Design Diving Speed Of Gliders

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Summary and Acknowledgment

This paper was prepared in conjunction with the Design Requirements for Gliders being worked out by the Technical Committee of the Soaring Association of Canada, under the chairmanship of Mr. B. S. Shenstone. It represents a project for evaluation of the design diving speed of gliders on the basis of the allowable time of vertical diving or the allowable altitude lost in a dive.

In 1936 the author had initiated at the Institute for Gliding and Motogliding in Lwow (Poland) a special study of diving of gliders. A considerable field of problems was covered and a special acknowledgment is due the work of Dr. M. Z. L. Krzywoblocki, Mr. Piatek and the author's other collaborators at that time. Flight tests carried out with several gliders supplied the necessary experimental data.

The present paper follows the general opinion about the evaluation of the design diving speed, expressed by the author at different occasions since 1936,* but of course it contains some amendments which seem to be advisable for the practical application.

At this point, the author wishes to express his appreciation for the valuable suggestions offered by Mr. D. Hissocks, and for his help in checking the formulae and computing figures necessary in preparing the graphs.

Introduction

A proper evaluation of the design diving speed should satisfy the two basic requirements: (1) it should provide maximum security within the possible and probable operational conditions; and (2) it should not impose excessively severe requirements on the designer that may jeopardize to a large extent the flying qualities of the aircraft.

In the case of gliders this general statement has its particular aspects. All gliders, including performance machines when flying in clouds, as well as primary single seaters when flown by inexperienced pilots, may find themselves in a dive or a similar flying attitude. This may occur much easier to gliders than, let us say, to powered civil aircraft. Especially in the case of accidental diving of performance gliders in blind flying, some time may elapse before the pilot is aware of his position and before he starts the necessary measures to get back to a normal flying attitude.

If the glider is equipped with some efficient airbrakes, in a doubtful situation the pilot will operate the brakes and the glider in the worst cases will be brought eventually to its terminal velocity with the brakes on.

At first glance it may seem that the design diving speed of gliders equipped with brakes must not exceed the terminal velocity of the machine with the brakes on. An excess of a few percent might be required as an additional margin of safety. Nevertheless, even in this case some time should be allowed for pilot confusion, putting the brakes into full operation, etc. In other words, it seems quite logical that even gliders equipped with brakes should fulfill the requirements of a free dive (brakes off) during some accepted length of time. The greater of the two speeds; that at the end of the allowable time of diving, or that corresponding to the terminal velocity with the brakes on, should be taken as a design diving speed.

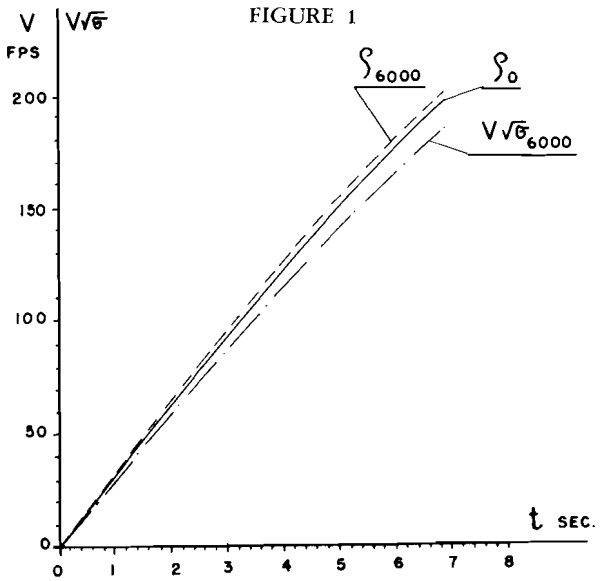
The establishment of the design diving speed for performance gliders without airbrakes would always bear a greater factor of uncertainty than in the case just considered. Only acceptance of the terminal velocity as a design diving speed would free the designer from this uncertainty. But, of course, such a solution would represent technical nonsense because of the very high terminal velocities—a direct result of the aerodynamic cleanliness of performance gliders. Evaluation of the design diving speed at a value smaller than the terminal velocity is then paramount.

Some official requirements attempted to solve this problem by simply taking design diving speed as a given fraction of the terminal velocity. Such a solution, as will be seen from further considerations, is unnecessarily severe for the aerodynamically clean machines of high wing loading (high terminal velocity), while it seems not to assure any similar degree of safety to the gliders characterized by a low terminal velocity.

It seems that a more uniform margin of safety would be assured to all performance and perhaps aerobatic gliders, if all of them will be granted the same allowable time of diving.

For primary, and perhaps some utility gliders, acceptance of the allowable time of diving as a basis for the evaluation of the design diving speed may not be

FIGURE 1



* See for instance: W. Stepniewski, L'approfondissement des Bases Theorique et Experimentales du Reglement Polonais de la Construction des Planeurs, ISTUS Mitteilungsblat Nr. 5.