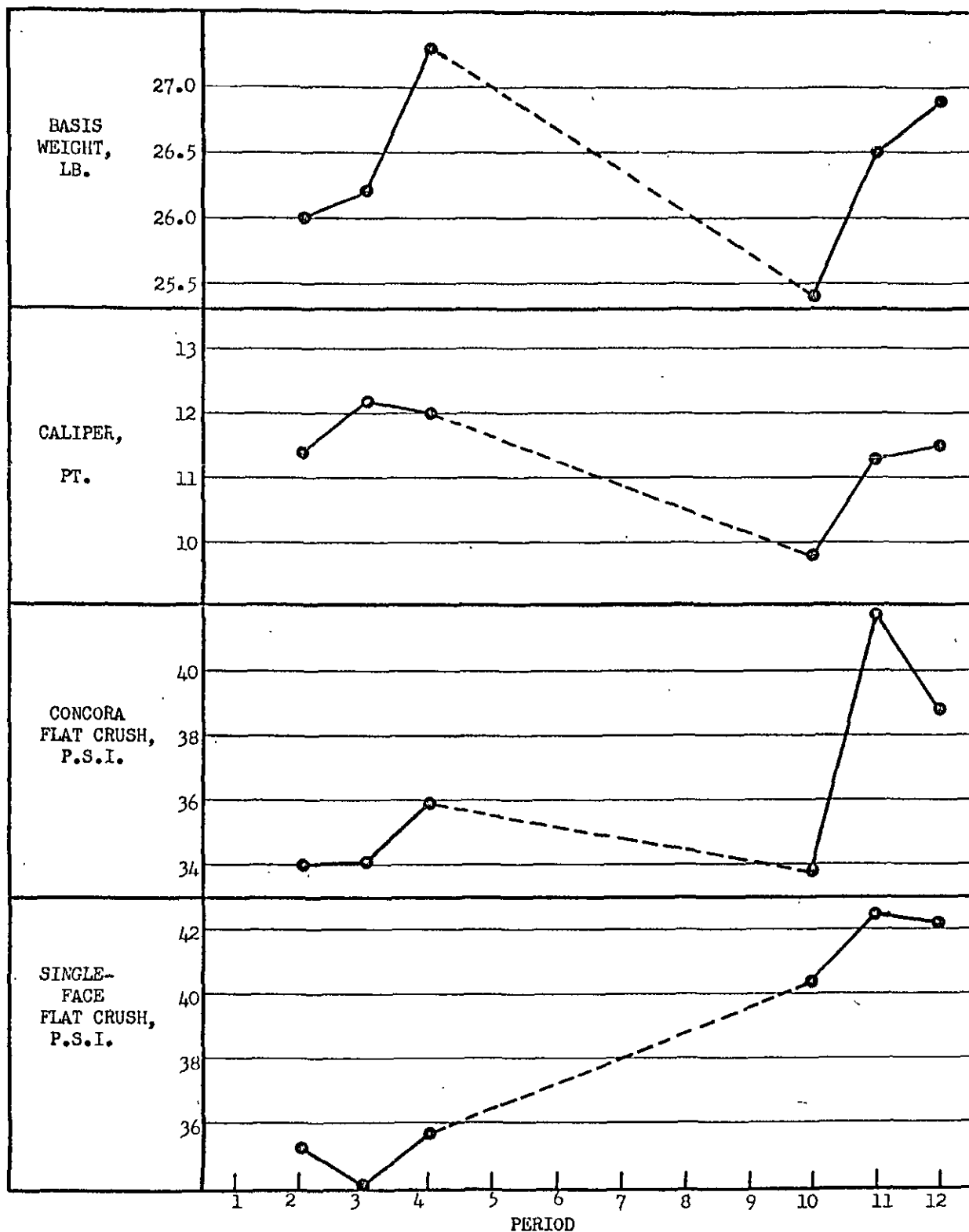


Figure 9. Comparison of Current Averages by Periods for Machine H.

Table XI presents the current averages for Machine I. It may be seen in Figure 10, where these results are plotted, that basis weight averages have maintained a level near 27 pounds; caliper averages have generally been rather close to 10 points; and Concora and single-face flat crush have maintained considerably higher levels during the second half of the first year than they did during the first half.

The current averages for Machine J are given in Table XII and presented graphically in Figure 11. From a consideration of these results, it may be seen that the basis weight averages have maintained a relatively constant level between 26 and 27 pounds. Caliper averages appear to be definitely lower for the second six months than they were for the first six months. Both Concora and single-face flat crush are currently maintaining the highest levels they have held during the first year of this study.

Presented graphically in Figure 12 are the current averages compiled in Table XIII for Machine K. The following observations would appear to be pertinent regarding these results: Basis weight averages have remained steady between 26 and 27 pounds; caliper averages have decreased; Concora flat crush averages have increased; and single-face flat crush averages have increased.

In Figure 13 the current averages for Machine L are shown graphically. This graph was prepared from the data shown in Table XIV. An inspection of these results indicates, for the six periods for which data are available, that basis weight averages have maintained a relatively constant level; caliper averages have decreased, whereas both Concora

TABLE XI

TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE I

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	26.8	10.2	32.9	34.2
2	26.8	10.0	33.6	35.2
3	27.0	10.4	32.9	34.2
4	26.6	10.5	33.2	33.4
5	26.7	10.5	33.9	34.2
6	26.9	10.4	34.0	36.4
7	27.1	10.1	37.9	42.3
8	27.0	9.9	37.8	40.9
9	26.8	10.1	37.9	39.4
10	26.9	9.7	38.2	40.2
11	26.6	9.6	37.6	39.7
12	27.1	9.9	37.3	41.0

TABLE XII

TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE J

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	26.1	11.0	28.4	31.0
2	26.4	11.0	30.2	31.1
3	25.5	11.1	28.7	30.1
4	26.3	11.1	30.5	31.1
5	26.1	11.2	32.9	32.8
6	26.7	11.0	33.7	35.3
7	26.5	10.4	35.2	39.2
8	26.5	10.6	37.4	37.3
9	26.7	10.5	37.5	37.6
10	26.7	10.4	37.4	37.0
11	26.5	10.3	40.2	38.1
12	26.6	10.3	37.9	39.5

TABLE XIII

TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE K

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	26.8	10.9	34.7	35.3
2	26.5	10.7	35.0	35.7
3	26.2	10.8	34.1	34.1
4	26.3	10.7	35.7	34.5
5	26.0	11.0	35.3	34.9
6	26.6	11.0	36.8	37.8
7	26.6	10.5	37.2	40.5
8	26.9	10.7	39.2	39.7
9	26.2	10.6	38.8	38.6
10	26.1	10.6	37.6	37.4
11	26.6	10.3	41.0	39.0
12	26.4	10.2	39.5	41.4

TABLE XIV

TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE L

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	--	--	--	--
2	--	--	--	--
3	26.0	10.5	29.8	29.4
4	--	--	--	--
5	--	--	--	--
6	26.7	10.4	28.5	30.1
7	--	--	--	--
8	26.6	10.2	31.5	32.2
9	25.8	9.8	33.2	31.1
10	26.5	10.0	33.3	34.5
11	--	--	--	--
12	26.1	9.3	27.1	31.0

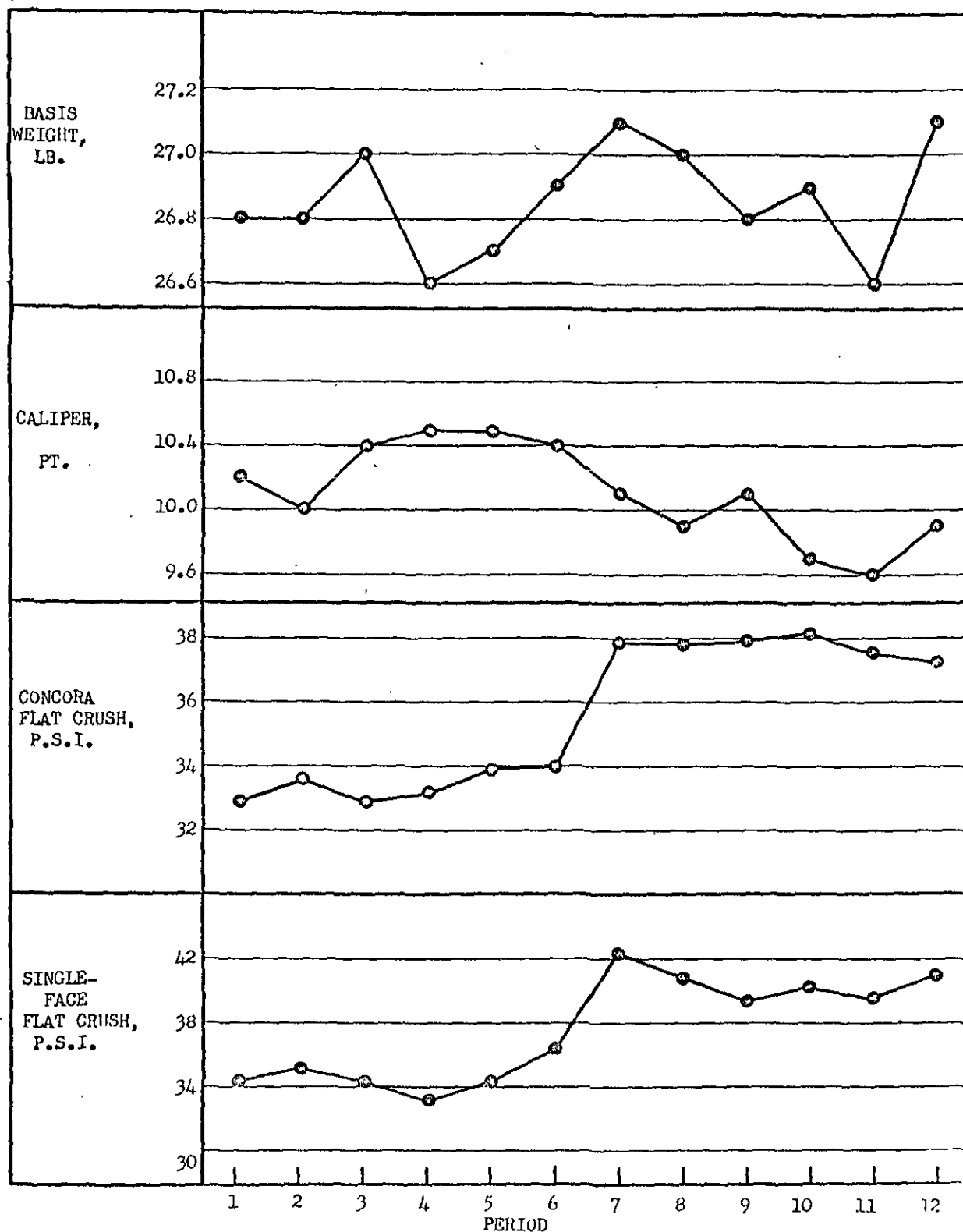


Figure 10. Comparison of Current Averages by Periods for Machine I.



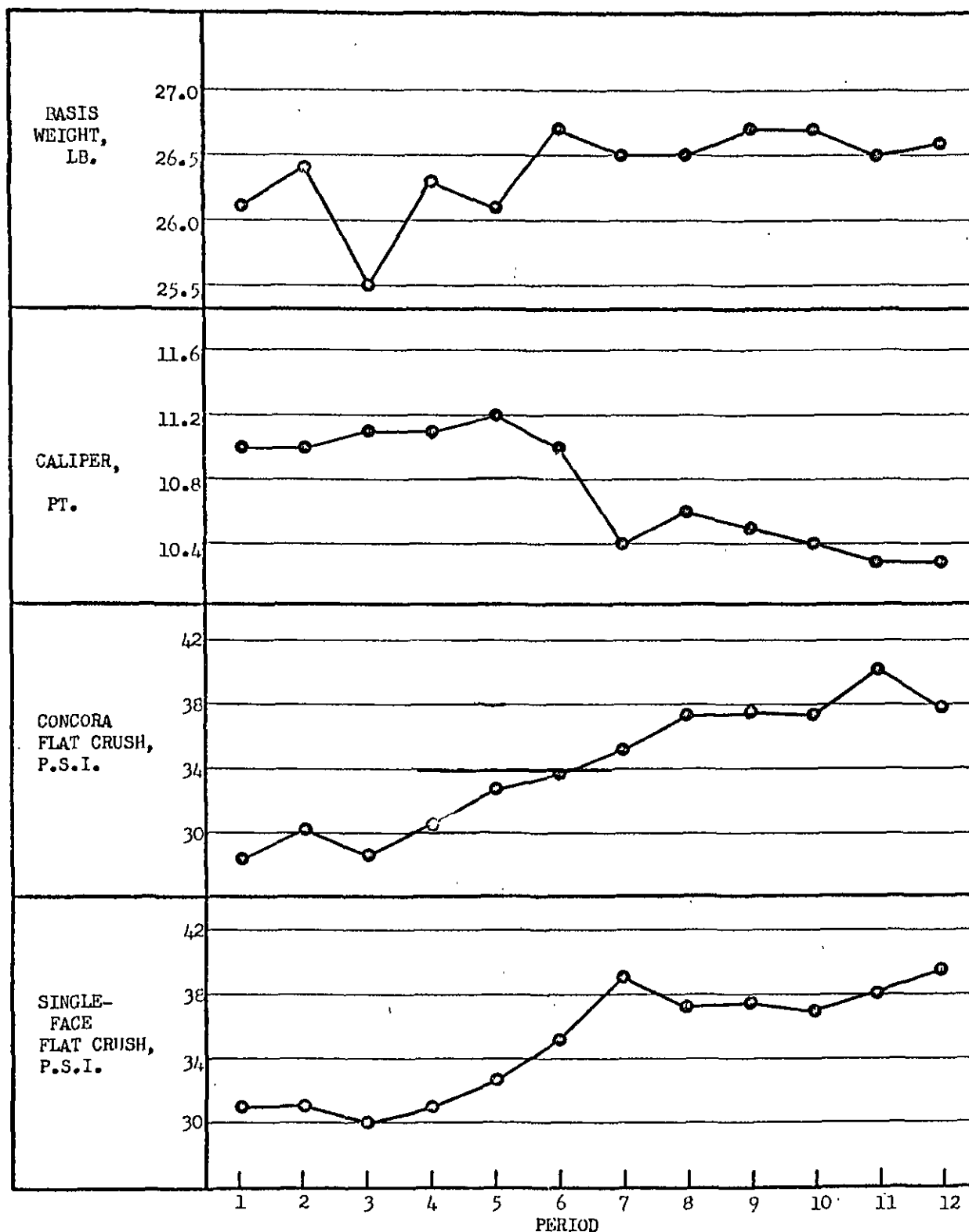


Figure 11. Comparison of Current Averages by Periods for Machine J.

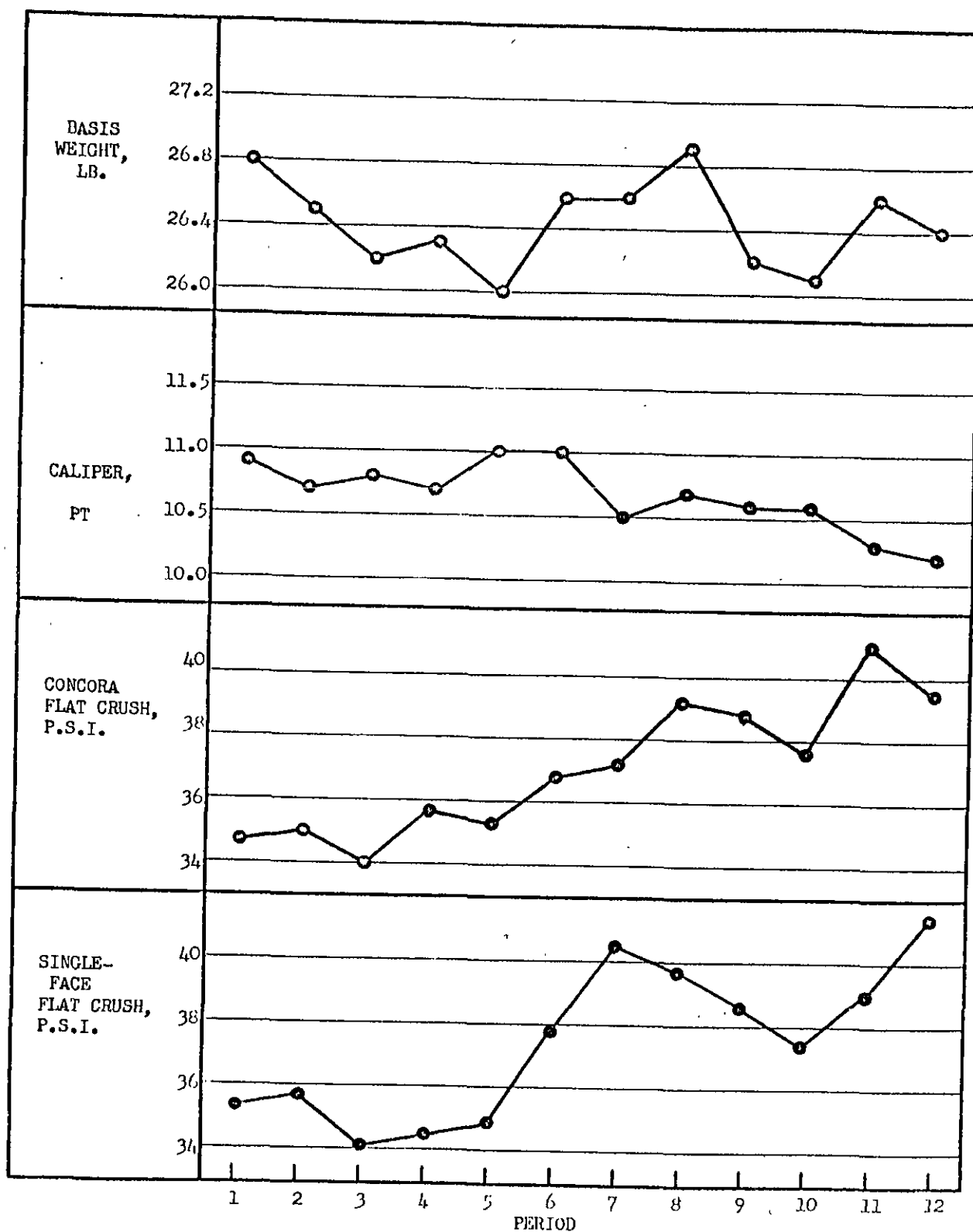


Figure 12. Comparison of Current Averages by Periods for Machine K.

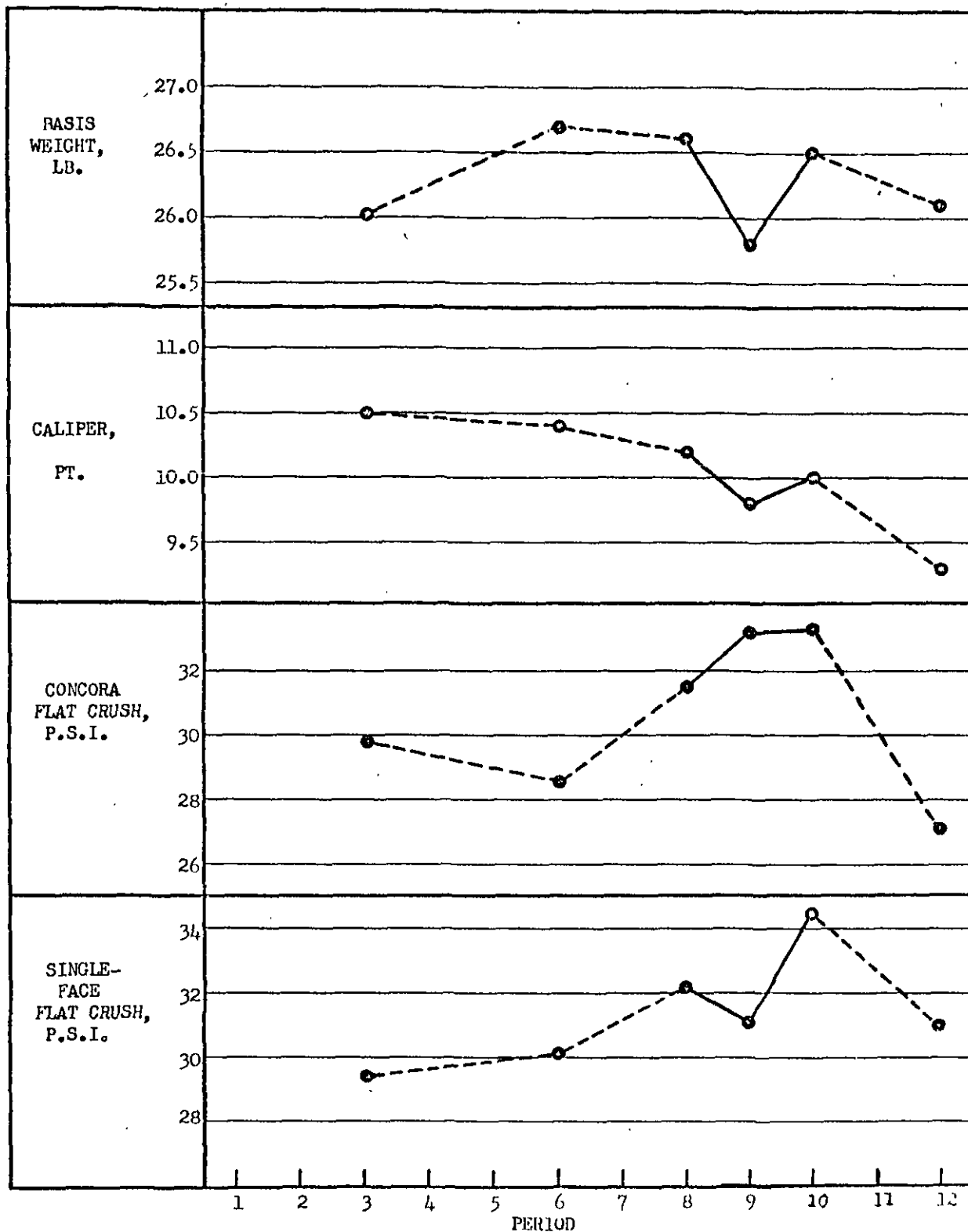


Figure 13. Comparison of Current Averages by Periods for Machine L.

and single-face flat crush reached their zenith during the tenth period but are currently somewhat lower.

Table XV presents the current averages for Machine M. A graphic presentation of these results is given in Figure 14. From a consideration of these results it may be concluded that basis weight averages have increased slightly; caliper averages have not changed appreciably; Concora flat crush averages were at a high level during the second period, hit a low level during the seventh period, and currently have regained the lost strength; single-face flat crush averages are currently at their highest level.

TABLE XV  
TABULATION OF CURRENT AVERAGES BY PERIODS FOR MACHINE M

Period	Basis Weight, lb.	Caliper, points	Concora Flat Crush, p.s.i.	Single-Face Flat Crush, p.s.i.
1	--	--	--	--
2	27.1	10.4	35.9	36.2
3	26.9	10.3	33.0	32.9
4	26.7	10.5	32.6	32.6
5	26.9	10.7	34.3	32.7
6	27.2	10.1	31.3	33.1
7	27.3	10.1	30.1	33.5
8	27.4	10.0	33.5	35.7
9	27.4	10.3	34.1	35.5
10	27.3	9.9	33.7	35.2
11	27.4	10.6	35.2	35.2
12	27.8	10.1	36.6	39.7

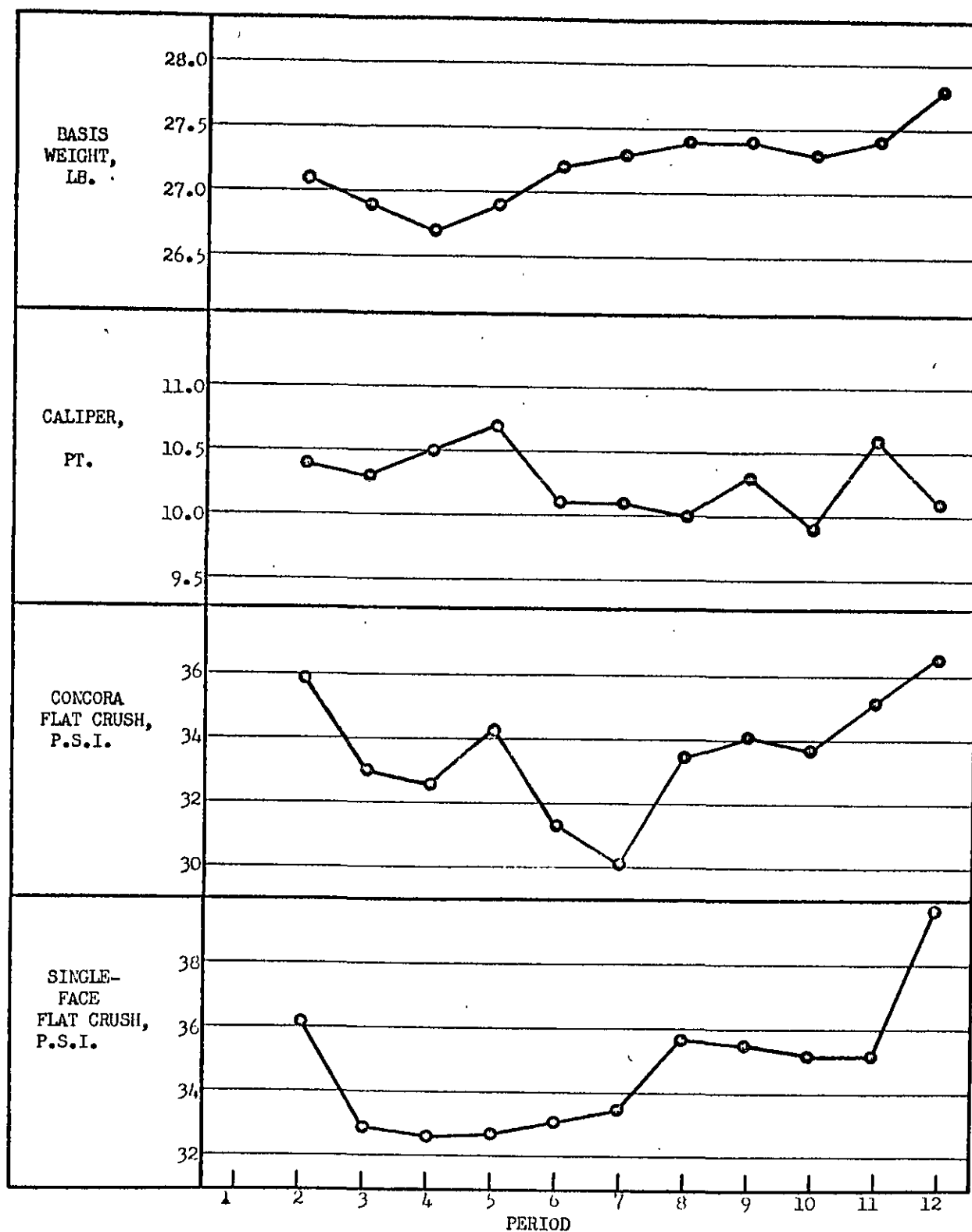


Figure 14. Comparison of Current Averages by Periods for Machine M.