
SHELL BUCKLING
KNOCKDOWN FACTOR

1
00:00:01,547 --> 00:00:04,864
The test article is a twenty-seven-and-half-foot diameter,

2
00:00:04,899 --> 00:00:08,248
twenty foot tall, aluminum-lithium orthogrid cylinder,

3
00:00:08,274 --> 00:00:12,104
very similar to the type of cylinders' that were flown

4
00:00:12,402 --> 00:00:15,312
on the space shuttle external tank. In fact, this test

5
00:00:15,586 --> 00:00:19,880
article is derived from some hardware from the space

6
00:00:19,915 --> 00:00:23,688
shuttle program, so it's configured very much like the

7
00:00:24,323 --> 00:00:27,793
future SLS core stage tank structures so it's very

8
00:00:28,602 --> 00:00:32,712
relevant to what NASA's designing today.In this test,

9
00:00:32,754 --> 00:00:35,832
we are going try to simulate a lot of the types of

10
00:00:35,867 --> 00:00:38,527
loads that a launch vehicle would be subjected to

11
00:00:38,562 --> 00:00:41,312
during flight. That includes internal pressure

12
00:00:41,347 --> 00:00:45,096
associated with the fuel tanks, as well as flight

13
00:00:45,131 --> 00:00:50,456

loads that you would see. That would include

14
00:00:50,491 --> 00:00:52,360
compression type forces and bending forces

15
00:00:52,705 --> 00:00:54,664
similar to what you would see if you crushed a

16
00:00:54,699 --> 00:00:57,689
beverage can under your foot.The black-and-white

17
00:00:57,724 --> 00:01:00,112
polka dot pattern you see on the outside of the

18
00:01:00,147 --> 00:01:02,856
test article is used in a system called digital

19
00:01:02,891 --> 00:01:06,864
image correlation. What that system does is we

20
00:01:06,899 --> 00:01:11,816
have a series of 22 cameras surrounding this test

21
00:01:11,851 --> 00:01:17,040
articles and they are monitoring minute movements

22
00:01:17,075 --> 00:01:20,864
of these dots and from that calculating the

23
00:01:20,899 --> 00:01:24,032
displacements of the test article. It is a

24
00:01:24,067 --> 00:01:29,624
really powerful type of technique that allows us

25
00:01:29,659 --> 00:01:34,528
to watch displacements of the test article during

26
00:01:34,563 --> 00:01:39,192
the test on the entire structure. Traditionally,

27
00:01:39,227 --> 00:01:42,368
we'd only get point to point measurements, a single

28
00:01:42,403 --> 00:01:44,016
gauge here, a single gauge there. For something

29
00:01:44,051 --> 00:01:47,816
this large, the digital correlation system really,

30
00:01:47,851 --> 00:01:51,719
really give us a lot of good information.The NESC,

31
00:01:51,754 --> 00:01:54,824
NASA's Engineering and Safety Center is the primary

32
00:01:54,859 --> 00:01:58,984
sponsor and funder of this project. They saw very

33
00:01:59,019 --> 00:02:02,328
early on the need to update these design guidelines,

34
00:02:02,363 --> 00:02:06,495
and I came to them with a proposal to form this

35
00:02:06,530 --> 00:02:14,519
project, so they've been the primary funder.

36
00:02:14,554 --> 00:02:18,392
The primary stakeholders would be people like

37
00:02:18,427 --> 00:02:22,968
SLS, as well as commercial crew, and industry at

38
00:02:23,003 --> 00:02:25,648

large. We have a large following of industry

39
00:02:25,683 --> 00:02:29,792
partners who come to workshops and we discuss a

40
00:02:29,827 --> 00:02:32,552
lot of the data and discuss their needs as an

41
00:02:32,587 --> 00:02:36,912
industry. So this project is going to have a

42
00:02:36,947 --> 00:02:41,048
large impact in the long term, not just NASA

43
00:02:41,083 --> 00:02:44,920
and SLS.Well we had several visual cues of this

44
00:02:44,955 --> 00:02:48,456
thing buckling. We look at data. We have our

45
00:02:48,491 --> 00:02:51,879
visual image correlation data that's streaming

46
00:02:51,914 --> 00:02:55,496
for us that indicated, even before buckling was

47
00:02:55,531 --> 00:03:00,735
occurring, that buckling was anticipated. We can

48
00:03:00,770 --> 00:03:03,152
also view the test article outside of our control

49
00:03:03,187 --> 00:03:05,647
room window, and we have it positioned in such a

50
00:03:05,682 --> 00:03:10,960
way that we can see it buckling at the time.

51
00:03:10,995 --> 00:03:14,351
It was quite dramatic. We could see it buckle.

52
00:03:14,386 --> 00:03:17,376
We heard the bang. The shell buckling test is

53
00:03:17,411 --> 00:03:21,336
being conducted at Marshall Space Flight Center

54
00:03:21,371 --> 00:03:23,576
because inside of our Load Test Annex is one

55
00:03:23,611 --> 00:03:24,840
of the largest tensile test machines in the

56
00:03:24,875 --> 00:03:26,247
world. We've got a movable crosshead that

57
00:03:26,282 --> 00:03:28,351
weighs 3 million pounds and can react 30

58
00:03:28,386 --> 00:03:30,776
million pounds of axial compression, making

59
00:03:30,811 --> 00:03:34,424
it perfect to do large-scale structural tests.

60
00:03:34,459 --> 00:03:37,056
It is an indoor facility, which makes it ideal

61
00:03:37,091 --> 00:03:39,136
for the video image correlation systems that

62
00:03:39,171 --> 00:03:41,192
we use to monitor real-time strain

63
00:03:41,227 --> 00:03:44,688

distributions during actual load events.

64
00:03:44,723 --> 00:03:47,488
The Space Launch System consists of five

65
00:03:47,523 --> 00:03:50,240
major components: the forward skirt, the

66
00:03:50,275 --> 00:03:52,448
liquid oxygen tank, the hydrogen tank,

67
00:03:52,483 --> 00:03:54,104
the inner tank, and the engine section.

68
00:03:54,139 --> 00:03:55,880
I am going to be the lead test engineer

69
00:03:55,915 --> 00:03:57,728
for the forward skirt and the liquid

70
00:03:57,763 --> 00:03:58,984
oxygen tank.

71
00:03:59,019 --> 00:04:00,991
One of the biggest examples of how this

72
00:04:01,026 --> 00:04:04,488
directly affects the Space Launch System

73
00:04:04,523 --> 00:04:07,464
is that we are learning on real hardware

74
00:04:07,499 --> 00:04:10,272
that is the same size, for example, as

75
00:04:10,307 --> 00:04:12,232
the forward skirt. As a matter of fact,

76
00:04:12,267 --> 00:04:13,656
the shell buckling test article is the

77
00:04:13,691 --> 00:04:15,240
same diameter as the forward skirt, and

78
00:04:15,275 --> 00:04:17,344
it's a little bit taller. So we've got

79
00:04:17,379 --> 00:04:20,720
a real-life test article that we are