



↑ Lancaster touchdown. The landing speed for the Lancaster is about 95 mph. (Photo: Gavin Smith)

Keeping 'em flying

Putting the brakes on the Lancaster

After every landing, the Lancaster – all 20 tons of it – has to be brought to a halt on the runway from a landing speed of around 95 mph. That is a job for the wheel brakes, which also provide braking and directional control while the Lancaster is being taxied.

Lancaster wheel brakes

A worst-case scenario would be a rejected take-off at the critical speed, around 95 mph, from which the Lancaster would need to be brought to a stop in just the remaining runway. The brakes need to be capable of doing that.

The Lancaster wheel brakes are pneumatically operated, the air pressure being provided by compressors, fitted to the No 2, 3 and 4 engines, charging the system to 300 psi. An accumulator in the system retains sufficient pressure for the wheel brakes in the event of a compressor failure or engine shut down.

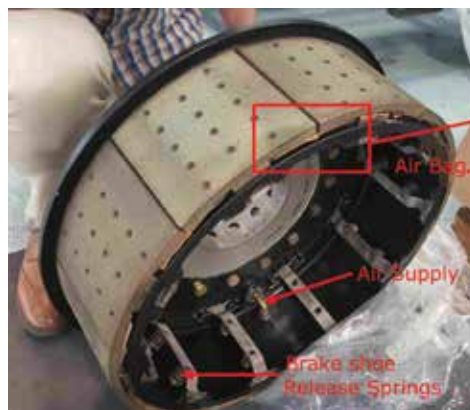
The brakes are controlled by levers, mounted on the pilots' control yokes, which also have parking catches. Differential braking is provided to the left and right wheels by the pilots' rudder pedals, to provide directional control on the ground.

The Lancaster has four brake units in total, with each of the two mainwheels having one brake unit on the inner and one on the outer hub. The four brake units each

have 10 brake shoes, so 40 brake shoes are needed for a complete set. Each brake shoe is made up of a metal backing plate and a friction-material brake pad, the two items being bonded and riveted together to form the brake shoe assembly.

When the Lancaster's brakes are applied, rubber brake bags fitted around the brake hubs inflate under pneumatic pressure to

force the brake shoes against the wheel hubs, slowing the rotation of the wheels. On releasing the brakes, the shoes are retracted under spring pressure. (The Lancaster brake bags were the subject of an urgent project some 15 years ago, when the supply of original items ran out, threatening to ground the Lancaster, and new brake bags had to be manufactured.)



☒ Lancaster brake unit. There are 20 brake shoes per wheel, which are forced against the wheel hubs by a rubber brake bag inflated by pneumatic pressure.

Brake shoes

The current life of a set of brake shoes during BBMF operations is forecast at around 400 landings per set, provided that the brake shoes are not contaminated, for example by oil leaks. The brake shoes are always replaced as a wheel set, as it is considered poor practice to mix old and new brake shoes in the same brake unit or on the same axle.

Until recently, the brake shoes fitted to the BBMF Lancaster have used the original, wartime-standard, friction material – Mintex A5 – with replacement shoes coming from existing stocks. However, stocks of the brake shoes made with the original material are now exhausted and there are none left to fit to the BBMF Lancaster. In addition, the original, wartime-standard, brake pads incorporated a friction material that is today considered hazardous to health and required special handling and disposal procedures.

Together, these factors meant that there was an urgent requirement to source replacement brake pads for the BBMF, made with material meeting modern standards and with equivalent friction properties to the original, otherwise the Lancaster would not be able to continue to operate.

Industry assistance

The BBMF Project Team's Mechanical Systems Engineering Authority, Mr David Mullen, has led the project to source new brake pad material for the Lancaster, with friction properties matching the original equipment.

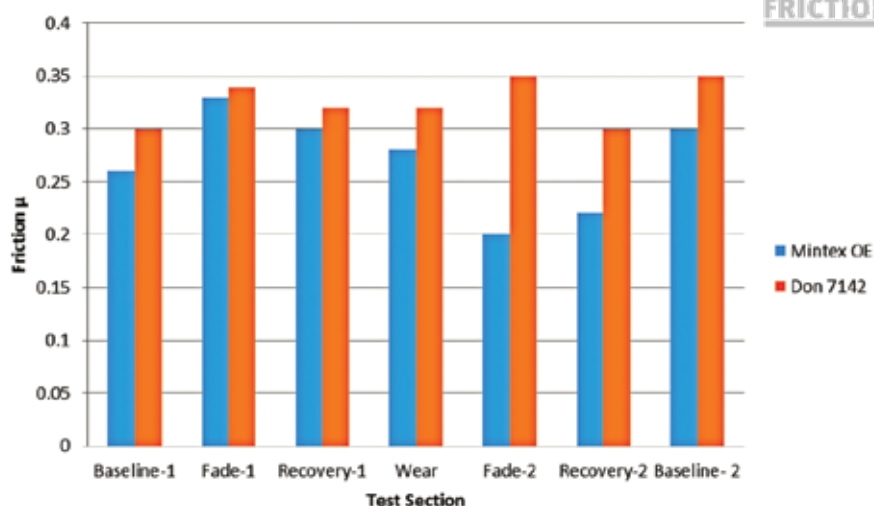
TMD Friction, a global company that is a fully owned business group of Nisshinbo Holdings Incorporated, is one of the world's largest manufacturers of braking friction material for passenger cars, racing cars and commercial vehicles. With over 135 years in the braking friction industry, TMD Friction's brands include Mintex, a British company that can trace its history back to 1876, manufacturing brake shoes from the birth of the motorcar and, during World War Two, for many RAF aircraft including the Avro Lancaster. As already mentioned, the original material for the Lancaster brake shoes was Mintex A5. With this history and pedigree in mind, TMD Friction UK Ltd's International Aftermarket and Research and Development Director, Ian Featherstone, enthusiastically offered to become involved with the project to provide new brake friction material for the BBMF Lancaster.

The first requirement was to evaluate the dynamic performance of the original Lancaster brake friction material, as no records of the original qualification work existed. This information would be vital to underpinning the Safety Assessment that the Project Team would need to produce, to demonstrate to the Type Airworthiness



Dynamic Friction SAEJ661

TMD
FRICTION



↑ Graph from TMD Friction's report, comparing the original friction material used in Lancaster brake pads – Mintex A5 – shown in blue, with the modern friction material – Don 7142 – shown in orange. This illustrates that the new material is as good as or better than the original, with improved resistance to brake fade.

Authority (TAA) that the new material was appropriate and safe. This work was carried out by TMD Friction in their facilities in India. Based on the results of that evaluation, TMD Friction then recommended a suitable modern alternative, known as Don 7142, a material that is used extensively in the pneumatic braking systems of today's modern bus and coach fleets. This material is known to provide a low but stable friction throughout a wide range of conditions.

Lancaster brake shoes with the proposed replacement material were tested in Brazil, and TMD Friction then produced a technical report for the BBMF Project Team.

This report compared the original friction material with Don 7142 and showed that the recommended replacement material closely replicated the friction characteristics of the original and, in addition, had a greater resistance to brake fade. Using this new material the effectiveness of Lancaster wheel brakes will be at least as good as or even better than before, especially in an emergency braking event, and there should be no noticeable difference in brake operation or 'feel' to the pilots.

TMD Friction had access to the original brake lining drawings and machined blocks of the Don 7142 friction material



RAF BBMF technician SAC(T) Jack 'Buzz' Busby completing the fitment of the new brake shoes to the Lancaster brake hubs in the BBMF hangar in January 2020.
(All photos this page: Clive Rowley)



Lancaster brake hubs on a rack in the BBMF hangar, fitted with the pneumatic rubber brake bags but not with brake shoes. The hub on the right is attached to the wheel axle. The other brake hub would fit on the other end of the axle.

to those specifications in their Brazilian factory, using Computer Numerical Control methods. This material was then provided to Supermarine Aero Engineering Ltd, one of the companies that supports the BBMF under contract, so that a prototype set of new brake shoes could be assembled. (Supermarine was previously involved in the project to remanufacture new brake bags for the Lancaster, mentioned earlier.) All of the work by TMD Friction, up to this point, was completed free of charge.

While this test and evaluation work was ongoing, the Lincolnshire Aviation Heritage Centre (LAHC) at East Kirkby, operator of taxiing Lancaster NX611, 'Just Jane', donated a full set of original-equipment brake shoes to the BBMF, to enable the Flight to continue to operate Lancaster PA474 in the meantime. In return, on completion of the project, a full set of new brake shoes with the replacement friction material will be provided by the BBMF to LAHC.

New Lancaster brake shoes

Following approval of the Safety Assessment and the supporting evidence by the TAA, a full set of new brake shoes, manufactured by Supermarine Engineering and using the new replacement friction material, Don 7142, was fitted to Lancaster PA474 over the 2019-20 winter maintenance period. This will allow the BBMF 'Lanc' to continue to operate into the future, with further sets of the new Lancaster brake shoes purchased by the BBMF Project Team to provide a source of spares.

The BBMF Engineering Authority has directed the continued monitoring of brake shoe wear with the new friction material and this will be expanded to include the monitoring of the brake drum wear rates.

The BBMF is grateful to all those who have assisted in overcoming what could have been a 'show stopper' for the BBMF Lancaster, and especially for the generosity and goodwill demonstrated by TMD Friction and LAHC. The project to provide new brake shoes for the BBMF Lancaster is a classic example of the challenges of operating historic aircraft, and of the BBMF Project Team and industry working together to provide modern alternatives to original equipment that is no longer available or is not considered viable today, literally 'keeping 'em flying'.



The new brake shoes will allow the BBMF Lancaster to continue flying into the future.

Words: Clive Rowley
(with thanks to Wg Cdr Andy March and Mr David Mullen of the BBMF Project Team)



✦ The BBMF Lancaster B1, PA474, has not featured much in this issue, so this is simply a gratuitous and beautiful image, for those who love to see the mighty 'Lanc' in action. (Photo: Darren Harbar Photography)