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Roller running friction tests

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1. SCOPE

- 1.1. This document reports on the work carried out in assessing the running friction of the HDPE rollers relative to the normal steel rollers. It aims to establish if the tightness of the seal in the HDPE rollers does not result in an increase in the running friction of the rollers. The rollers in question are new and used 152/30 460-GL series steel and HDPE

2. TESTING FACILITY

- 2.1. Figure 1 and 2 show the general construction and/or arrangement of the testing facility. A roller whose shaft is tightly coupled to a lever arm is placed over four wheels and driven by a motor through a belt. A scale is used for measuring the force exerted by the lever as the roller is rotating in a clockwise direction.



Figure 1: Illustration of the testing facility



Figure 2: Illustration of the testing facility

- 2.2. The length of the lever arm is 552mm and the shaft coupling is connected in the middle. Thus each side of the liver arm is 276mm when measured from the edge to the centre.

3. THEORETICAL CONSIDERATIONS

3.1. Figure 3 shows the forces acting on the system. From a simple equilibrium consideration, the running friction is derived.

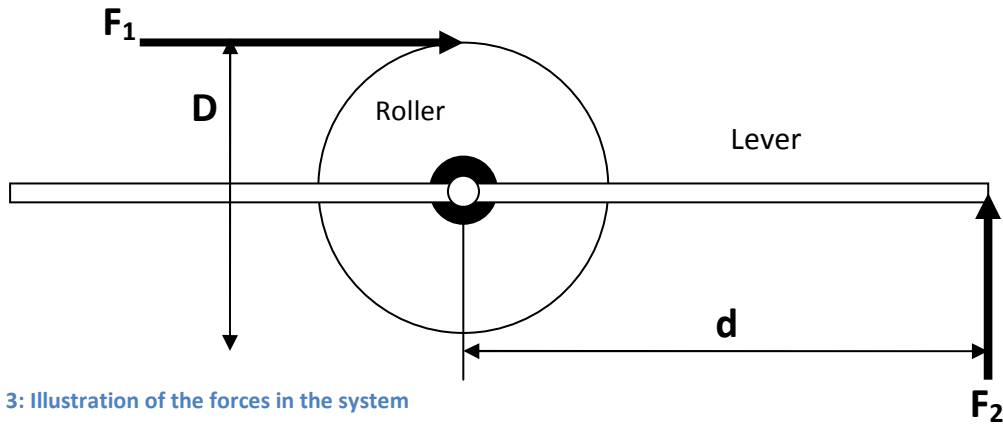


Figure 3: Illustration of the forces in the system

From the figure:

$$\text{friction [N.m]} = F_1 \times D = F_2 \times d$$

Or

$$\text{friction [N]} = F_1 = \frac{d}{D} \times F_2$$

For the purposes of the current test, the following values apply:

$$d = \frac{552}{2} = 276\text{mm}$$

$$D = \frac{152}{2} = 76\text{mm}$$

Thus

$$F_1 = \frac{276}{76} \times \frac{\text{reading} \times 9.81}{1000} = \frac{276}{76} \times \frac{\text{reading} \times 9.81}{1000} = \frac{35.63}{1000} \times \text{reading}$$

Where reading is in grams.

SANS 1313-1 requires that the reading be taken for both rotational directions such that the average of the two is used in the above calculation. For the purposes of this experiment, the reading is not averaged. This is because the current study does not intend to verify any SANS compliance, but to get an approximation of the running friction relative to the ideal (SANS).

For the same reason as outlined above, the testing apparatus is not designed to take into account any friction related to or arising from the roller bearing. It solely considers the roller's sealing arrangement.

4. PROCEDURE

- 4.1. With the belt coupling the roller and the motor, the motor is run such that a roller linear speed of 5m/s is attained. The scale reading is recorded at regular intervals.

5. RESULTS

Table 1, 2, and 3 show the collected readings for the different rollers used. All readings are in grams. Shaded values indicate values calculated as an average of the neighbouring values. This is due to the irregular capturing of the data (irregular time intervals). Where the values seem to have reached equilibrium (no significant changes between consecutive values), the last value has been repeated to make up for the empty data points after it.

Table 1: Steel roller readings

Time elapsed	00:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	00:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00
Steel: F-1	835	370	362	356	350	312.5	275	242	356	470	217	100	95	90	120	137	130
Steel: F-6	755	497.5	240	235	230	225	220	215	410	605	367.5	130	130	130	130	130	125
Steel: F-5	610	140	137.5	135	130	125	120	117.5	115								
Steel: F-14	570	135	105	95	85	82.5	80	80	80								
Steel: F-17	585	145	122.5	100	100	100	95	95	95								
Steel: F-18	600	362.5	125	120	115	110	105	85	197.5	310	205	177.5	150	130	110	95	
Average	659.17	275.00	182.00	173.50	168.33	159.17	149.17	139.08	208.92	461.67	263.17	135.83	125.00	116.67	120.00	120.67	127.50

Table 2: Used HDPE roller readings

Time elapsed	00:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00
HDPE: F-18	60	45	30	27.5	25	25	25	20
HDPE: F-20	70	50	30	27.5	25	28.75	32.5	27.5
HDPE: F-21	110	75	40	37.5	35	37.5	40	35
HDPE: F-3	20	5	5	5	5	5	5	5
Average	65.00	43.75		24.38		24.06		21.88

Table 3: HDPE roller readings

Time elapsed	00:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	00:00	02:00	03:00	04:00	05:00	06:00	07:00
HDPE: F-9	310	131	125.5	120	120	120	120	120	120							
HDPE: F-10	485	105	100	95	95	95	92.5	90	90							
HDPE: F-13	570	347.5	125	120	115	104.25	95	95	95							
HDPE: F-2	370	203	155	131	107	88.5	70	70	70	195	115	97	94.5	92	81	72
HDPE: F-8	515	308	101	98	95	87.5	80	80	80							
Average	450.00	218.90	121.30	112.80	106.40	99.05	91.50	91.00	91.00	195.00	115.00	97.00	94.50	92.00	81.00	72.00

5.1. Table 4, 5, and 6 shows the running friction values. All the values are in Newton [N]. Table 7 shows the maximum allowable running friction values according to SANS 1313-1.

Table 4: Steel roller running friction values

Time elapsed	00:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	00:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00
Steel: F-1	29.75	13.18	12.90	12.68	12.47	11.13	9.80	8.62	12.68	16.74	7.73	3.56	3.38	3.21	4.28	4.88	4.63
Steel: F-6	26.90	17.72	8.55	8.37	8.19	8.02	7.84	7.66	14.61	21.55	13.09	4.63	4.63	4.63	4.63	4.63	4.45
Steel: F-5	21.73	4.99	4.90	4.81	4.63	4.45	4.28	4.19	4.10								
Steel: F-14	20.31	4.81	3.74	3.38	3.03	2.94	2.85	2.85	2.85								
Steel: F-17	20.84	5.17	4.36	3.56	3.56	3.56	3.38	3.38	3.38								
Steel: F-18	21.38	12.91	4.45	4.28	4.10	3.92	3.74	3.03	7.04	11.04	7.30	6.32	5.34	4.63	3.92	3.38	0.00
Average	23.48	9.80	6.48	6.18	6.00	5.67	5.31	4.95	7.44	16.45	9.38	4.84	4.45	4.16	4.28	4.30	3.03

Table 5: HDPE roller running friction values

Time elapsed	00:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	00:00	02:00	03:00	04:00	05:00	06:00	07:00
HDPE: F-9	11.04	4.67	4.47	4.28	4.28	4.28	4.28	4.28	4.28							
HDPE: F-10	17.28	3.74	3.56	3.38	3.38	3.38	3.30	3.21	3.21							
HDPE: F-13	20.31	12.38	4.45	4.28	4.10	3.71	3.38	3.38	3.38							
HDPE: F-2	13.18	7.23	5.52	4.67	3.81	3.15	2.49	2.49	2.49	6.95	4.10	3.46	3.37	3.28	2.89	2.57
HDPE: F-8	18.35	10.97	3.60	3.49	3.38	3.12	2.85	2.85	2.85							
Average	16.03	7.80	4.32	4.02	3.79	3.53	3.26	3.24	3.24	6.95	4.10	3.46	3.37	3.28	2.89	2.57

Table 6: Used HDPE roller running friction values

Time elapsed	00:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00
HDPE: F-18	2.14	1.60	1.07	0.98	0.89	0.89	0.89	0.71
HDPE: F-20	2.49	1.78	1.07	0.98	0.89	1.02	1.16	0.98
HDPE: F-21	3.92	2.67	1.43	1.34	1.25	1.34	1.43	1.25
HDPE: F-3	0.71	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Average	2.32	1.56	0.94	0.87	0.80	0.86	0.91	0.78

Table 7: SANS maximum running friction values

Nominal diameter of roller [mm]	Maximum running friction[N]	After 1hour rest period (1.5 times values to the left) [N]
100	3	4.5
125	2.8	4.2
150 to 180	2.6	3.9

5.2. Figure 4, 5, 6, show the variation of the running friction with the time. Figure 7 shows the variation of the average running friction for all the rollers.

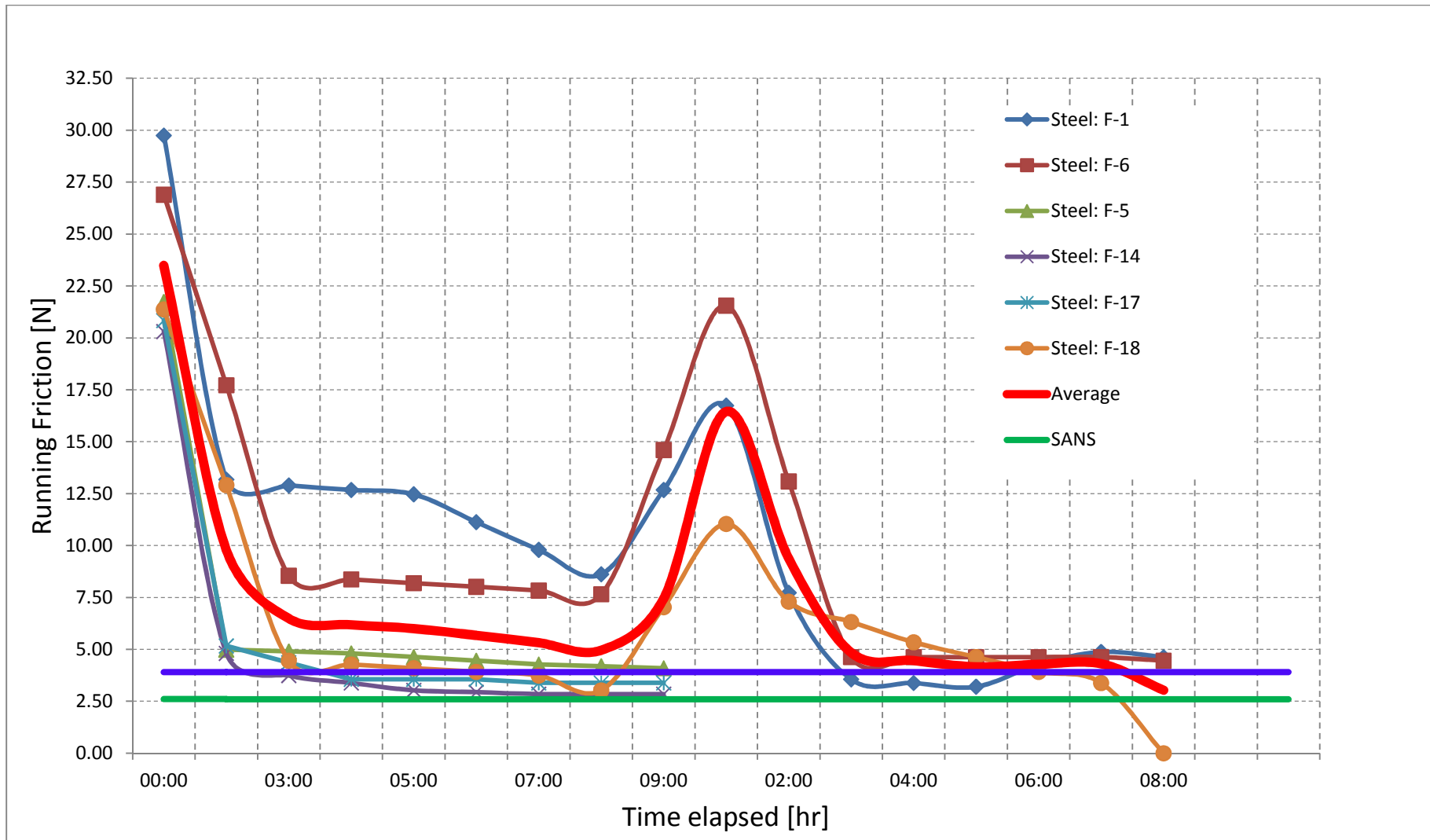


Figure 4: New steel roller running friction

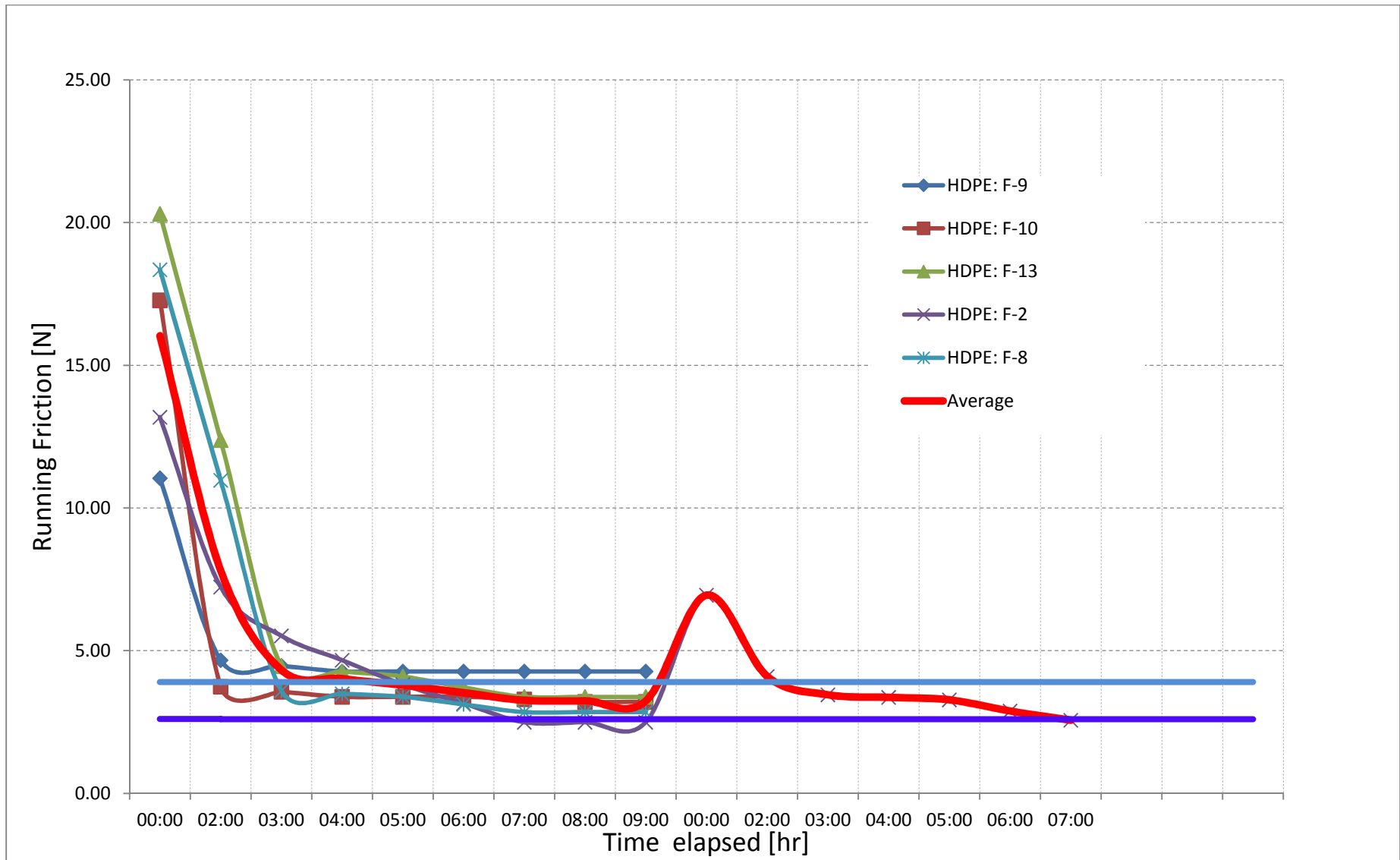


Figure 5: HDPE roller running friction

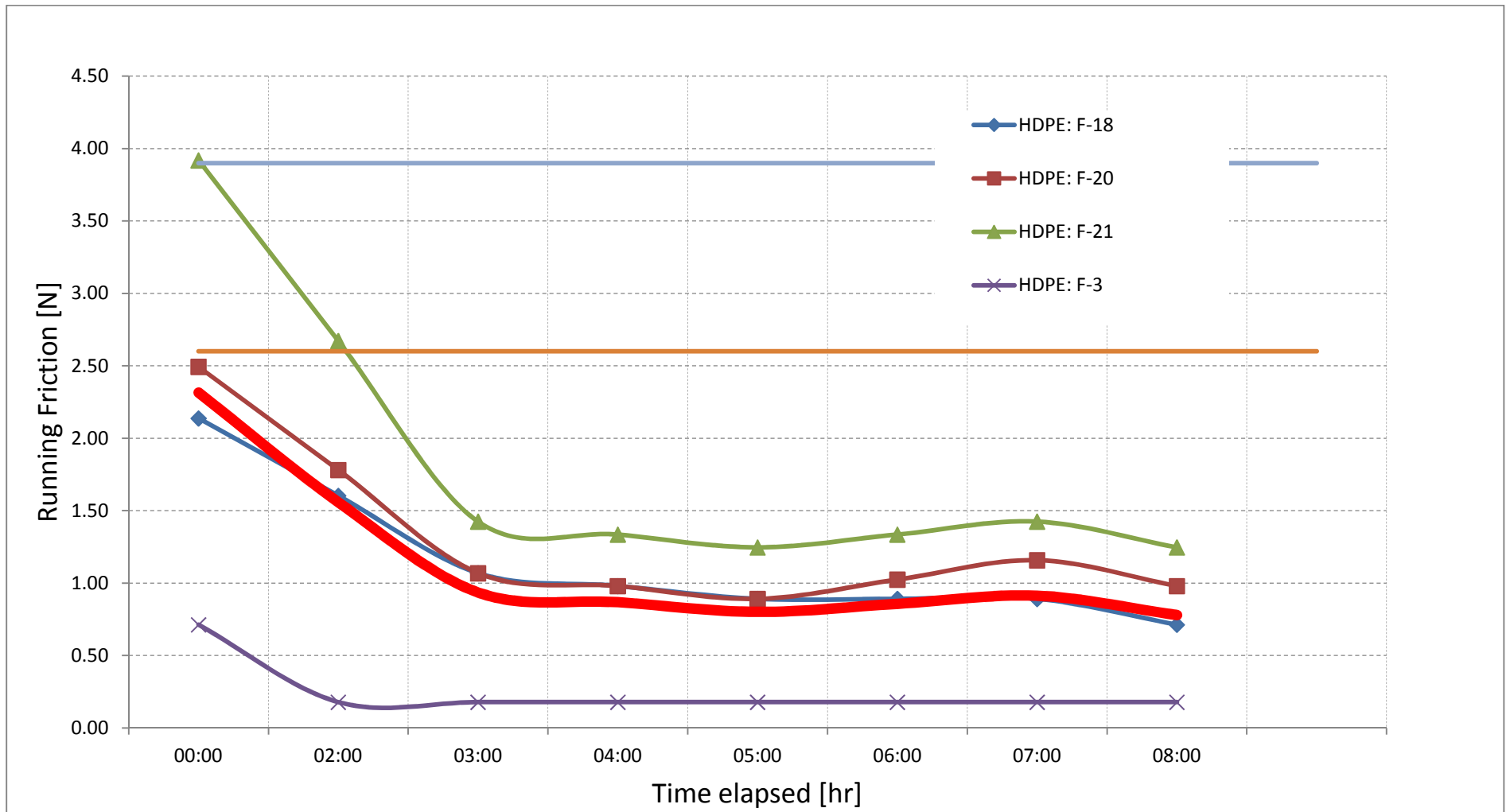


Figure 6: Old HDPE roller running friction

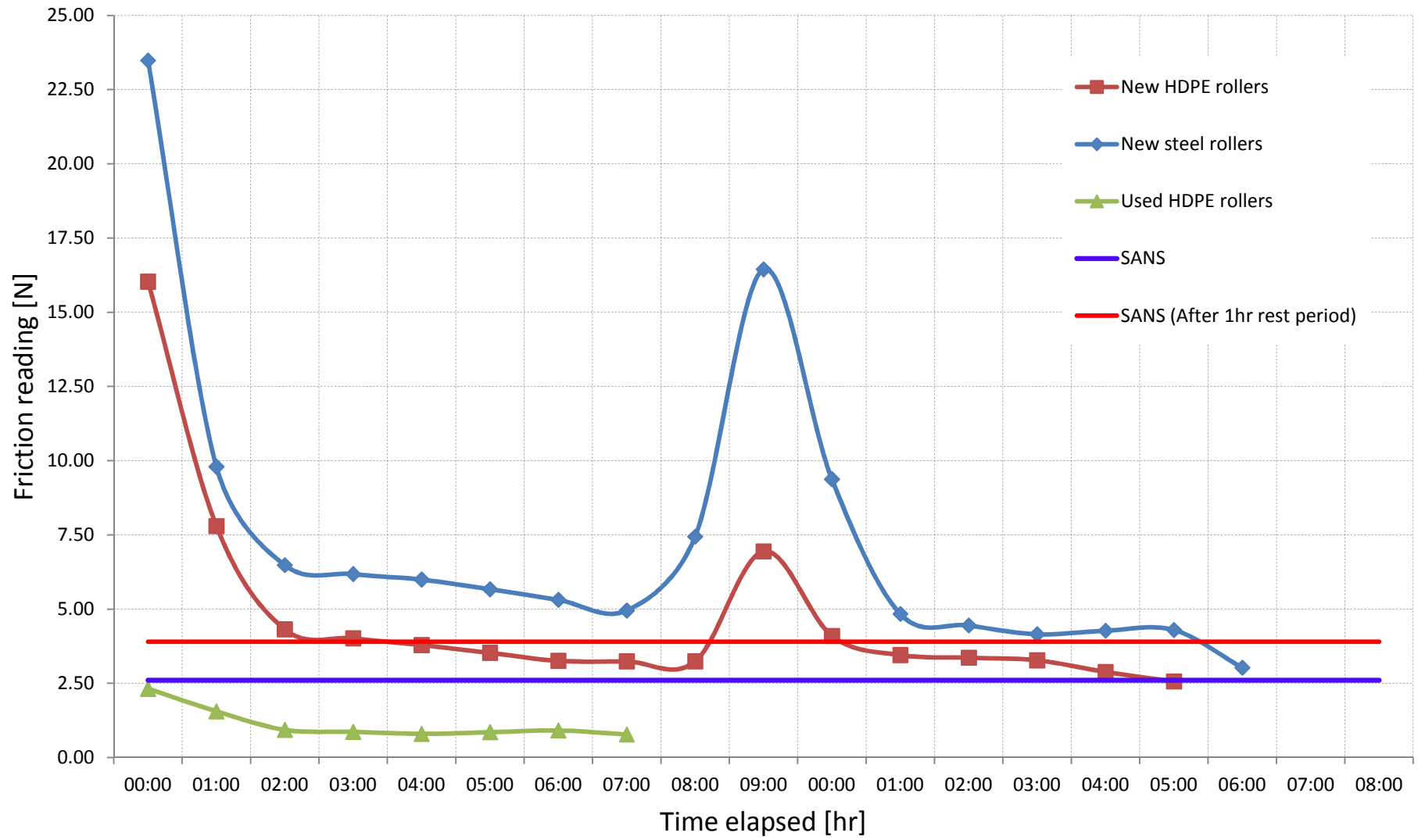


Figure 7: Average roller running friction