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APOGEE

PEAK OF FLIGHT

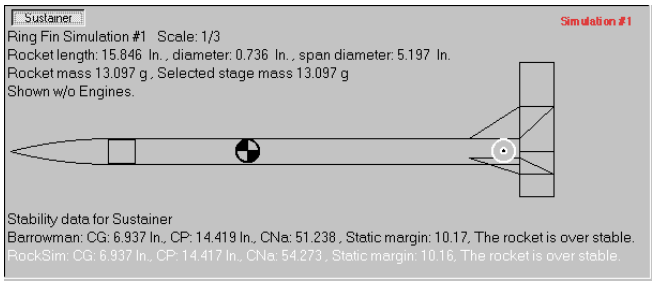
NEWSLETTER

Simulation of Ring Fin Designs Using RockSim v4.0

By Bruce S. Levison

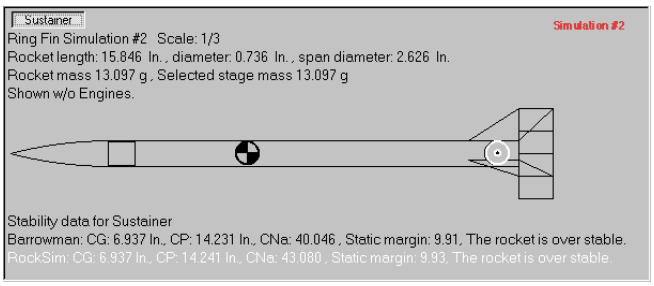
With the development of computer software like RockSim Ver 4.0 to predict typical model rocket's flight and stability, there is a desire to simulate more complex rocket designs. In a previous article (Apogee Tube Fin Simulation Techniques) I have shown that tube fins are best simulated by three flat fins that have the same area as the lateral cross sectional area of the tube fin. Thus, a tube finned rocket with six tube fins could be simulated as a rocket having 18 flat fins that have the shape of the lateral cross sectional area of the tube fins.

When you attempt to extend this concept to a ring finned model rocket (see simulation #1) you get a design that doesn't "look" quite right.



The three fins stick out much further from the body than the actual ring fin would, giving a more stable design than expected. These three fins, with the same shape as the lateral cross sectional area of the ring fin, give approximately the correct amount of surface area. The surface area of the ring fin is pi (3.14159...) times its' diameter times the height of the fin, where as the total surface area for all three flat fins used in this simulation, is the diameter of the fin times the height times three (since there are three fins). The area of the actual ring fin is slightly larger (by about 5%) since pi is not equal to three. The overlap of the ring fin with the supporting struts or fins will probably decrease the effective surface area of the ring fin by this same amount.

To get the ring fins to "look" right in the simulation, the flat fin span should only extend out from the body tube by only half the rings fins' diameter (its' radius) and not the total diameter (twice the radius). To do this, I simulate a ring fin as six flat fins that have a span equal to the radius of the ring fin and an equivalent height (see simulation #2).



This makes for a less stabilizing set of fins (the CP is closer to the rockets nose or higher along the body tube) as would be expected. The area of these six fins which is the radius of the ring fin times its' height times six (since there are now six fins) is also approximately surface area of the ring fin which is pi (3.14159...) times 2 times the ring fins' radius times the height of the fin.

Note that the two designs used in the above CP calculations do not have a body tube that extends through the ring fin itself. To allow RockSim version 4.0 to work with the full area of the fins, the body tube section through the ring fin of the model was simulated as a very narrow tube with a very thin wall and bore.

If the body tube extends through the ring fin, the ring fins effective surface area will be decreased by the surface area of

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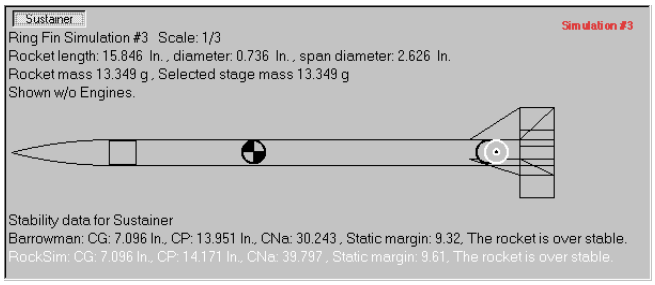
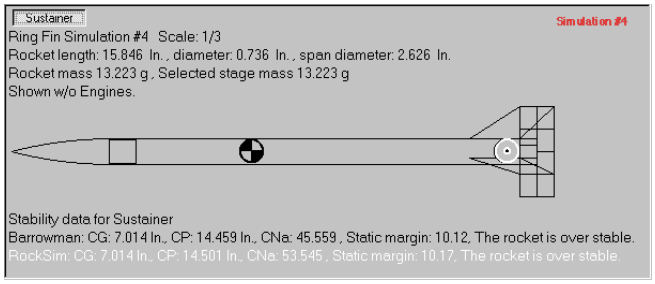
the body tube. The closed nature of the body tube prevents crosswise airflow through the ring fin; the magnitude of this effect is equivalent to the body tubes surface area passing through the ring fin. For this type of design the span of the six flat fins is equal to the radius if the ring fin minus the radius of the body tube (see simulation #3).



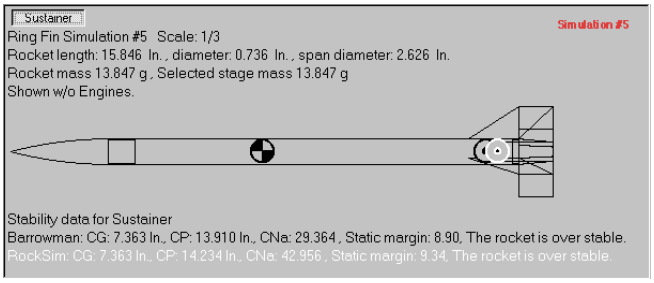
The fin height will still be the same as the ring fins height. Note that the CP is higher or closer to the nose of the model rocket which would be expected for a less stable design.

This brings us to the case where the body tube extends only part of the way through the ring fin (see simulation #4). For this type of design, the ring fin is separated a long its' length into two portions and each portion handled as the separate cases as in simulations #2 and #3 above.



For a boat tail through the ring fin attach the fins to the boat tail (see simulation #5) and simulate the span of the flat fins as the radius if the ring fin minus the radius of the body tube at the widest part of the transition. Again a boat tail that doesn't extend all the way through the ring fin or ends in a straight extension, such as a motor overhang, should be treated as two separate cases. Separate the ring fin along it length, simulate one section for the boat tail and one for the extension.

These techniques and my previous work on tube finned designs allows designers to simulate both tube finned and ring finned model rockets using RockSim version 4.0. These two articles allow the software package to handle designs that it



was reportedly unable simulate at release, demonstrating the utility of such a software package for use with more complex rocket designs. My article on "On the Pad Recovery Using RockSim Ver 4.0" along with my other two other articles on tube fins and ring finned designs have extended the capabilities of the RockSim program, making it by far one of the most useful and valuable tools available to a model rocket hobbyist.

For those who are teachers, this article demonstrates how a little thought can be used to make a computer program do a lot more than it was reportedly designed for. It should serve as an example for your students on how to use advanced technology in real world situations like the flight simulation of a model rocket with rings fins. Again I must state that, this treatment has not been verified with actual field tests and data; I will leave it up to future model rocketeers to verify these simulations with actual flight data. Feel free to contact me vial e-mail at: bsleviso@cc.ysu.edu to share your results and let me know what you think about this simulation and/or what you learned about its' sources of error.

About the Author:

Bruce S. Levison (NAR #69055, MTMA #606), A.K.A. The Teflon Rocketry Man, is a rocketeer from Ohio, a member of the National Association of Rocketry (NAR), and NAR section #606, the Mantua Township Missile Agency (MTMA). He has published articles on ejection charge proof expanded Teflon recovery systems (hence the nickname), camera tripod mounted launch pads, ablative blast deflectors, a horizontal painting swivel for model rockets, a method for the simulation of tube fin rocket designs (found at: http://www.apogeerockets.com/simulating_tube_fins.asp), and a RockSim method to determine how far away from the launch pad a parachute recovered model rocket will land. Bruce holds an advanced degree in chemistry, and is the manager of an instrumentation facility in the Department of Biological Sciences at Youngstown State University.