Case Study:

Carbon Plus: High Power Durability Test of Carbon Plus vs OEM Friction Material

Conducted by Industrial Brake & Friction Supply, last updated: April 2025

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Introduction

At Industrial Brake & Friction Supply, we are committed to supplying high-performance, rigorously tested friction materials to the heavy equipment industry. This case study highlights the results of an SAE No.2 High Power Durability Test comparing two materials: **Carbon Plus** (our advanced Carbon Composite friction material) and an **OEM Graphite Friction Material** (a standard haul truck transmission benchmark material).

Test Overview

The test was designed to simulate extreme working conditions using **UTTO oil** and measured several key performance indicators over **10,000 cycles**.

Test Conditions:

- Dynamic RPM: 3600
- Inertia: 0.490 kgf.m.sec^2
- Absorbed Power (Break-in): 130.1 W/cm^2
- Absorbed Energy (Durability): 216.5 W/cm^2
- Oil Flow Rate: 2.57 L/min @ 115°C
- Plate Dimensions: 146.15 mm OD / 120.55 mm ID
- 6 EA Disc surfaces

Parameters Measured

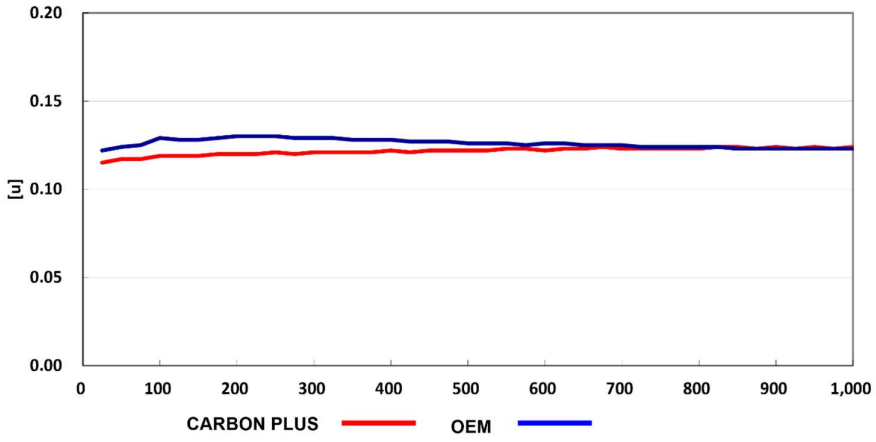
Coefficient of Friction (μ), Wear, Torque Trace / Consistency, Cycle Count, Energy Absorption / Power Density and Surface Condition (Post-Test)

Test Stages

1. Break-in Stage: Lower power engagements to seat the material surfaces and stabilize μ.
2. Durability Stage: Repeated high-power engagements at set intervals (e.g., every 60 seconds) to stress the material thermally and mechanically.
3. Failure Point (if applicable): The test may continue until the friction material fails (e.g., drops below performance threshold or physically breaks).

1. Break-In Performance

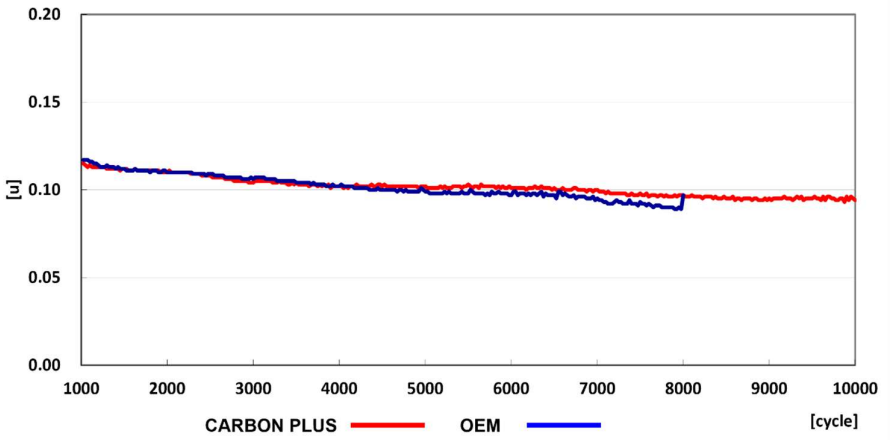
During the break-in stage, Carbon Plus maintained a stable and predictable coefficient of friction (μ), showing minimal fluctuation. OEM Friction Material began to show a slight upward trend in μ, indicating earlier wear or surface instability.



	50	100	200	400	600	800	1000
CARBON PLUS	0.117	0.119	0.120	0.122	0.122	0.123	0.124
OEM	0.124	0.129	0.130	0.128	0.126	0.124	0.123

2. Dynamic Friction (Durability Stage)

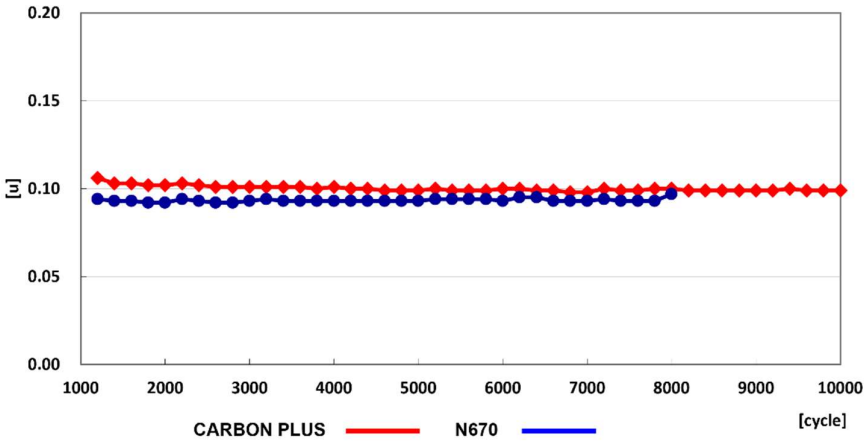
At 216.5 W/cm^2: **Carbon Plus** maintained consistent friction levels with a gradual increase in performance over time. **OEM Friction Material** experienced a noticeable decline and ultimately **suffered damage before completing the full cycle**.



	1050	5000	6000	7000	8000	9000	10000
CARBON PLUS	0.114	0.102	0.101	0.100	0.097	0.095	0.094
OEM	0.117	0.099	0.097	0.095	0.097		

3. Static Friction (Durability Stage)

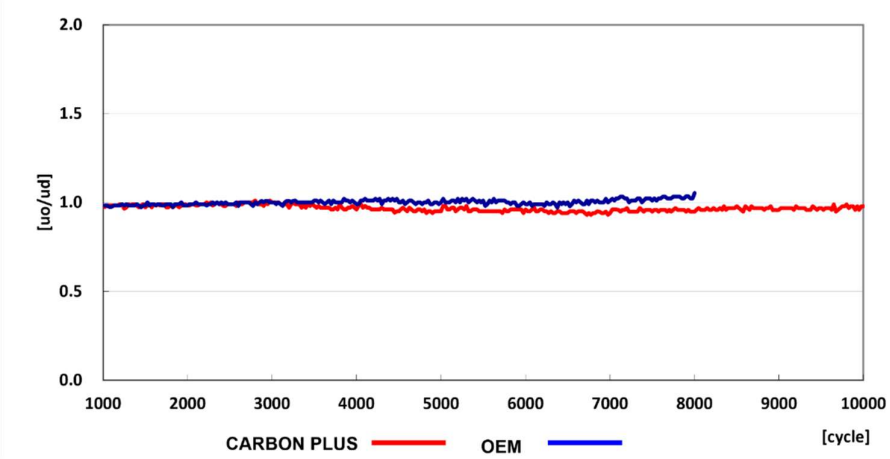
Carbon Plus again outperformed **OEM Friction Material**, showing better stability and grip throughout the test cycles. **OEM Friction Material**'s performance degraded steadily.



	1050	5000	6000	7000	8000	9000	10000
CARBON PLUS	0.106	0.099	0.100	0.098	0.100	0.099	0.099
OEM	0.094	0.093	0.093	0.093	0.097		

4. μ-V Characteristics

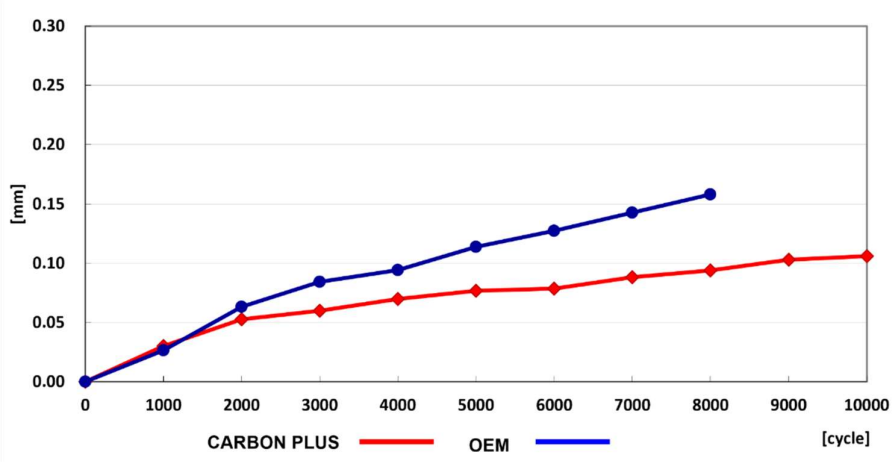
Carbon Plus demonstrated excellent consistency in torque control and responsiveness across all test stages. In contrast, **OEM Friction Material**'s μ-V performance was less predictable and started to degrade under sustained load.



	1050	5000	6000	7000	8000	9000	10000
CARBON PLUS	0.982	0.951	0.960	0.940	0.948	0.958	0.979
OEM	0.983	1.000	0.990	1.011	1.052		

5. Wear Comparison

One of the most important test metrics, **material wear,** clearly highlighted the durability of **Carbon Plus**: **Carbon Plus** showed minimal wear over 10,000 cycles, reducing gradually from 0.106 mm to 0.030 mm. While the **OEM Friction Material** exhibited more aggressive wear, with the test halted at 8,000 cycles due to part failure.

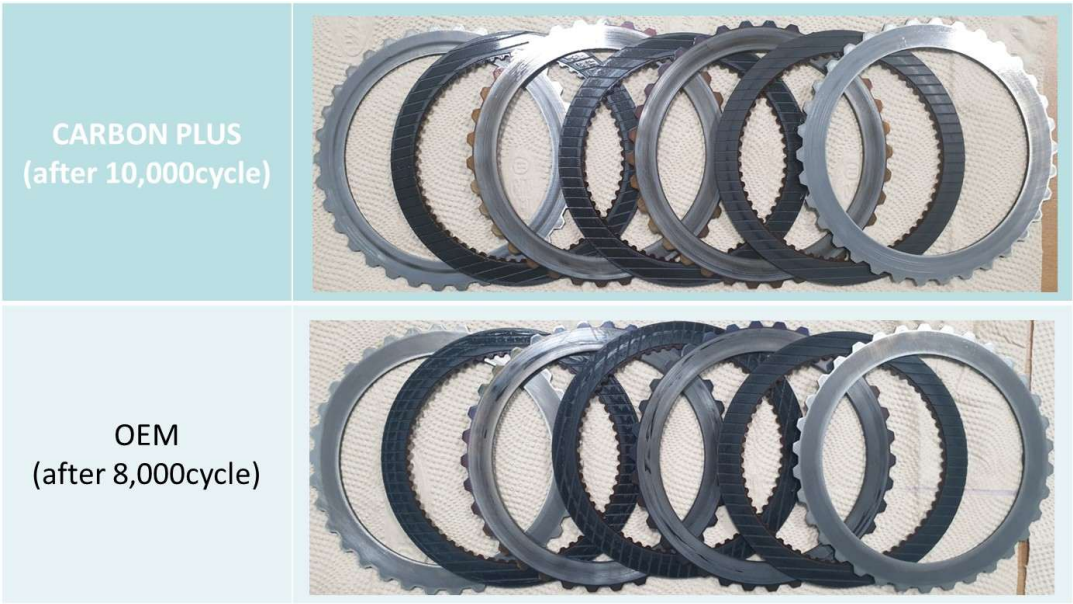


	1000	2000	4000	6000	8000	9000	10000
CARBON PLUS	0.030	0.053	0.070	0.079	0.094	0.103	0.106
OEM	0.027	0.063	0.094	0.127	0.158		

6. Visual Condition After Test

Carbon Plus components remained intact and visibly less worn even after 10,000 cycles.

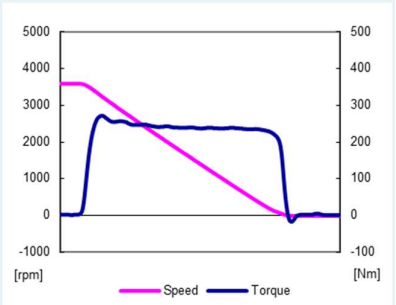
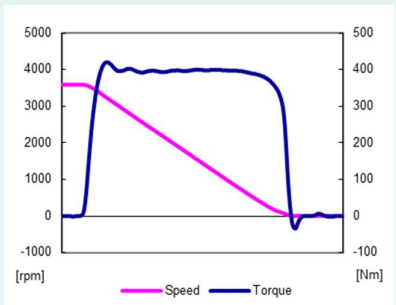
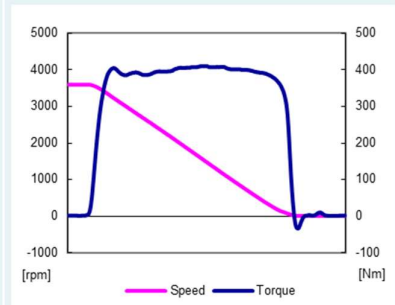
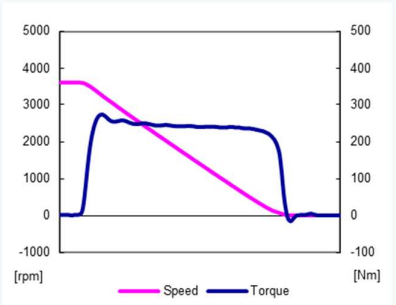
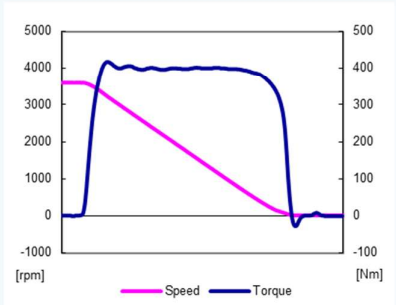
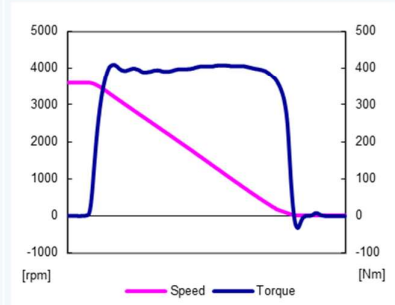
OEM Friction Material components showed clear damage and surface breakdown by 8,000 cycles.

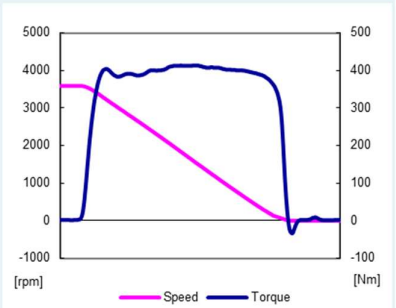
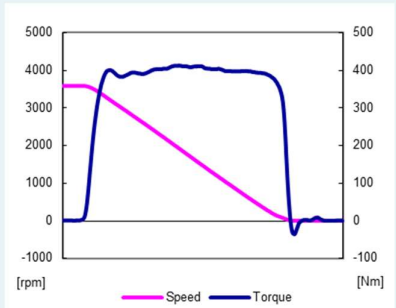
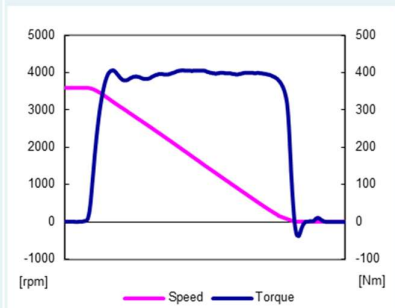
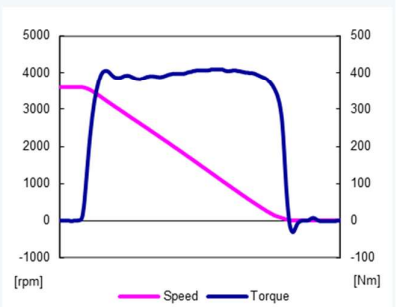
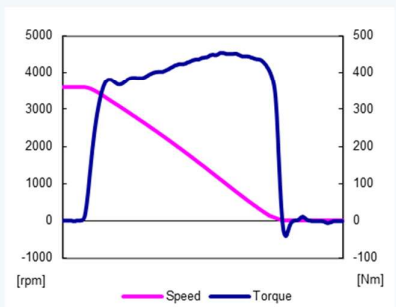


7. Dynamic Torque Trace

Carbon Plus maintained stable torque delivery at all stages, from break-in to 10,000 cycles.

OEM Friction Material, however, showed increasingly erratic torque characteristics before complete failure.

	1,000cycle[brake in]	2,000cycle[216.5W/cm2]	4,000cycle[216.5W/cm2]
CARBON PLUS			
OEM			

	6,000cycle[216.5W/cm2]	8,000cycle[216.5W/cm2]	10,000cycle[216.5W/cm2]
CARBON PLUS			
OEM			No data – parts failed

Conclusion

The results of this SAE High Power Durability Test demonstrate a clear and measurable advantage of **Carbon Plus** over the OEM graphite-based friction material. Across every critical performance metric: dynamic and static friction, wear resistance, torque stability and surface integrity, - **Carbon Plus** consistently delivered superior results under demanding, high-power conditions.

Most notably, Carbon Plus maintained predictable, high-friction coefficients and minimal wear throughout the entire 10,000-cycle test, while the OEM material experienced progressive performance degradation and ultimately failed before reaching the test limit. The visual integrity of Carbon Plus discs post-test further underscores its robustness and suitability for heavy-duty transmission applications where reliability and service life are paramount.

For operators seeking to reduce downtime, extend maintenance intervals and improve long-term cost efficiency **Carbon Plus represents a premium aftermarket solution** that exceeds OEM performance. Backed by thorough testing and proven in real-world environments, it is an ideal choice for high-inertia, high-heat and high-load applications across mining, construction, and heavy transport.

Crossover Part Numbers

OEM part numbers cross referenced to IBFS internal part numbers:

ELASTOMER (F37)		GRAPHITE (HDT 303)		CARBON PLUS	
9P7390	3921	6Y9807	2245	Alt	20165
9W9856	4157	1697055	2127	Alt	9891
8E9849	4431			Alt	9921
1733271	4667	2414890	2979	Alt	20163
8E0985	6131			Alt	9923
1733272	9151	2627320	9167	Alt	20167
		6I9255	2387	Alt	20327
		8E6961	2383	Alt	20341
		1028671	2751	Alt	20169
		4430663	8105	Alt	20329
		6Y7219	2755	Alt	20171

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Disclaimer

This case study is intended for informational purposes only. All product comparisons, performance evaluations, and claims are based on research conducted by Industrial Brake & Friction Supply (IBFS) and may vary under real-world conditions.

All product specifications, test results, and benefits described herein are subject to change without notice. Customers are responsible for verifying product suitability for their specific equipment and operational environment. IBFS shall not be held liable for any damages or losses resulting from the use of products referenced in this case study.

For additional product support, technical information, or purchasing terms, please contact IBFS directly.

Appendix

CARBON PLUS FRICTION COMPOSITE FRICTION MATERIAL OVERVIEW

CARBON PLUS is an advanced carbon friction material based on natural and synthetic fibres and fillers strengthened by a unique resin binder. It provides superior heat resistance and anti-wear performance under severe power conditions with varying pressures and temperatures.

- High energy capability
- Close to 1:1 relationship between static to dynamic coefficient of friction giving smooth engagement and superior NVH performance.
- Stable coefficient of friction over speed and pressure
- Superior wear resistance
- Good oil compatibility
- Able to withstand higher temperatures than F37 and graphite

AVERAGE FRICTION COEFFICIENT (WET)

Static: 0.09 - 0.14

Dynamic: 0.10 - 0.13

RECOMMENDED MAX LOAD

Max dynamic pressure: 6 N/mm^2 (870 psi)

Max rubbing speed: 50 m/s (164 Ft/sec)

Max specific power: 4.4 W/mm^2 (3.74 HP/in^2)

OIL GROOVING

Multi-pass tangential groove patterns in variety of configurations.

Grooves can either be pressed or machined.

MATING MATERIAL

The steel mating plate used for Elastomer and Graphite OEM discs can also be used for Carbon Plus, there is NO special requirement for the steels when changing the friction plates.

As a general guide we suggest a Surface finish of 0.5µm Ra (20µ“CLA)

TYPICAL APPLICATIONS

Transmission clutch, LSD, and Wheel Brakes

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