AIRCRAFT ACCIDENT REPORT

No. 91-016

SANTANA
HANG GLIDER

NEAR LEVIN

30 JUNE 1991

Transport Accident Investigation Commission
Wellington · New Zealand

Price $11.45 (including G.S.T.)

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Transport Accident Investigation Commission
Wellington

Chief Commissioner
Transport Accident Investigation Commission

The attached report summarises the circumstances surrounding the accident involving a Santana Hang Glider near Levin on 30 June 1991 and includes suggested findings and safety recommendations.

This report is submitted pursuant to Section 8(2) of the Transport Accident Investigation Commission Act 1990 for the Commission to review the facts and endorse or amend the findings and recommendations as to the contributing factors and causes of the accident.

7 November 1991

R CHIPPINDALE
Acting Chief Executive

APPROVED FOR RELEASE AS A PUBLIC DOCUMENT

9 December 1991

M F DUNPHY
Chief Commissioner

TRANSPORT ACCIDENT INVESTIGATION COMMISSION

AIRCRAFT ACCIDENT REPORT NO. 91-016

Aircraft Type:	Santana Hang Glider
Year of Manufacture:	Not known
Date and Time:	30 June 1991, 1610 hours
Location:	4 km north-west of Manakau Latitude 40°41'07" south Longitude 175°13'05" east
Type of Flight:	Auto tow
Persons on Board:	One
Injuries:	1 Fatal
Nature of Damage:	Substantial
Pilot in Command's Licence:	Novice
Pilot in Command's Age:	21
Pilot in Command's Total Flying Experience:	21 hours
Information Sources:	Transport Accident Investigation Commission Field Investigation
Investigator in Charge:	Mr R. Chippindale

1. INTRODUCTION

1.1 Members of the Manawatu Hang Gliding Club arrived at a farm near Manakau at 1100 hours for a session of auto tow hang gliding.

1.2 The area in use was a north/south path formed by two adjacent paddocks separated by a post and wire fence. For the launches which used the full length of the tow rope, the tow vehicle, a 1600cc Subaru station waggon, was located adjacent to the dividing fence line and the glider at the southern end of the other field.

1.3 There had been seven successful launches prior to the accident flight including two by Miss Beever who flew her own Lancer 4 glider on those occasions.

1.4 Miss Beever was a Novice Pilot who was almost ready for an Intermediate Rating. She had some 21 hours' experience of hang gliding which commenced in May 1990.

1.5 Her own aircraft was similar to the Santana hang glider which was involved in the accident but had a lesser wing area.

1.6 The Santana was a single surface glider, controlled by weight shift by the pilot while holding the bar which formed the base of a trapeze or "A" frame. Luff lines and blow down tubes were fitted to recover the aircraft from any dive which was too steep for the pilot to exert a nose up influence on the glider. Deflexers were fitted above and below the wing leading edges to ensure any warping of the wing's leading edge was limited to an extent which would not affect the controllability or performance of the glider. The sail was stiffened with flat, flexible but unformed battens.

1.7 When controlling the glider the pilot pushed on the "A" frame bar to make it climb and pulled the frame towards her to descend.

1.8 The instructions for the hang glider specified a minimum weight for the pilot. As she was below this weight some form of ballast such as a sand bag should have been carried for the flight. The normally accepted weight was that which would produce a minimum wing loading of 0.7 pounds/square foot, 1.3 pounds/square foot being a common loading. On this flight Miss Beever would have been flying with a loading of approximately 0.64 pounds/square foot.

1.9 A "hang" check was made to check the pilot's attitude in her harness was correct.

1.10 At the time of the launch four persons were present, the pilot, a launchmaster, who was an experienced instructor, was with the pilot to assist her and transmit hand signals to the car driver, an observer seated behind the driver and facing rearwards, to keep him informed of the overall progress of the launch, and the driver of the Subaru station wagon.

1.11 It was some time since the club had engaged in auto tow launches and the day's activities were intended to refamiliarise the members with the procedures for using this method to get airborne. The club's safety officer was present but he was driving the car so had no direct input into the preflight inspection and briefing for each launch.

1.12 The launchmaster controlled the operation by a series of three hand signals which were verbalised for the benefit of the pilot as follows:

"Take the Strain "

"Stop" and

"Go, Go, Go".

1.13 When the pilot was ready to launch the launchmaster signalled the car driver to "Take the strain" and as the car moved slowly forward the pilot remained stationary. As soon as she felt she could no longer resist the tension in the rope she called, "Stop." and the launchmaster made the appropriate signal. When the pilot was ready for take-off she called "Go, go go" and started running as soon as the strain on the rope became irresistible. The resilience in the rope thus helped her to accelerate to take-off speed.

1.14 The pilot's first flight in this glider was a short hop immediately before the accident flight. This was in fact an aborted launch. During the take-off run she had not kept the aircraft straight and the tow rope had caught against a fence post. On this occasion she had no difficulty in gliding into the field from a height of some 40 or 50 feet. This also provided proof that the "hang" check had been made correctly.

1.15 On the second attempt the launch started normally. Two witnesses disagreed as to whether the rope snagged, briefly, on a batten in the fence on this occasion. If it did snag, the rope came free without any apparent ill effect as the pilot continued to climb the aircraft and the launch was continued.

1.16 As the aircraft approached the normal top of climb point and the vehicle driver was about to stop the vehicle the aircraft's nose up attitude was seen to increase by some 15°. Almost simultaneously the tow rope parted and the aircraft pitched upwards into a near vertical position. Its nose then dropped into a steep dive from which it again pitched upwards to a steep angle then dropped a wing to complete a stall turn like manoeuvre. In the ensuing dive the nose started to lift towards the horizontal but the glider collided with the ground in a 58° nose down, right wing low attitude.

1.17 The ground was soft, well grassed pasture into which the aircraft's nose penetrated some 270 mm. The pilot collided with the ground in a face down horizontal attitude.

1.18 The glider and the car were connected by a 1130 foot long (345 m) synthetic rope with a nominal breaking strain of 445 kg. No weak link or load measuring device was fitted to the rope. The rope was believed to have met the specifications for auto tows, provided by the designer of a similar auto launching system, as it was purchased some six years earlier from a rope manufacturer who was given the specifications to meet.

1.19 One fundamental premise made by the members was that the rope would not break therefore no briefing was given as to what action should be taken by the pilot if such an event occurred.

1.20 Neither the Safety Officer nor the Launchmaster had given any thought as to what would be included in a briefing for such an eventuality.

1.21 The rope did break earlier in the day, during a launch of the Santana aircraft prior to those made by Miss Beever. On that occasion the pilot

involved recalled earlier training in Australia where he had been told to pull the bar towards him immediately in such an event. He followed this advice and experienced no difficulty in pulling the bar back. Even so he noted that the glider pitched upwards before he regained control. The weight of the still attached section of tow rope did cause him some difficulty when he had to push the bar out to recover from the ensuing dive.

1.22 Following the first failure of the tow rope the affected section was cut out of the rope and the rope was tied with a reef knot the free ends of which were each secured by a single half hitch. The security of the knot was then tested by attaching one end to the car's tow bar and two men pulling on the rope on the opposite side of the knot. No tendency to slip was seen at that time.

1.23 When the rope was examined after the accident there was no evidence of such a knot and only one end of the rope showed signs of a recent break. The tow rope had separated 181 m (595 feet) from the glider release end. The tow rope had recoiled and twisted around the bridle at least nine times. There was also evidence of kinking and twisting, which was typical of a sudden release of the load in a resilient rope, in the 7.5 mm polypropylene section of the tow rope.

1.24 A thin nylon cord which was used to withdraw the pin from the single point release was still tied to the pilot's wrist at the accident site and the pin itself was fully in place. As found after the accident the release rope was wrapped around the bridle five times.

1.25 The pattern of injuries to the pilot's face and the twisted coils in the rope indicated that the rope, to which the glider was attached, may have recoiled when it broke and struck the pilot in the face with sufficient force to break her skin.

1.26 In addition the drag of the still attached tow rope would have affected the pilot's control of the glider to some degree. It was possible that this prevented her from regaining control of the glider when it recovered automatically from the first "whip" stall.

1.27 The system for towing which was originally intended to be followed required the following components:

A tension monitor,

1000 feet of 4mm or 6mm polyethylene ski rope,

1000 feet of 3mm (1/8 inch) polypropylene hollow braid,

A weak link located near the glider, designed to fail at or below a load of 200 pounds (90 kg),

100 feet of 6mm polyethylene ski rope,

A glider release and,

A Hewitt Bridle (see Figure 1).

1.28 The rope used was fitted directly to the car's tow ball. It consisted of 875 feet (267 m) of 5 mm nylon rope, 165 feet (50 m) of 6 mm polyester, prestretch, double braided rope and 90 feet (27 m) of 7.5 mm polypropylene, 3 strand, laid rope attached via a glider release to a Hewitt bridle which was correctly rigged.

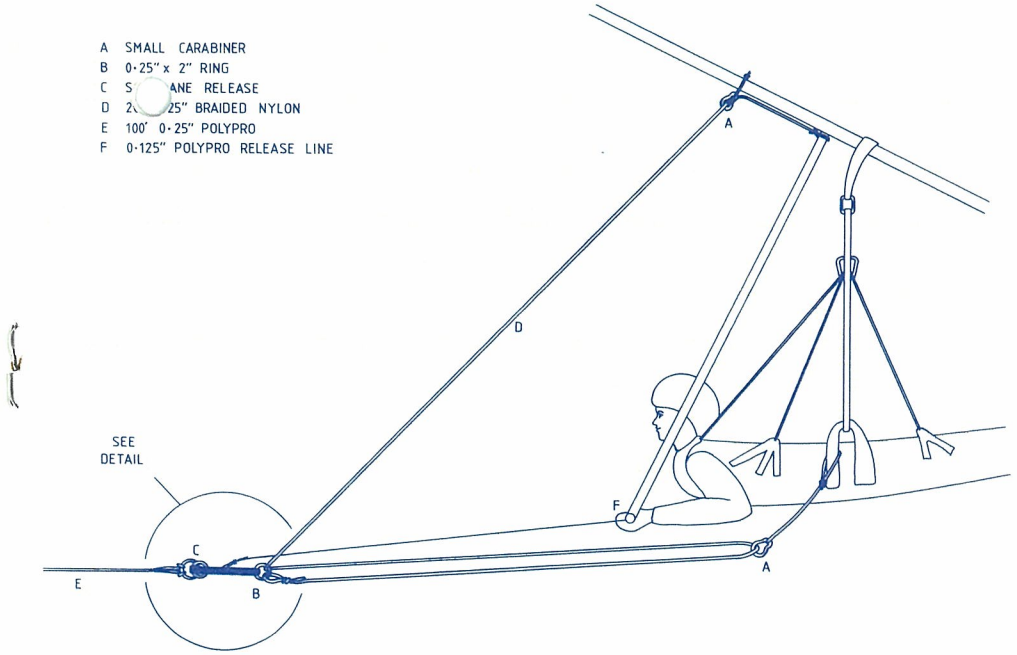

Figure 1.

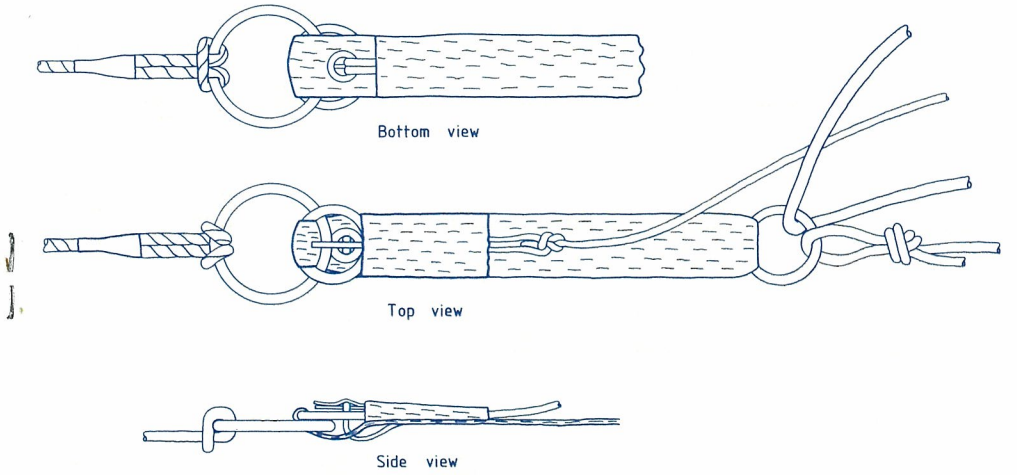

Figure 2.

1.29 The glider release operated normally under load when tested after the accident.

1.30 The car driver believed that the pilot had released the glider normally as he was approaching the end of his available tow run as it was normal for pilots to release when they saw the car's brake lights come on at that stage.

1.31 Prior to Miss Beever's launch there had been a discussion, to which she had been listening, on the potential for improving the height gained during the launch by pushing forward on the bar to increase the glider's rate of climb just prior to the end of the tow.

1.32 It appears that in this accident the pilot may have increased the angle of climb just prior to the end of the tow. If so this action would have increased the load on the tow rope and could have provided the cause for the knot in the rope to undo or break. Alternatively the pitch up which was observed may have resulted from the cessation of the pull exerted by the tow rope as was experienced by the pilot on the occasion when the rope broke previously.

1.33 Miss Beever appeared not to make any attempt at a recovery and the aircraft stalled then pitched into a steep dive which may have caused her to fall through the bar. She may have failed to react because she had not been briefed on the need to react swiftly or she may have been disoriented by the tow rope slapping her face. Whatever happened she did not take control when the aircraft recovered to a climbing attitude after the stall and it entered a second stall from which it did not recover.

1.34 Miss Beever owned a parachute which she had brought to the site but it was not fitted on this occasion because it was unsuitable for the harness used.

1.35 The parachute was intended to control the descent of both the aircraft and the pilot in an emergency but required considerable effort in such a situation for the pilot to throw the drogue, which was used to open it, clear of the aircraft in an area where it could deploy without becoming entangled in the aircraft structure.

1.36 The absence of a load monitoring device and a weak link meant the glider might have been subjected to loads which approached its structural limit. While a weak link could have failed at a critical stage of the flight such a contingency should not have lead to a loss of control if the pilot had been briefed and trained on the correct recovery technique.

1.37 As no weak link or tension monitor was provided the rope would have parted at a load of approximately 160kg which was 70kg in excess of the intended failure load for the weak link and some 90kg in excess of the recommended tension of between 57 and 73 kgs.

1.38 As the rate of climb was determined by the tension in the tow rope and the wing loading of Miss Beever's glider was below the optimum, the rate of climb at the time of the rope failure would have been greater than normal. In addition, had she wished to release the tow, the additional load would have made this action more difficult and the pitch up more pronounced than at the intended towing tension.

2. TESTS AND RESEARCH

2.1 The ropes in use at the time of the accident were examined by a manufacturer of similar products.

2.2 The nylon rope which failed was subsequently tested to establish its breaking strain.

2.3 The rope was over 6 years old and the braided outer layer which took the majority of the load showed evidence of damage due to abrasion and some areas of significant failure where several strands of the braid had failed.

2.4 Three sections were tested; the abraded but otherwise intact rope, knotted in a straight length and a damaged section in a straight length. The results showed that the rope which had a nominal breaking strain of 455 kg failed as follows:

Abraded	270 kg
Abraded and knotted	120 kg
Partially failed braid	160 kg

2.5 It was evident during the tests that the knot would have undone under two or three loadings as the stretching of the rope within the knot caused the elements to move towards the ends. When the knot failed it broke at a point of greatest curvature of one end of the rope. This produced a break a short distance from one end resulting in three pieces.

2.6 The ropes recommended (polyester and polypropylene) had approximately 25% elasticity compared with 50% in nylon. The ski rope recommended also had good resistance to abrasion because of its "slippery" surface. However, the rope was no longer readily available in the sizes specified.

2.7 The consultant advised that nylon rope not be used for towing due to the potential for lethal recoil in the event of a failure, caused by the release of the energy stored in the stretching process.

2.8 The practice of knotting tow lines after a failure was not recommended as:

(i) the knot further reduced the strength (as demonstrated by the test) and

(ii) a failure indicated a significant reduction in strength due to some damage indicating the rope had reached the end of its useful life.

2.9 A sample of 2mm wide, flat towing line being manufactured for an overseas hang gliding organisation was demonstrated. This had enhanced resistance to stretch, had a breaking strain in excess of 1000 kg and was resistant to tangling and abrasion.

3. FINDINGS

3.1 The pilot was appropriately qualified for the flight.

3.2 The aircraft was airworthy prior to the flight.

3.3 The weather was not a factor in the accident.

3.4 The pilot's weight was less than the minimum required to ensure proper control of the aircraft.

3.5 The pilot carried no ballast to make up for her light weight.

3.6 The auto tow launching system was deficient in several areas.

3.7 The absence of a weak link to limit the load imposed on the rope was a factor in the accident.

3.8 The absence of a load monitoring device was a factor in the accident.

3.9 The use of nylon rope for the majority of the rope instead of the recommended polyethylene and polypropylene rope was a factor in the accident.

3.10 The tow rope recoil caused part of the towing line to wrap around the bridle.

3.11 The knot used to repair the rope after it failed was not appropriate for the material used or the conditions under which it was used.

3.12 The knot in the rope failed at a stage of the flight which was likely to result in the greatest pitch up of the glider as it separated.

3.13 Had the pilot acted correctly when the rope failed the aircraft would have been prevented from stalling.

3.14 The pilot had not been briefed on the actions to take in the event of a rope "break" during an auto tow launch.

3.15 The pilot may have been incapacitated by the rope recoiling into her face.

3.16 The pilot may have been prevented from controlling the glider after it recovered from the stall, by falling through the "A" frame or other mispositioning as a result of the extreme attitudes experienced in the stall, or by the upper section of the tow rope interfering with the normal functioning of the glider.

3.17 Had a parachute been fitted to the aircraft the pilot may have been able to use it to reduce the glider's rate of descent to a survivable level.

3.18 No suitable parachute was available to the pilot for her flight on this occasion.

3.19 Although undesirable the bisection of the towing area by a post and wire fence was not a causal factor in the accident.

3.20 The accident was unsurvivable.

3.21 The accident was probably caused by one or more factors preventing the pilot from taking the correct action when the tow rope separated. Contributory factors included; the use of an unsuitable knot to tie the rope after it had failed, the non-availability of a suitable parachute for the pilot, the use of a strong rope without a weak link and/or a load monitoring device, and the use of a rope (nylon) with almost twice the stretch of the recommended types. Other factors which had the potential to contribute were the failure to brief and train the pilot on the action to be taken in the event of a rope break, the light weight of the pilot, and the failure to use ballast to improve the pilot's control of the glider.

4. SAFETY RECOMMENDATIONS

4.1 As a result of the investigation of this accident it was recommended that the Hang Gliding Association of New Zealand:

Ensure each hang glider pilot be made aware of the desirability of using ballast to achieve optimum controllability of the glider if its sail area relative to the pilot's weight, decreased the wing loading below the advised minimum,

Develop a standard for auto tow systems to meet and require each system to be approved by the Club Safety Officer,

Enlist the services of an authority on knotting synthetic ropes to approve suitable knots for this purpose,

Encourage the use of parachutes in their sport,

Require Safety Officers in charge of auto tow operations to ensure each pilot is familiar with the procedure to be implemented in the event of a rope break, and

Evaluate the use of purpose manufactured ropes as soon as practicable.

5. REGULATORY

5.1 Pursuant to Section 14(5) of the Transport Accident Investigation Commission Act 1990 the Club Safety Officer and the legal personal representative of the pilot were invited to avail themselves of the opportunities afforded to them thereunder.

5.2 As a result of representations received the report was amended and amplified to clarify some of the points raised.

5.3 The representations made to the undersigned are not to be taken as an admission of liability on the part of the parties concerned and their statements are without prejudice to their right to act in any way they may consider fit in any proceedings or action which may be based on the events to which this report refers.

7 November 1991

M F DUNPHY
Chief Commissioner