Debris Analysis - Main Landing Gear Trunnion Door Panel

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1. Introduction.

On a sandy road on the Antsiraka Peninsula in Madagascar Blaine Gibson and a friend called Rija stopped at the home of a fisherman named Tataly on 17th November 2022. He had a large yard full of things he collected washed ashore from the sea. There were buoys and boat parts, but one piece caught Rija's eye and he called Blaine over because it had a similar appearance to floating debris from MH370.

Since the crash of MH370 in the Indian Ocean 33 pieces of floating debris have been found according to official reports. 3 further pieces have been identified by experts from photos and delivered to Malaysia for investigation, but no official report has been published yet. Some smaller pieces were not identifiable but 21 pieces have been subsequently shown to have come from the aircraft registration 9M-MRO (flight MH370) or were almost certain, highly likely or likely from MH370. Part numbers, manufacturing records, materials used, paints applied, name plates, stencils, etc., have all been used to analyse the MH370 debris.

19 items of floating debris probably originating from MH370 have been found washed ashore in Madagascar and handed in to the authorities. Madagascar is situated in the Indian Ocean at the latitudes where the South Equatorial Current interacts with the island. 4 items of MH370 debris have been found on the same beach on the Antsiraka Peninsula in Madagascar. The location was predicted by the University of Western Australia (UWA) oceanographic model.

The debris item had barnacles on it when it was found. Tataly did not know what it was, and just said it came from the sea. His wife used it as a washing board. Except for the barnacles Tataly said the debris item was in the same condition as he found it in 2017.

Figure 1: Blaine Gibson and finders of the debris item.

2. Location of the Debris Find.

The item of floating debris was found washed ashore on the South beach of the Antsiraka Peninsula in Madagascar in March 2017 at 16.862289°S 49.726188°E.

Figure 2: Map of Madagascar showing the general location of debris find.

The currents are strong off the coast of North-East Madagascar and flow from South to North at the location of the debris find. The prevailing wind is from the East and East-South-East and Antsiraka South Beach is in the lee of Nosy Boraha Island.

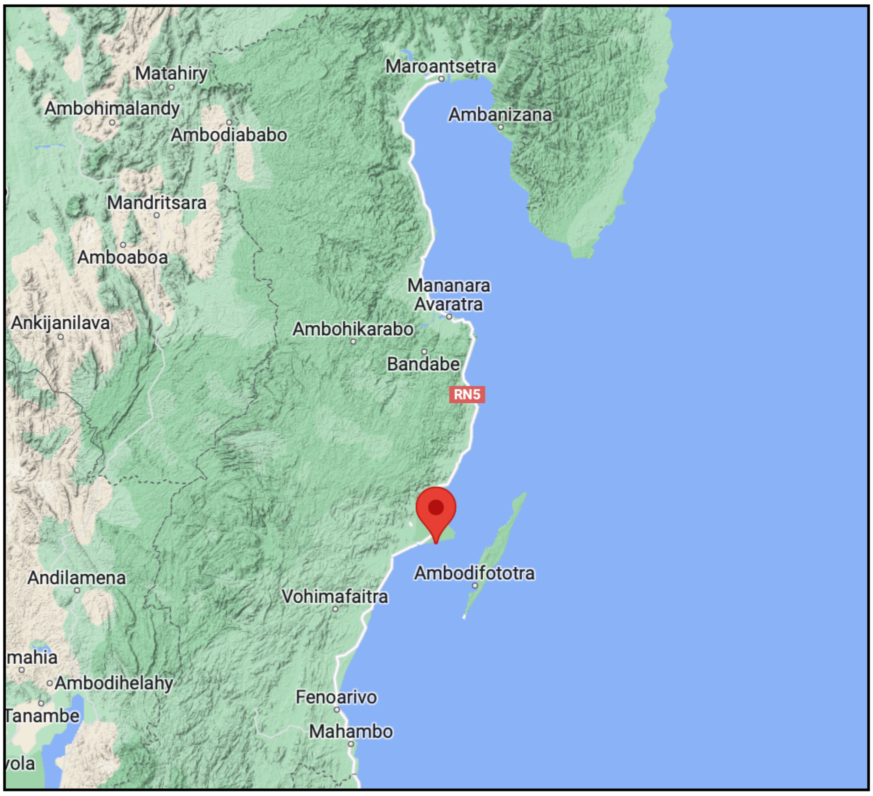

Figure 3: Map of North-East Madagascar showing the location of debris find.

The Antsiraka South Beach is exposed to the currents that flow from South to North between Madagascar and Nosy Boraha Island and according to local fishermen debris usually comes ashore on the Antsiraka South Beach.

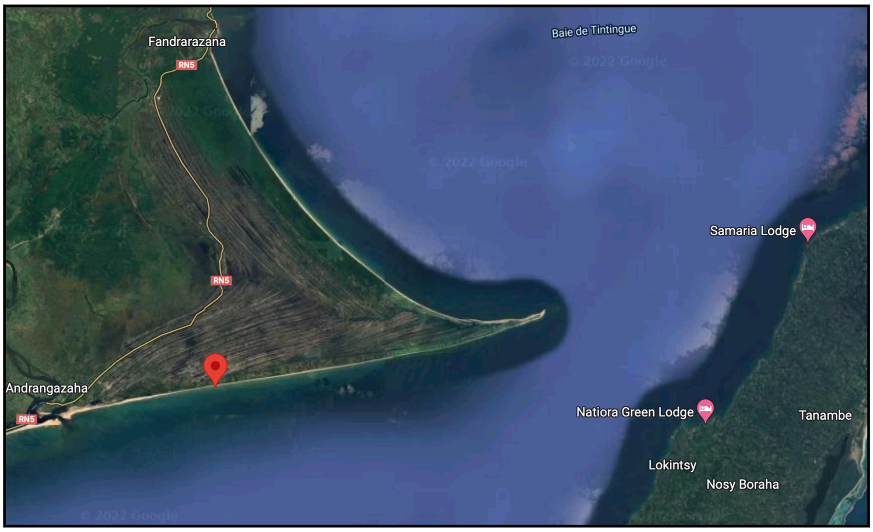

Figure 4: Map of Antsiraka Peninsula showing the location of debris find.

Tataly said he found the debris in March 2017 washed ashore on the beach near his home just after the tropical storm Fernando had passed by.

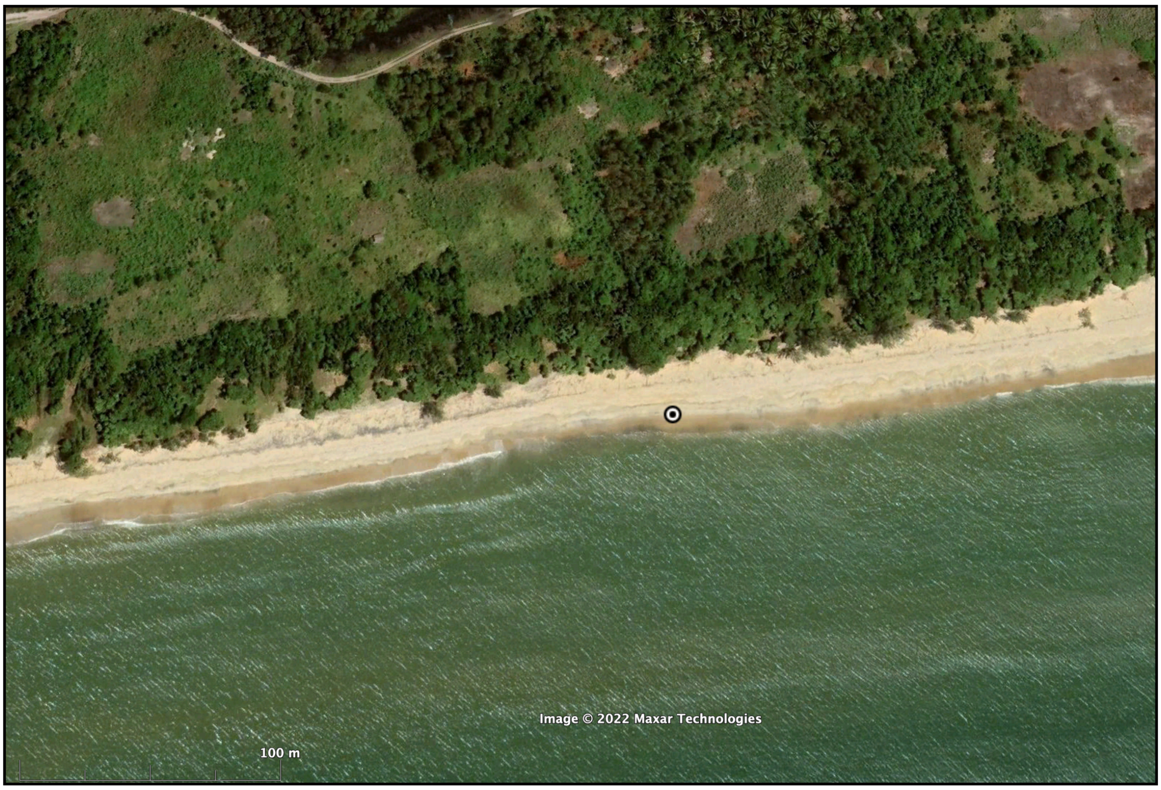

Figure 5: View of Antsiraka South Beach showing the location of debris find.

Fernando developed far east in the Indian Ocean off the British Indian Ocean Territory on 3rd March 2017 and slowly proceeded South-West towards Madagascar.

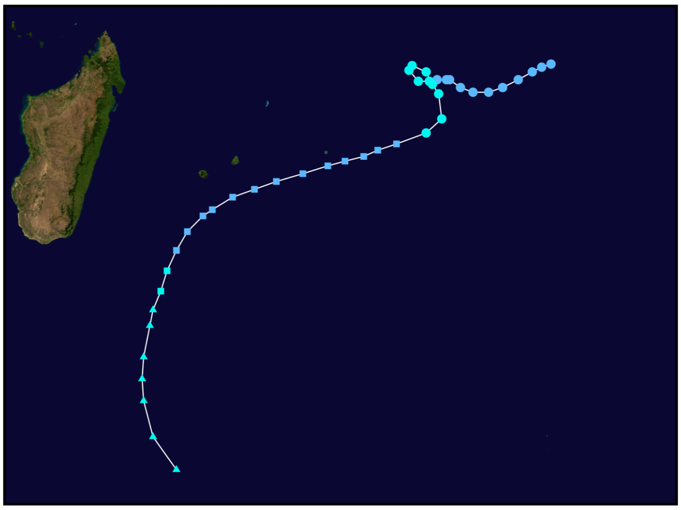

Figure 6: Path of Tropical Storm Fernando.

RSMC La Réunion upgraded the tropical depression to a moderate tropical storm on 14th March 2017. Winds peaked at 75 km/h and the storm dissipated on 15th March 2017.

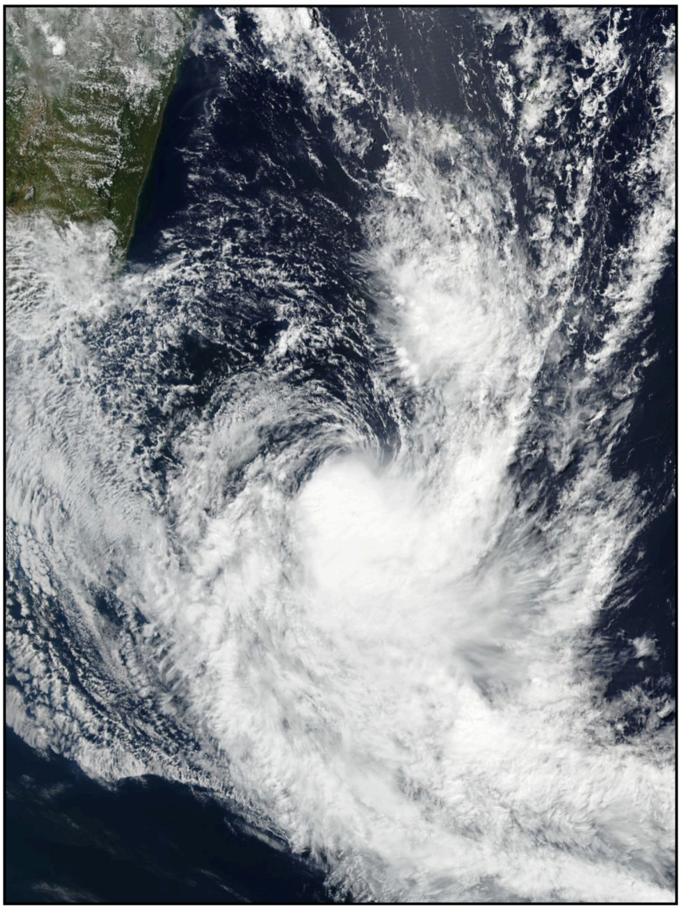

Figure 7: Tropical Storm Fernando South-East of Madagascar on 14th March 2017.

3. Debris Item.

The debris is white on one side and black on the other side with brown honeycomb in between. The debris item was slightly curved and measured 32" × 28” (81.3 cm x 71.1 cm).

Figure 8: Debris Item White Side.

Figure 9: Debris Item Black Side.

The debris item is light weight and 1” thick (2.54 cm). The thickest part of the honeycomb is 1" but in some parts it appears to have been compressed to 7/8” or 3/4”.

Figure 10: Debris Item Honeycomb Sandwich.

The white side is slightly convex, the black side is slightly concave.

Figure 11: Debris Item Side View.

Figure 12: Debris Item Side View with maximum 3/4” curvature.

The sandwich is mostly honeycomb based but partly a more solid material.

Figure 13: Debris Item Side View with honeycomb and a more solid fill.

Figure 14: Debris Item Side View with different thicknesses.

The debris item has a clearly delineated smooth area in the middle surrounded on both sides with areas which are rougher to the touch.

Figure 15: Debris Item White Side View with different areas.

Figure 16: Debris Item White Side View with different areas against daylight.

The debris item white side shows a distinct straight line and curved line, which has been outlined in Figure 18 below.

Figure 17: Debris Item White Side View with straight and curved line.

Figure 18: Debris Item White Side View with straight and curved line (photo enhanced).

The debris item black side shows clear lines and structure, which have been outlined in Figure 20 below. There is a rectangular indent, which is possibly where a base plate was positioned.

Figure 19: Debris Item Black Side View showing lines and structure.

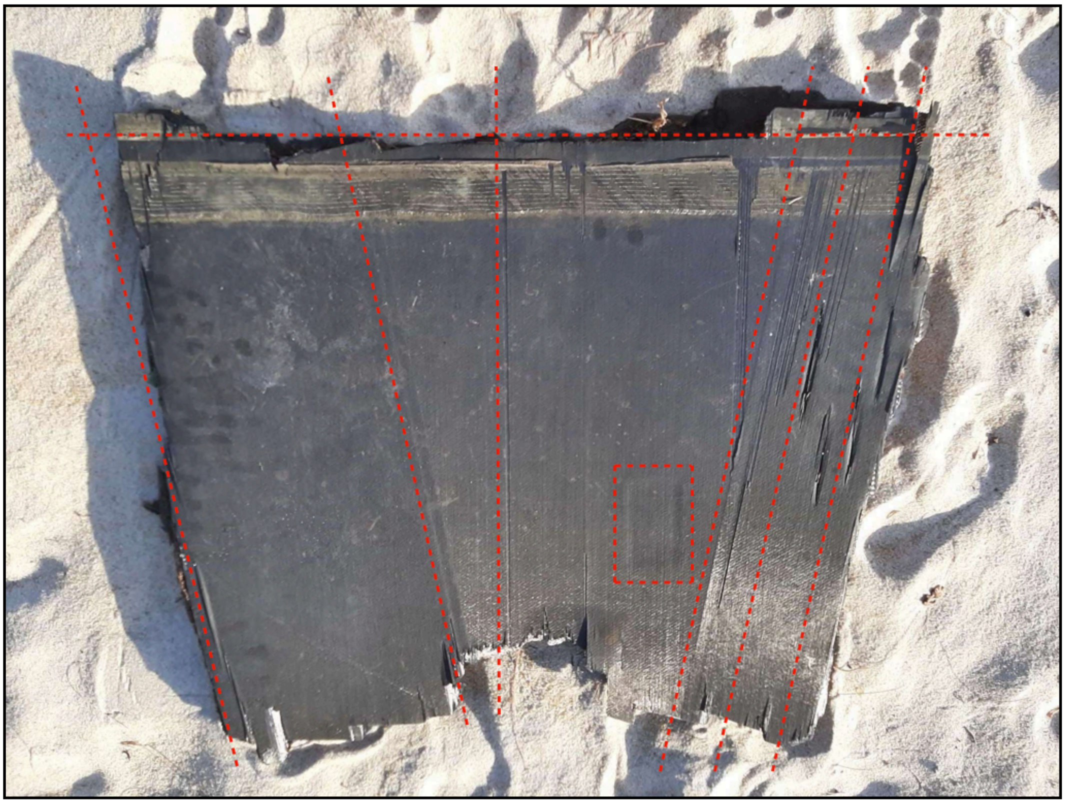

Figure 20: Debris Item Black Side View showing lines and structure (photo enhanced).

There are remnants of a stripe along one edge and an attachment, where possibly a hinge was previously fixed.

Figure 21: Debris Item Black Side View showing stripe and attachment.

Figure 22: Debris Item Black Side View showing attachment.

3. Debris Item Damage.

The debris item shows cuts, scratches, pits and tears on all sides. On one side the tear is circular marked in red in Figure 24. There is also a circular cut and circular scratch marking on the white side marked in blue in Figure 24. There are fractures on all four edges of the debris item.

Figure 23: Debris Item White Side with tears and circular marking.

Figure 24: Debris Item White Side with tears and circular marking (photo enhanced).

There is puncture damage penetrating right through the debris item, which upon closer examination is from the black side to the white side. There are 4 almost parallel slicing type punctures.

Figure 25: Debris Item with puncture damage both sides.

Figure 26: Puncture damage position 13” from the edge.

The largest puncture damage is 4” long and of narrow width.

Figure 27: Close up of puncture damage white side up to 4” long.

Figure 28: Close up of puncture damage black side (photo mirrored).

The lifting of the white surface is shown in Figure 29 in relief and in Figure 30 by the shadows.

Figure 29: Close up of the lifting of the surface of the white side.

Figure 30: Close up of the lifting of the surface of the white side with shadows.

The indentation of the black surface is shown in Figure 31 and in close up of the largest indentation in Figure 32.

Figure 31: Close up of the indentation of the surface of the black side.

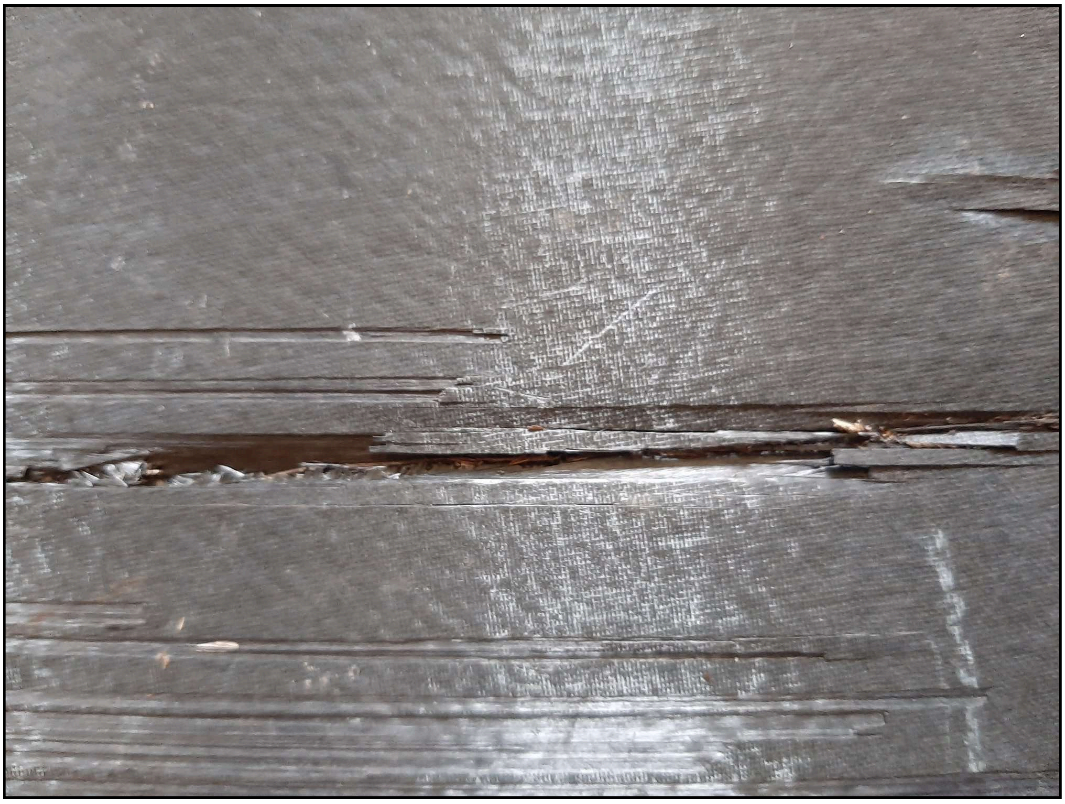

Figure 32: Close up of the largest indentation of the surface of the black side.

4. Comparison to other MH370 Debris.

The debris item thickness of 1” and material composition of a carbon fibre reinforced plastic with non-metallic honeycomb core is similar to other wing fairing or wing underbody items, which have been found and determined to likely be from MH370. Figure 33 shows the Wing to Body Fairing which can be found in the Malaysian MH370 Safety Investigation Report (SIR) page 189 and Appendix 1.12 E page 769 (SIR reference Item 7). Figure 34 shows the Bottom Panel of the Wing or Horizontal Stabiliser which can be found in the Malaysian MH370 Safety Investigation Report (SIR) page 191 and Appendix 1.12 J page 791 (SIR reference Item 1).

Figure 33: Wing to Body Fairing found 30th April 2016 in Chemucane, Mozambique.

Figure 34: Bottom Panel found 6th June 2016 in Nosy Boraha, Madagascar.

The debris item is similar in construction to the part of the right nose landing gear door which was also found on Antsiraka Beach, Madagascar. The nose wheel door debris also shows tension damage and partial delamination or debonding.

Figure 35: Nose Wheel Door Debris found 12th June 2016 in Antsiraka Beach, Madagascar.

Figure 36: Nose Wheel Door Debris showing tension damage and partial delamination.

The debris item also shows puncture and compression damage similar to the damage to the nose wheel door.

Figure 37: Nose Wheel Door Debris showing puncture damage.

Figure 38: Nose Wheel Door Debris showing puncture damage.

The debris item shows cuts, scratches, pits and partial delamination similar to the panel found on 19th August 2016 in Praia de Rocha, Mozambique by Barry McQuade.

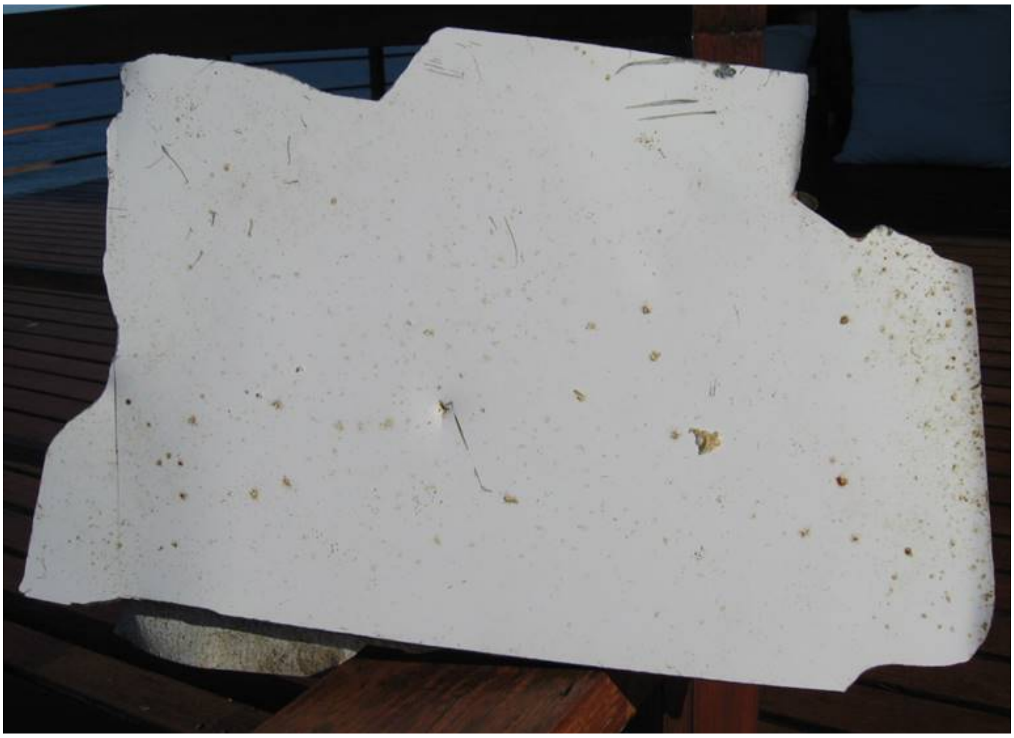

Figure 39: Panel Debris showing cuts, scratches and pitting damage.

Figure 40: Panel Debris showing partial delamination.

The debris item shows possible delamination of the white upper coating revealing the black next layer similar to the right engine inner side vortex generator rear part found on 1st September 2016 in Maroantsetra Beach, Antongila Bay, Madagascar by local fishermen and handed to Blaine Gibson.

When the black layer is removed the honeycomb is revealed as shown in Figure 41 on another item of debris found in Madagascar in 2016.

Figure 41: Vortex Generator showing partial delamination.

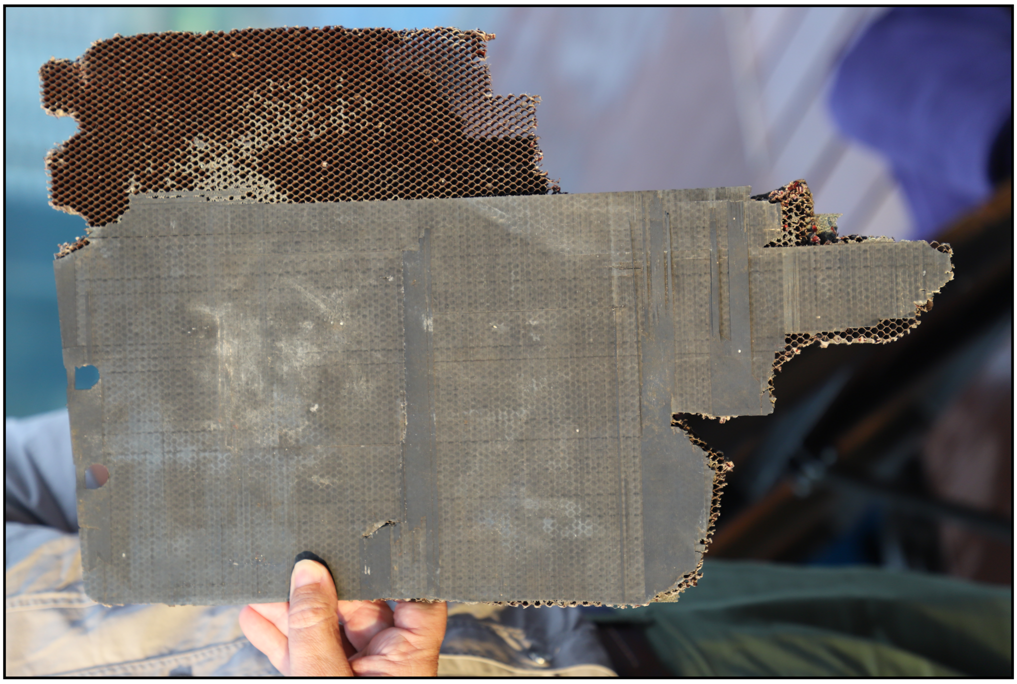

Figure 42: Black covering layered on top of honeycomb.

5. Debris Provenance.

Parts with composite materials are used on a Boeing 777 for a number of control surfaces, engine cowlings, nose and main landing gear (MLG) doors and wing-to-body fairings.

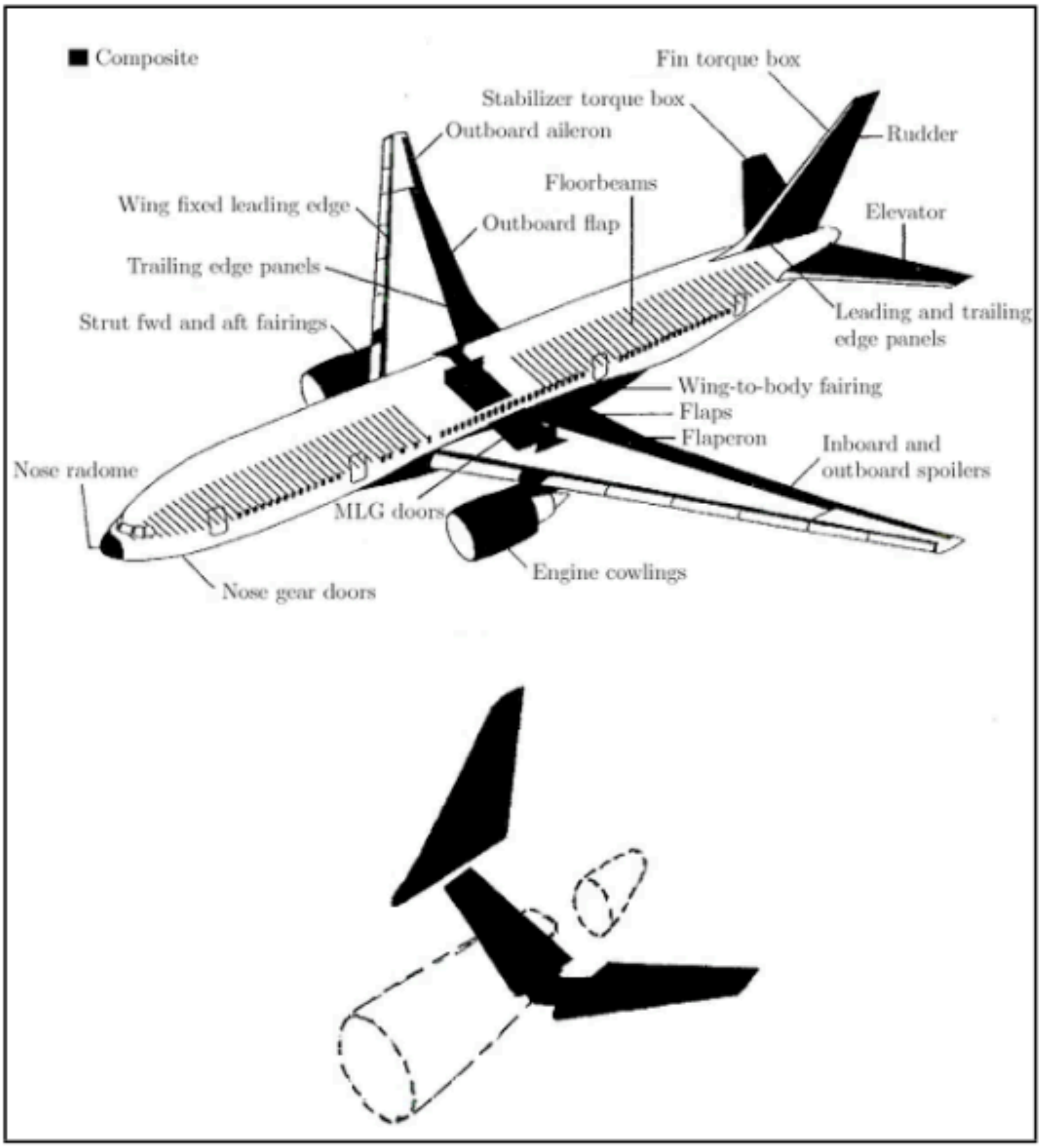

Figure 43: Boeing 777 Parts using Composite Materials.

There are only a few components using composite materials which match the following criteria:

(1) Show the indent of a single base plate for a fixing attachment.

(2) Show the remnants of a door latch or hinge fitting.

(3) Located in the vicinity of the engine to experience such slicing damage.

One component that fits these criteria is the Main Landing Gear Trunnion Door.

The debris item is similar in construction and found in the same location as other floating debris items from MH370. The 1" thick carbon fibre reinforced plastic with a non-metallic honeycomb core is typical of the size and material used in other MH370 floating debris items found and handed in for expert analysis.

The debris item has the same thickness, construction and materials as other wing panels and landing gear door panels found and likely from MH370.

From the slightly convex white side as well as the curvature line seen in Figure 18, we conclude that the white side was on the exterior and the black side was on the interior of the aircraft. It is possible that the debris item is part of the small landing gear door at the root of the wing.

A close up picture of the main landing gear shock strut shows two doors immediately to the right of the shock strut. The larger door is attached to the shock strut and is known as the shock strut door and the much smaller door is known as the trunnion door.

Figure 44: Boeing 777-200 Main Landing Gear Doors.

When the landing gear is extended there are two doors that open on the underside of the wing, the shock strut door and the trunnion door. The larger door is much longer and reaches down the main landing gear shock strut. The small door has a trapezoid shape around 41” wide at the base. Both wing main under carriage doors sits directly behind the engine.

Figure 45: Main Landing Gear Doors with Under Carriage Extended Left Wing.

Figure 46: Main Landing Gear Doors with Under Carriage Extended Right Wing.

When the landing gear is lowered, the two wing doors open in sequence from the underbody.

Figure 47: Main Landing Gear Doors Opening Sequence.

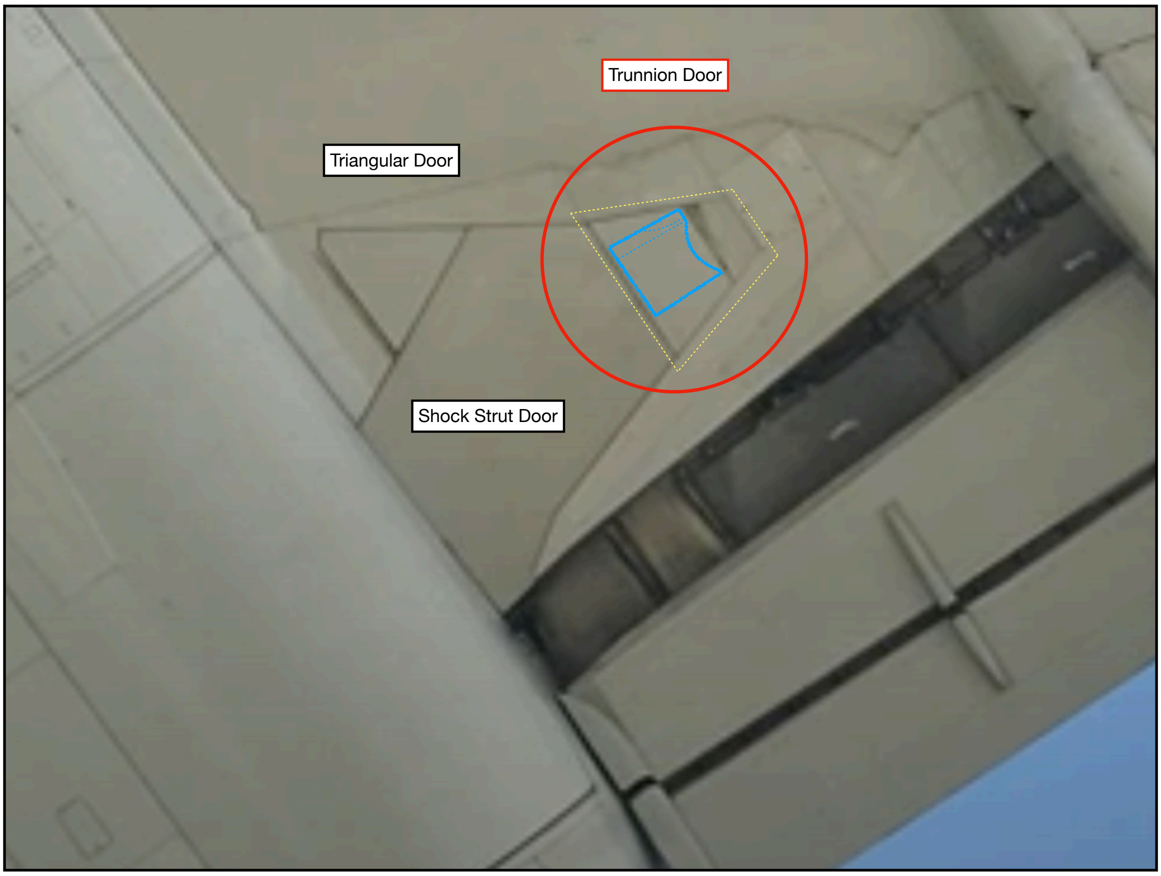

Figure 48: Main Landing Gear Doors Left Wing.

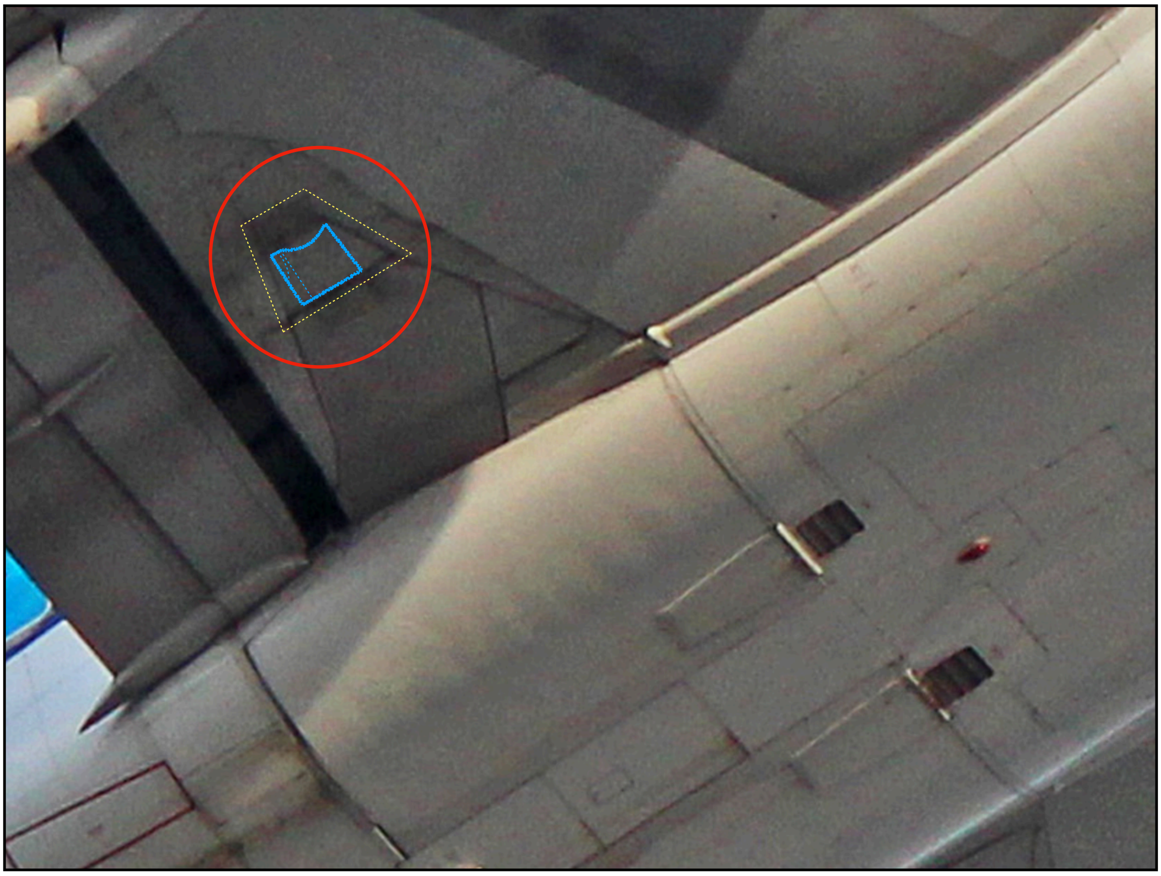

Figure 49: Main Landing Gear Doors Right Wing.

The trunnion door has a back cover plate with a single fixing. No hinge fitting or door latch is evident in Figure 50 below. If the cover plate was ripped off from the black side of the debris item leaving fracture damage on all four edges, then the impact force was considerable. The attachment shown in Figure 22 is possibly the remnant of the back cover plate fixing at that point. The single rectangular indent shown in Figure 20 is a possible match for the base plate of the single fixing on the main landing gear trunnion door. The trunnion door is light weight.

Figure 50: Close Up Main Landing Gear Trunnion Door Right Wing.

There is also a main landing gear triangular door shown in position in Figure 48, which has two fixings and a single drive rod base plate. The part is made of metal, which is designed to withstand the slip stream forces and weighs around 60 kg (132 lbs). The item shown below in Figure 51 fell off an Air France Boeing 777 shortly after departure from Shanghai airport.

Figure 51: Main Landing Gear Triangular Door.

In Figure 15 we indicate that the debris item has a clearly delineated smooth area in the middle surrounded on both sides with areas which are rougher to the touch.

There are parts of the wing which may benefit by slight roughening of the surface under certain flight conditions, for example, helping the airflow to remain attached. This job is currently done by different kinds of vortex generators, because, like the smooth wing, the roughened part of the wing skin is also liable to change in its characteristics over time during real-life service, rendering it ineffective for its primary purpose.

Abrasions, bugs, and domed rivets add drag to a wing. If vortex generators are installed, there will be less drag in certain low speed flight configurations because the vortex generators add energy to the boundary layer of air, keeping it smoothly attached to the wing and still providing lift rather than otherwise forming turbulence at the aft part of the wing (and likely stalling the wing). Ice is the ultimate rough high drag surface, which kills lift on the wings.

The lower the frictional resistance of an aircraft in the air, the lower the fuel consumption. Using nature as a role model, the aviation industry has been intensively researching ways to reduce aerodynamic drag for many years. A surface structure consisting of riblets measuring around 50 micrometers imitates the properties of sharkskin and therefore optimises the aerodynamics on flow-related parts of the aircraft. An airplane wing with micro-abrasions or a rough surface will have better lift than a wing that is perfectly smooth.

Wing skin surface treatment has been experimented upon not only for lift enhancement, but also for drag reduction, and some pretty dramatic results have been obtained.

It is no secret since the 1920s that dimpled golf balls fly farther and truer (straighter) than smooth-finish golf balls.

It is hoped that debris item will undergo a full and professional examination and analysis leading to an identification of the item and clarifying whether the provenance is from a Boeing 777-200 ER or even 9M-MRO and the MH370 flight in particular.

5. Debris Damage Cause.

The damage to the debris item includes light cuts, scratches and pits, medium force trans-laminar and inter-laminar cracks and damage caused by large tensile and compressive forces as well as partial delamination of the white side and possible total delamination of the black side.

The four nearly parallel extremely forceful penetration slices from the black side to the white side may have been caused by the engine disintegrating on impact. The engine comprises 3 sections, fan at the front, compressor highlighted in yellow and turbine at the rear.

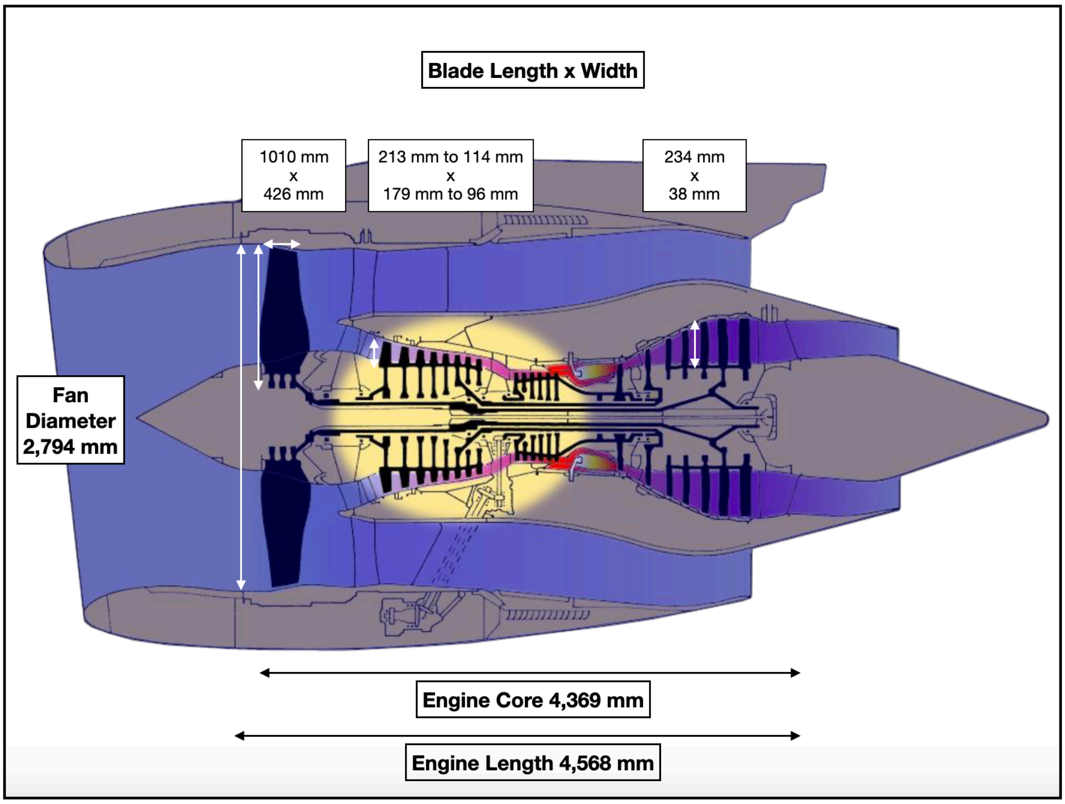

Figure 52: Rolls Royce Trent 892 Engine Core and Blade Dimensions.

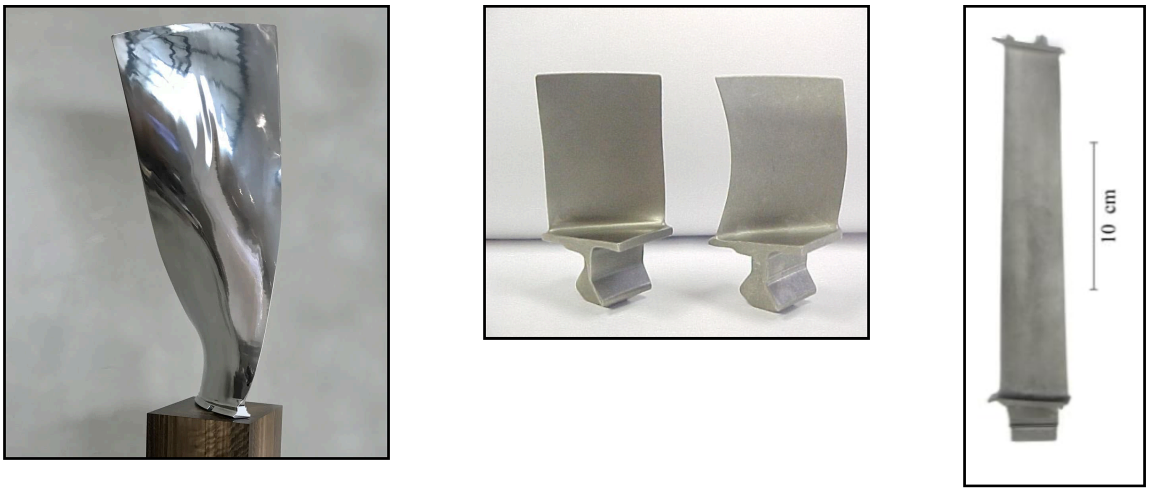

Figure 53: Rolls Royce Trent 892 Fan, Compressor and Turbine Blades.

If an engine compressor ring penetrated the black side of the small door panel with considerable force on impact, then depending on the angle of impact, it is possible to cause the four parallel slices observed penetrating right through the debris item to the white side.

The fan blades are too wide and the turbine blades are too blunt, but the compressor blade rings range in width along the axis of the engine core from between 179 mm down to 96 mm (7.05” down to 3.78”). A compressor ring with a set of damaged blades of up to 4” in width fits the penetration observed in the debris item with slices of up to 4” long.

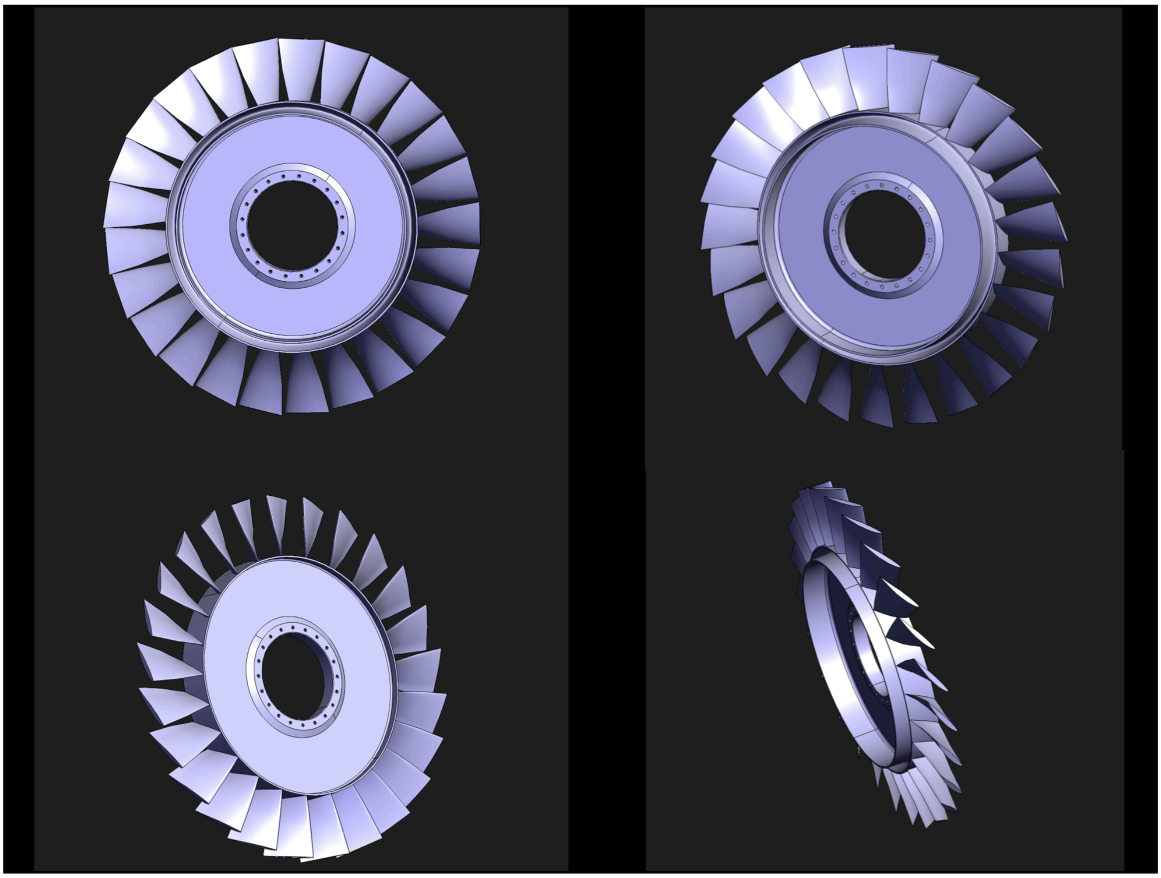

Figure 54: Rolls Royce Trent 892 Compressor ring with Blades.

6. Debris Aircraft Position and Orientation.

The debris item is fractured on all sides and is therefore smaller than the undamaged part in both length and width. The debris item has a middle section around the indent possibly made by the base plate connected to the attachment foot, which aligns with the attachment shown in the schematic in Figure 55 below. This middle section is perpendicular to the lower edge.

The debris item has a band along one edge marked in yellow in Figure 55 below and is likely the remnants of the back cover plate adhesive fixing on the lower bevelled edge.

The indent on the black side of the debris item is likely from the base plate of the attachment arm, which is located in a central position on the undamaged part. This implies that a larger part of the front edge is missing than the rear edge.

There is a slightly larger angle at the front of the trapezoid shaped debris item at ≈13.1° as opposed to ≈11.3° at the rear, which aligns with the overall trapezoid shape of the undamaged part.

The slicing damage is at the front of the debris, which is in the vicinity of the engine. It is possible that a part of the front or leading edge of the debris item was sliced off completely.

The debris item is likely the remnant of the left main landing gear trunnion door, which has been fractured on all sides (upper, lower, front and rear).

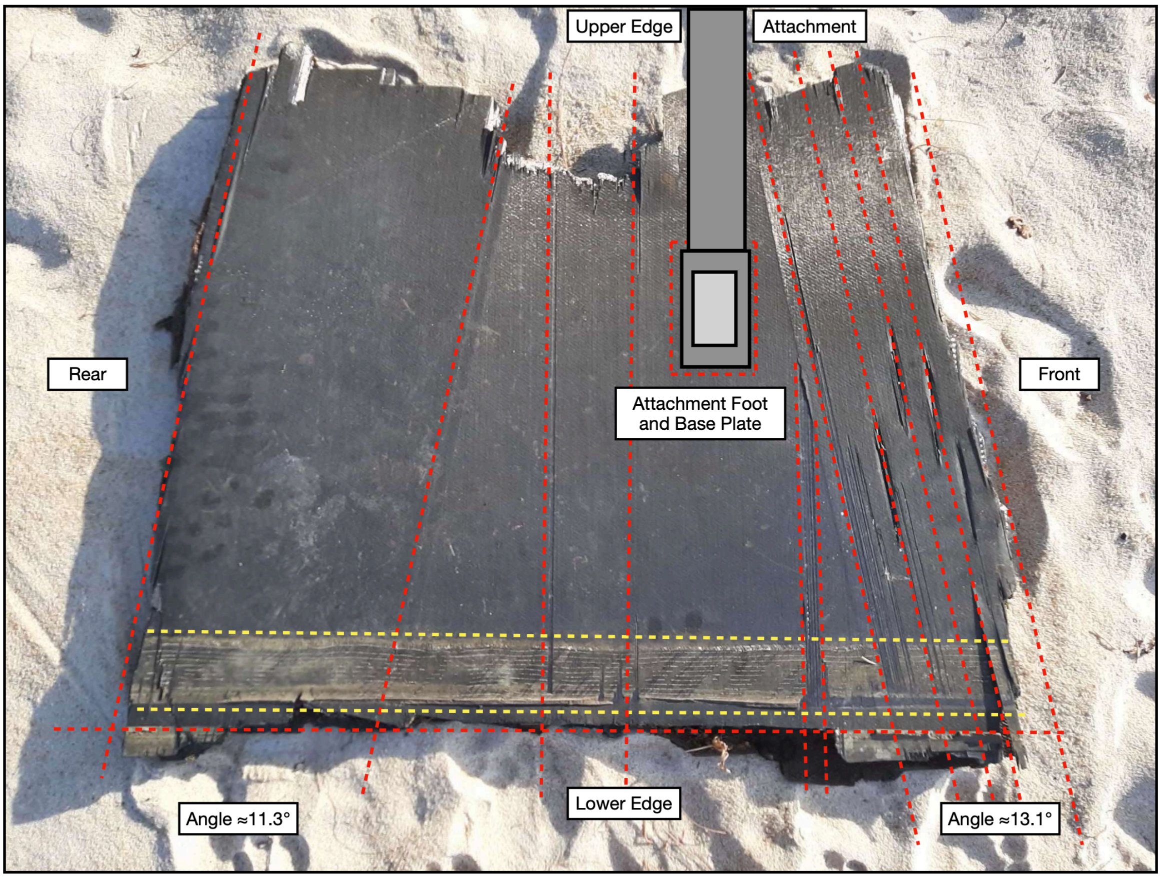

Figure 55: Debris Aircraft Position and Orientation Schematic.

There have been 3 floating debris items recovered which are from the left wing and 9 which are from the right wing. In our view, it is not possible to conclude whether or not either wing separated from the aircraft due to the high loads suffered by the wings in the high speed dive prior to impact.

From the 15 items of wing debris found, we have concluded it is not possible to determine whether either the left or the right wing separated from the aircraft before impact. Although there are only 3 debris items are from the left wing, but on the other side 9 debris items from the right wing, does not prove the right wing separated from the aircraft before impact.

The fact that 2 debris items, the flaperon and the outboard flap, are largely intact and are both from the right wing does not prove that either wing separated from the aircraft before impact. All the 15 wing debris items listed in Table 1 are fractured.

The fact that 2 debris items are from the right wing-to-body fairing, implies the right wing probably broke off, but whether before or on impact cannot be determined.

Date	SIR ref.	item	State	MH370	Finder	Location
2015-07-29	1	Right Wing Flaperon	Largely Intact, Hinges Fractured, Trailing Edge Broken Off	Confirmed	Johny Begue	Saint-Andre de la Reunion
2015-12-27	2	Right Wing No.7 Flap Fairing 676EB	Fractured	Almost Certain	Liam Lotter	Daghatane Beach, Paindane Resort, Mozambique
2016-04-30	7	Right Wing to Body Fairing Aft Section	Fractured on All Sides	Likely	Unknown	Anvil Bay, Chemucane, Mozambique
2016-05-24	8	Wing No. 1 Flap Support Fairing Tail Cone	Fractured	Highly Likely	Coast Guard Foot Patrol	Gris-Gris Beach, Mauritius
2016-05-22	9	Left Wing Trailing Edge Panel Forward of Flaperon	Fractured in Two Places	Highly Likely	Tourist	Maçaneta Peninsular, Maputo Bay, Mozambique
2016-03-15	10	Left Wing Outboard Flap Aft Section	Fractured	Confirmed	Tourist	Ilot Bernache, Mauritius
2016-06-06	12	Wing or Stabiliser Bottom Panel	Fractured	Likely	Blaine Gibson	Riake Beach, Nosy Boraha Island, Madagascar
2016-06-06	15	Right Wing Trailing Edge Panel	Fractured in Three Places	Highly Likely	Blaine Gibson	Riake Beach, Nosy Boraha Island, Madagascar
2016-06-20	19	Right Wing Outboard Flap	Largely Intact, Hinges Fractured, Trailing Edge Broken Off	Confirmed	Unknown	Kojani Island, Pemba, Tanzania
2016-06-21	20	Right Wing to Body Fairing Aft Section 196MR	Fractured on All Sides	Highly Likely	Unknown	Kosi Bay Mouth, Kwa Zulu Natal, South Africa
2016-12-23	26	Right Aileron Inboard Section	Fractured on All Sides	Highly Likely	Unknown	Nautilus Bay, South Africa
2017-01-27	27	Right Wing No. 7 Flap Support Fairing	Fractured along Symmetry Axis	Highly Likely	Unknown	Mpame Beach, South Africa
2016-03-17	none	Left Wing Main Landing Gear Trunnion Door	Substantially Damaged, Slicing Penetration, Fractured on All Sides	Not Officially Analysed	Blaine Gibson	Antsiraka Peninsular, Madagascar
2016-08-19	none	Panel	Fractured	Not Officially Analysed	Barry McQuade	Praia de Rocha, Mozambique
2020-08-31	none	Right Wing Inboard Spoiler	Fractured	Not Officially Analysed	Unknown	Jeffreys Bay, South Africa

Table 1: Wing Debris Overview.

6. Conclusion.

The debris item is almost certain to be from MH370 and is similar to other items of floating debris found in the Western Indian Ocean and subsequently shown to be from a Boeing 777 or more specifically from the Boeing 777-200ER aircraft with the registration 9M-MRO used for the flight number MH370.

The debris item is concave on the black side and there is a rectangular indent on the black side typical of the base plate of an attachment or a drive rod. There is also evidence of a possible hinge like attachment on the black side. There is a curve and line on the white side fitting to the shape of the adjacent parts of the aircraft. The black side is therefore considered to be the interior side and the white side full of cuts, scratches and pitting is considered to be the exterior side. The size of the debris item and alignment of the curved shape fit the main landing gear trunnion door from the left wing underbody.

The debris item was torn from its fixings and has suffered considerable damage. The possibility that there is an indent typical of the base plate of an attachment or drive rod indicates that the debris item is part of a movable panel. It is therefore even more likely that the debris item is part of the left trunnion door on the main landing gear.

The slicing damage to the debris item from the black side penetrates right through the item and is the result of a significant force. One possibility for the four almost parallel slices is caused by one of the engine compressor rings separating from a disintegrating engine on a forceful impact. The debris item would have to be located in the vicinity of the engine in this case.

Whatever the cause of the slicing damage, the fact that the damage was from the interior side to the exterior side of the debris item leads to the conclusion that the landing gear was highly likely extended on impact, which in turn supports the conclusion that there was an active pilot until the end of the flight.

The level of damage with fractures on all sides and the extreme force of the penetration right through the debris item lead to the conclusion that the end of the flight was in a high speed dive designed to ensure the aircraft broke up into as many pieces as possible. The crash of MH370 was anything but a soft ditching on the ocean.

We know from the analysis of the right outboard flap found on Kojani Island, Tanzania that this was not an attempted ditching, where the flaps would normally be partially extended, because the expert analysis showed that the flaps were not extended. The realistic possibility that the landing gear was lowered shows both an active pilot and an attempt to ensure the plane sank as fast as possible after impact.

The combination of the high speed impact designed to break up the aircraft and the extended landing gear designed to sink the aircraft as fast as possible both show a clear intent to hide the evidence of the crash.

The recovered 370 floating debris speaks to how the plane crashed, and the oceanographic drift analysis speaks to where. Neither can tell us who was flying the aircraft or why.

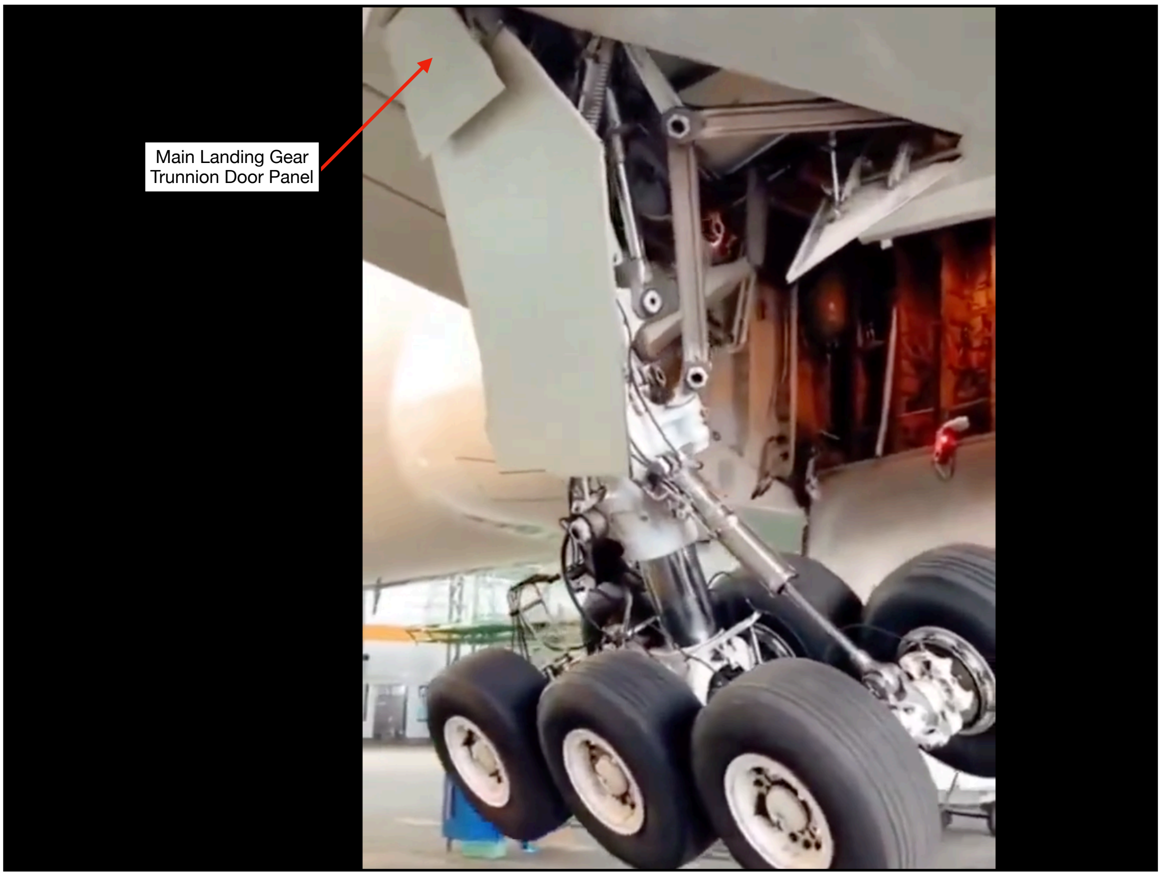

Figure 56: Boeing 777-200ER Left Wing Main Landing Gear Trunnion Door Panel.