



# When does lighting truss crack?

The ULTIMATE safety test!





We are proud to test our Titan AV truss in Australia with esteemed public research experts, USQ in collaboration with the Australian Federal Government.

Testing locally has provided us with invaluable insights into truss safety and will also inform future design development. The independent findings will help establish a safer framework for engineers, riggers and installers.

*Kerri Economopoulos, Managing Director - VFM Group*



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## The Project

# Structural behaviour of lighting truss systems

This project aims to validate the structural performance of lighting truss through experimental investigations and finite element simulations of the structural behaviour of Titan AV lighting truss systems.

This is a joint venture between the Australian Government Department of Industry, Innovation and Science, the University of Southern Queensland and VFM Group.

Our collective goal is to improve the safety and use of lighting truss. The project may also suggest new designs and/or materials to enhance the structural and load bearing capacity of truss.



## VFM Group

### Who are we?

VFM Group is a family-owned Australian company. We make quality rigging, cases, comms, and everything else you need to perform!

We're focused on bettering our people and products. Whether that's through our recycling, manufacturing, or safety initiatives. Our collective goal is to grow responsibly. Which is why we put our Titan AV products through some of the most rigorous tests imaginable. We break it so you don't!

### Our brand

Titan AV is our proprietary brand of quality truss, cases, cables, server racks and so much more! We design

products to solve problems, look good, save time and live tough. Our solutions help Event Producers, AV Installers, and DIYers to set up with no costly hiccups.

### Titan AV truss

Titan AV lighting truss are built to handle the heaviest gear with the upmost confidence. Designed in Australia, Titan AV truss use the strongest materials and are constructed by expert welders.

When holding heavy equipment overhead, trusting your truss is an absolute must. That's why Titan AV truss is tested in Australia by structural engineers. This certified testing ensures the safety of your crew, your clients, and their audiences.



**Rick Eckert**  
Director & Head of Product  
Design and Development

**Kerri Economopoulos**  
Managing Director



*Rick outside the University of Southern  
Queensland's Centre for Future Materials.*

## Not All Truss are Created Equal!

**When holding heavy equipment overhead, trusting your truss is an absolute must! That's why Titan AV truss is tested in Australia by structural engineers.**

**This certified testing ensures the safety of your crew, your clients, and their audiences.**

In today's marketplace, the quality of lighting truss can vary impacting its safe application. Differences in welding, manufacturing and raw materials can make or literally break truss.

Truss structures often hold hundreds, if not thousands, of kilos above patrons. With this type of risk, it's critical to know with 100% assurance that it's safe to use.

*"We need to do better, we need to be 100% certain that the truss is going to be safe, it's going to hold what it says it holds. And to set a standard that ensures better & safer practices around using truss in Australia."*

*Rick Eckert, Head of Product Design & Development - Titan AV*

But without an existing Australian safety standard tailored to lighting truss, inferior trussing is available. International truss safety measures lack transparency and objectivity. With most brands of truss manufacturing and testing in the same facility.

This kind of in-house testing lacks independence and can leave you guessing how much of a factor rating (safety buffer) has been allocated? For example, if a truss span is said to hold 5 tonnes, is that 5T until break-point? Or could the truss hold 2 or 3 times that amount before failure? There's a big difference.

*"We want 100% safety in our truss! We want to know exactly what Titan AV truss can and can't do. That way we know exactly what our truss is capable of, where the limits are, and can pass that information onto our customers to ensure the safest outcomes."*

“

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*Rick Eckert, Head of Product Design & Development - Titan AV*



*Inside USQ's Centre for Future Materials performing a non-destructive structural behaviour test on Titan AV 290 box truss.*

## Ensure Quality with Australian Testing

How VFM Group came to coordinate with the University of Southern Queensland (USQ) to ensure the quality of our Titan AV lighting truss systems.

When looking for a testing company, we didn't need to travel far. The University of Southern Queensland (USQ) may seem an unlikely choice. Yet USQ's Toowoomba campus is home to the Centre for Future Materials (CFM). This facility is a world-leading research centre in advanced composite materials.

CFM has gained a reputation for pioneering research and development in engineered materials. They boast a diverse and experienced team of engineers and researchers. With these resources, USQ was the best place to test Titan AV truss.

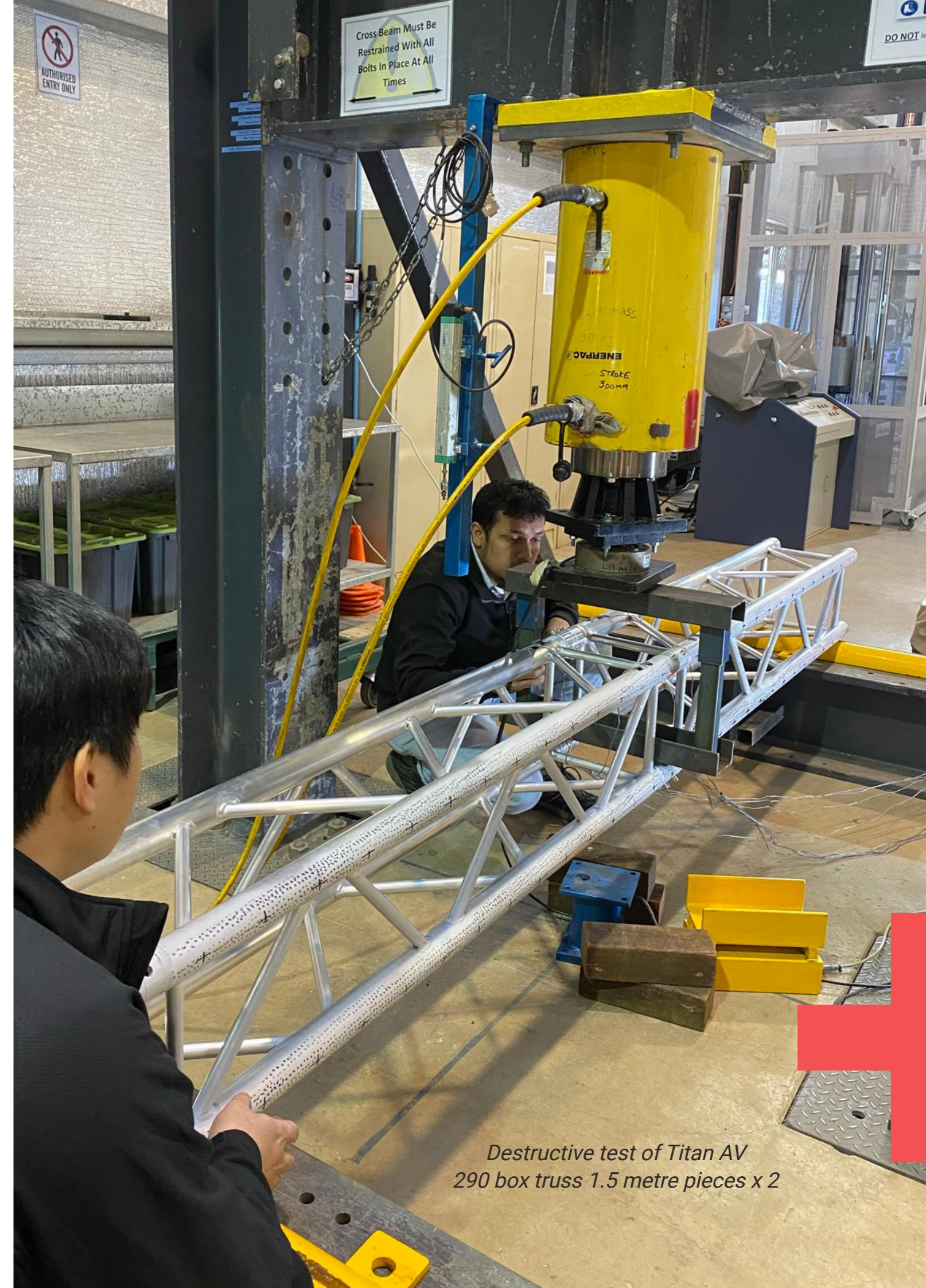
"Why not? Let's push the boundaries. Let's do it properly & be the best! It's not a cheap process by any means. But at the end of the day we're choosing to support a local business (USQ) and we're happy putting that money back into the Australian economy."

*Rick Eckert, Head of Product Design & Development - Titan AV*

To ensure the quality of Titan AV truss, USQ's team of structural engineers performed a series of structural behaviour tests. The tests were the biggest of their kind ever conducted in Australia.

They tested individual truss lengths, truss spans and the raw materials of truss. The engineers studied how much the truss bends, twists and strains under pressure. Furthermore, this data informed simulations to model the most widely used applications of truss.

"The idea is to work out exactly where and how the truss breaks, and then look at improvements for the future. Knowing this critical data, we can accurately assess the safety by calculating load ratings. So you will know at any one time what amount is safe to load."



*Destructive test of Titan AV  
290 box truss 1.5 metre pieces x 2*

# Truss Structural Tests

Within a big shed in Toowoomba lives USQ's Centre for Future Materials. This facility is a world-leading research centre in advanced composite materials. Here Titan AV 290 box truss underwent a series of structural behaviour tests.



## The Testing

- 1st ← Non-destructive testing across 9 & 12 metre spans using 3 metre lengths of 290 box truss.
- 2nd ← Destructive test of 290 box truss 3 metre piece, horizontal.
- 3rd ← Destructive test of 290 box truss 1.5 metre pieces x 2, horizontal.
- 4th ← Compression test of 290 box truss 0.5 metre piece x 2, vertical.
- 5th ← Compression test of 290 box truss 1 metre piece, vertical.
- 6th ← Destructive tests on the raw materials and components of lighting truss.
- 7th ← Finite Element Simulations of lighting truss systems.

## Why 290 box?

290 box truss is the most popular style of aluminium trussing in Australia. This great all-round truss can create very strong structures indoors or outdoors. Capable of rigging weighty AV equipment, it's ideal for events and commercial fitouts.

## How the data was captured...

To replicate tests, the engineers used a hydraulic press pump to apply downward force onto the truss. They recorded this force in 'Newtons'. This unit of measurement is used in the building industry to state safety holding values.

As a guide, roughly every 10,000 Newtons is equal to 1 Tonnes of pressure. That's the weight of a baby humpback whale, saltwater crocodile or 1979 VW Beetle.

Strain gauges were attached in critical points to measure the strain/stresses in members and the deflection was measured using a digital image correlation (DIC) camera. The DIC camera tracks markings (the '+' symbols) placed on the truss. With this, the engineers can calculate how much the truss bends, twists and strains.

## NDTs to show intended use.

Non-destructive tests (NDT) are a quality assurance tool. Engineers use them to detect and check flaws in structural components and systems. These tests allow us to determine whether 290 box truss is suitable for its designed use.

## Testing to breaking point!

A destructive test forces the material, in this instance aluminium truss, to fail under increasing pressure. Titan AV truss underwent destructive testing in horizontal & vertical directions, because... why not!? Both tests had two variations over the same span. The variations would test if one piece of truss is as strong as two connected pieces.



*Non-destructive structural testing truss spans  
using three metre lengths of Titan AV 290 box truss.*

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Why not? Let's push the boundaries. Let's do it properly & be the best!

It's not a cheap process by any means. But at the end of the day we're choosing to support a local business (USQ) and we're happy putting that money back into the Australian economy.

*Rick Eckert*

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# We Break Truss So You Don't!

Destructive tests force the material, aluminium truss, to fail under increasing pressure. They find the break-point!

When it came time to destructively test Titan AV truss we had two goals in mind. The first, to test an individual length of truss. And the second goal was to challenge a popular assumption... that the joins are the weak link in trussing.

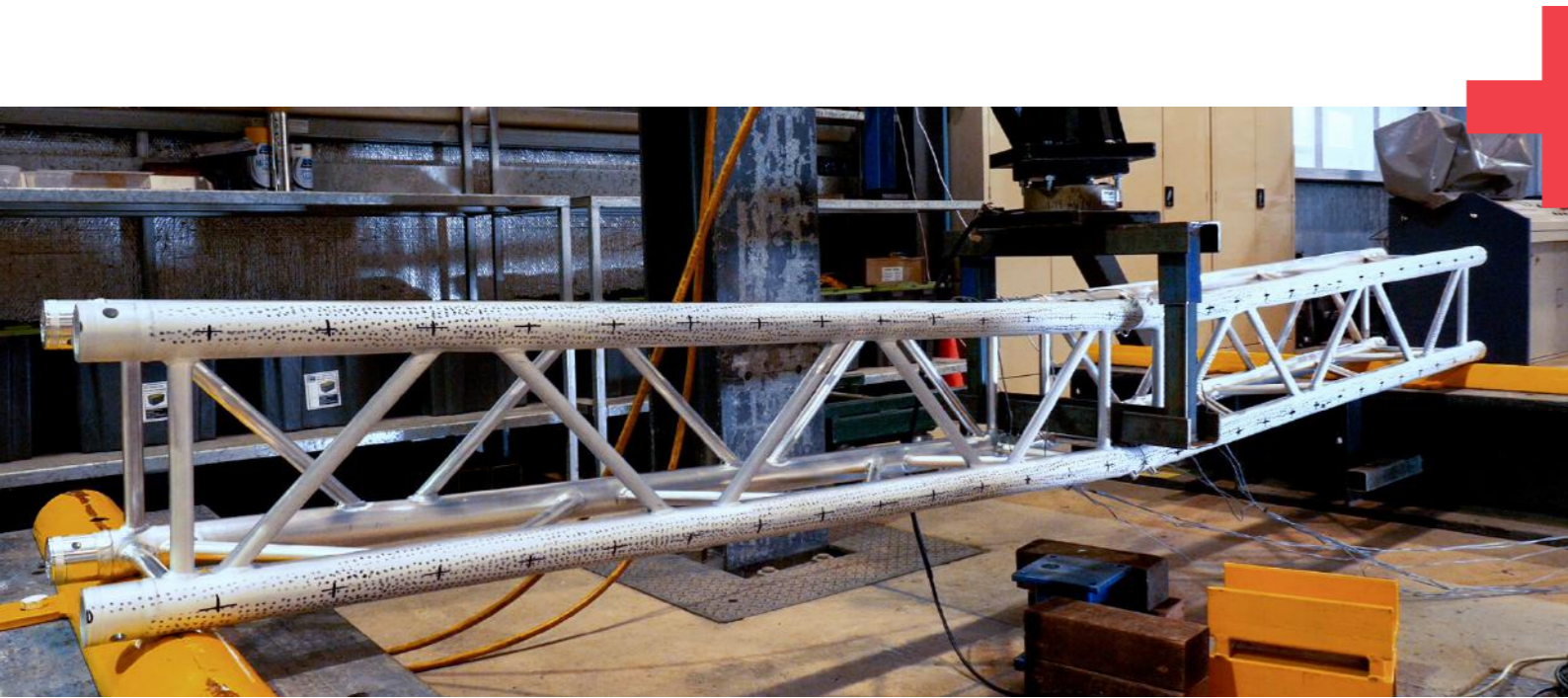
To do this, the structural engineers at USQ's Centre for Future Materials set up carbon copy destructive tests for single & connected pieces of truss over 3m spans.

Simultaneously, the engineers compared the effects of loading pressure onto different parts of the truss. With this, we can see how the end couplers hold up under direct pressure.

**Are joins the weak link?**  
During live testing the team discovered that truss joins are *not* the weakest link. In fact, the 2 connected lengths of truss were 27% stronger than the single length.

"That's well above what we originally thought. In this industry there's a misconception that the joins (are) the weakest part. No, definitely not. It's very strong!"  
*Rick Eckert, Head of Product Design & Dev - Titan AV*

The connected lengths (2 x 1.5m truss) held a massive 4.2 tonnes of load before failure. While the single 3m span managed 3.2 tonnes of load before failure.



## TitanAV Load span table 290mm Box Truss (TR-SQ30)\*

SPAN (M)	UDL (KG/M)	DEFL (mm)	CPL (KG)	DEFL (mm)	Two Point Load	DEFL (mm)	Three Point Load	DEFL (mm)	Four Point Load	DEFL (mm)	FOS
3	320	10	1260	12	900	12	660	13	480	12	1.5
4	285	24	1080	19	760	20	600	24	440	22	1.5
5	290	50	960	29	700	33	560	39	420	41	1.5
6	175	60	870	42	640	50	500	56	410	57	1.5
7	110	69	780	57	540	65	440	70	320	69	1.5
8	78	80	720	76	460	80	320	79	220	80	1.5
9	55	90	600	89	360	89	260	90	200	90	1.5
10	40	100	600	99	290	109	210	100	160	99	1.5
11	30	109	500	109	250	110	180	110	140	110	1.5
12	24	120	420	118	210	120	150	120	120	120	1.5

[DEFL] Deflection. [UDL] Uniformley Distributed Load. [CPL] Centre Point Load. [FOS] Factor of Safety.

*\*NOTE:* Load table information is supplied as a guide only. A Factor Of Safety (FOS) of 1.5 and a maximum developed flexural stress of 175 Mpa was considered based on the serviceability requirements suggested in AS/NZS 1576.1. Moreover, the deflections were limited to (span length)/100 for each loading scenario.

**Disclaimer:** These tests were done under strict observation. We do not recommend replicating these professional tests or overloading truss beyond a safe capacity. Please consult a structural engineer for advice related to your application.





Setup for compression test of Titan AV 290 box truss 0.5 metre x 2.

## Crushing truss is not so easy!

### Titan AV truss underwent destructive testing in horizontal & vertical directions, because... why not!?

Next, the engineers performed compression tests to better understand how truss uprights react. The results were incredible! The connected 1m span of truss held a massive 20 tonnes.

"That's a very strong beam! 20 tonnes!? That's a lot of pressure. When we're testing structural stuff, when they come to their limit, they (usually) collapse."

*Daniel Mateus, Technical Officer - USQ*

While the 1m Titan AV truss upright held a staggering 26 tonne of load before failure.

"It's interesting to see the straight one metre was stronger. It just goes to show you the actual space frame

design, the cross welds, do play a huge part in holding the integrity of the product together."

*Rick Eckert, Head of Product Design & Dev - Titan AV*

Notably, failure was due to buckling and not a complete collapse of the truss.

"It doesn't just collapse. It gives you some warning, some protection, so you can unload."

*Choman Salih, Senior Research Technical Officer (Composite Materials) - USQ*

For peace of mind, USQ engineers have calculated a minimum 1.5 factor rating into Titan AV truss load tables.

### Titan AV<sup>+</sup> Load vertical compression span table 290mm (TR-SQ30)\*

SPAN (M)	Allowable Load (KG)	DEFL (mm)	Factor Of Safety
1	9500	1.3	2
2	9300	2.3	2
3	9000	3.4	2
4	5400	4.7	2
5	3600	5.9	2
6	2500	7	2

*\*NOTE:* Load table information is supplied as a guide only. These tests were done under strict observation. We do not recommend replicating these professional tests or overloading truss beyond a safe capacity. Please consult a structural engineer for advice related to your application.

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when they come to their limit,  
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*Daniel Mateus, Technical Officer - USQ*

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## Testing Truss Components

USQ's team performed destructive tests on the raw elements of truss. These tests included compression & stress strain tests on truss components to discover what they can handle before welding.

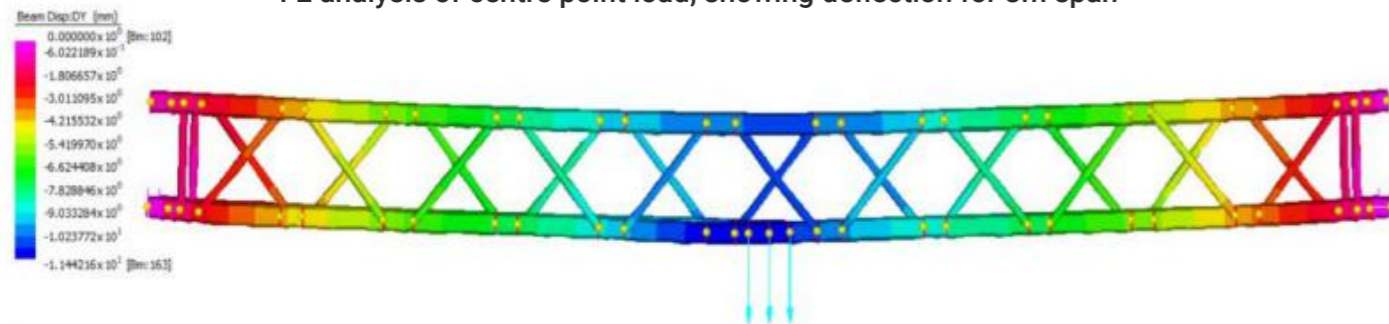
These tests provided a huge amount of data on the structural integrity of the aluminium used to make Titan AV truss.



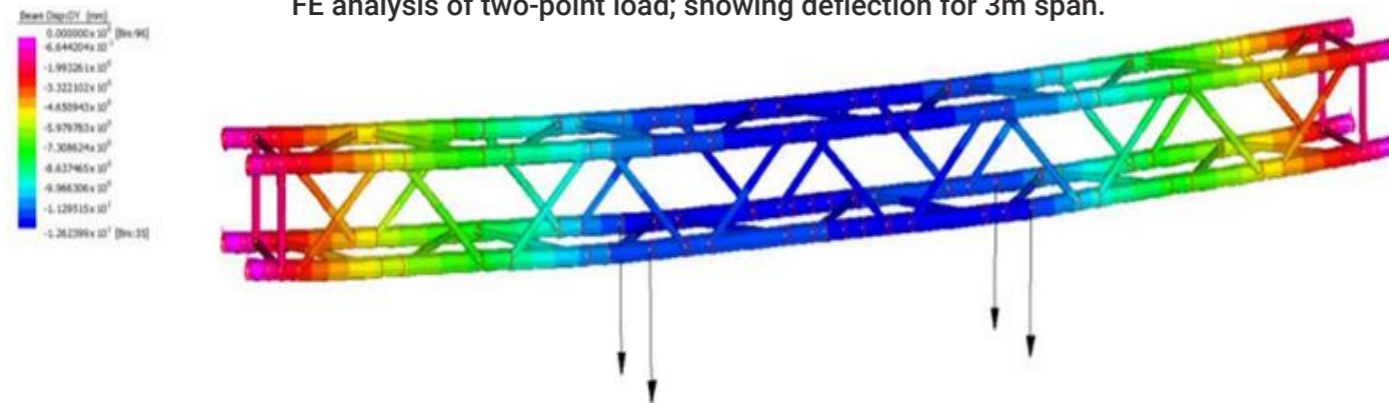
# Finite Element Simulations

With the physical tests out of the way the team went digital. USQ's engineers used software & test data to create Finite Element Simulations (FEA). Their FE analysis focused on lighting truss systems under bending & subjected to concentrated (point load) and distributed loading conditions. These truss system simulations modelled horizontal (3-12m) and vertical (1-6m) spans.

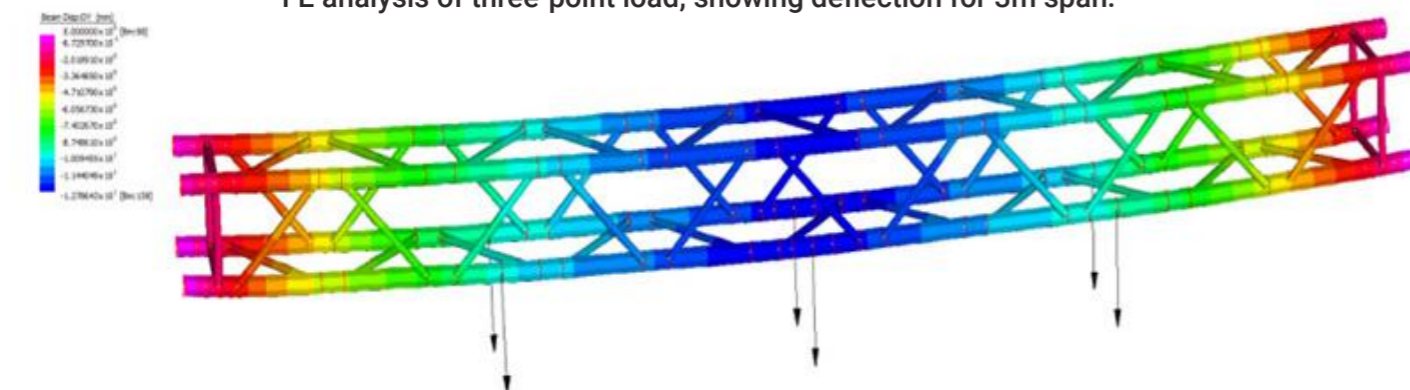
FE analysis of centre point load; showing deflection for 3m span



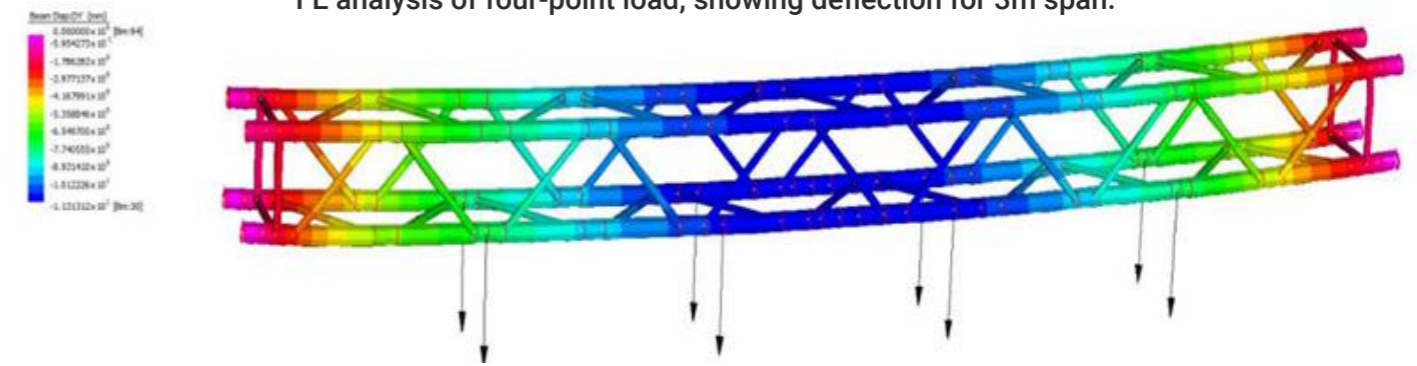
FE analysis of two-point load; showing deflection for 3m span.



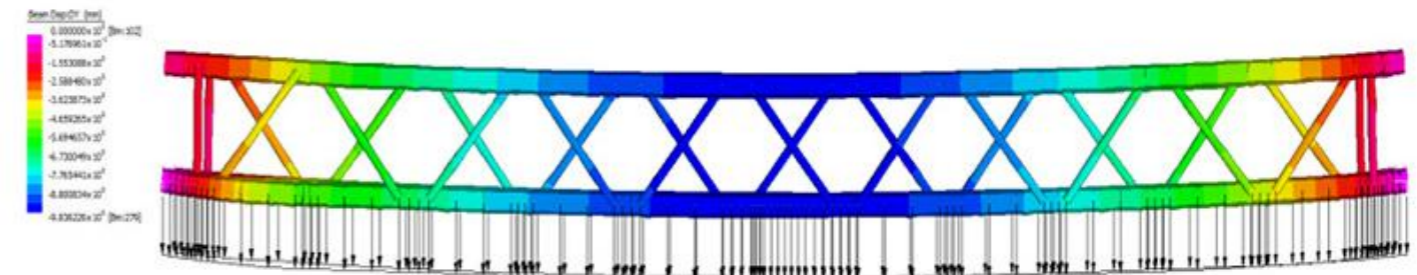
FE analysis of three-point load; showing deflection for 3m span.



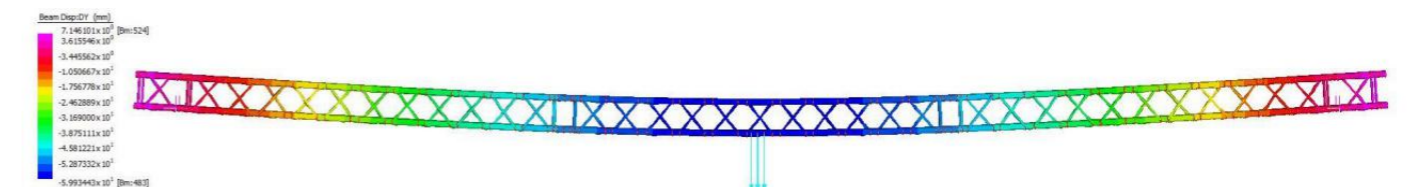
FE analysis of four-point load; showing deflection for 3m span.



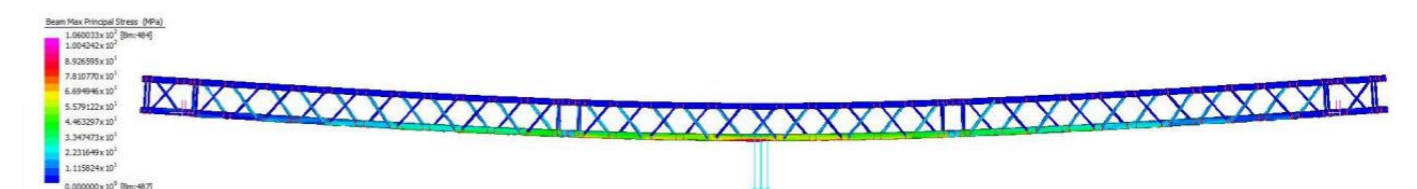
FE analysis of Uniformly Distributed Load (UDL) showing deflection for 3m span.



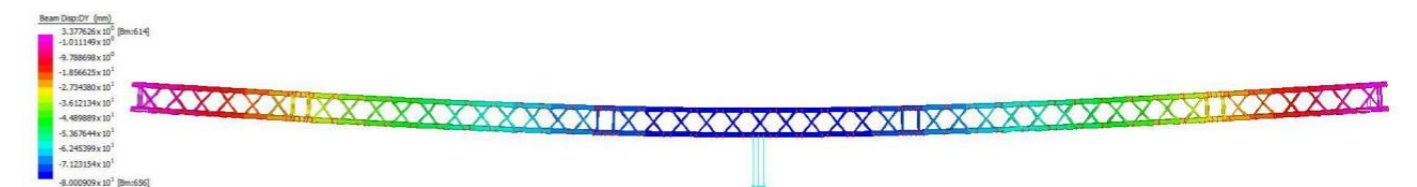
FE analysis showing deflection for 9m span.



FE analysis showing stress for 9m span.



FE analysis showing deflection for 12m span.

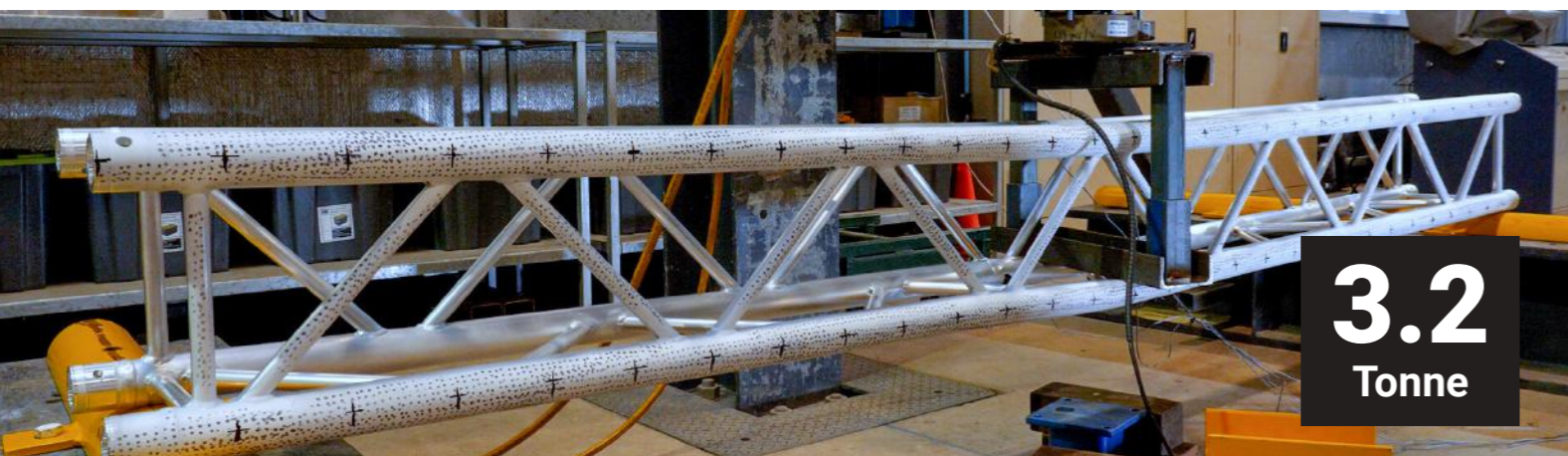




1 metre length - Compression test of Titan AV 290 box truss



2 x 0.5 metre - Compression test of Titan AV 290 box truss



3 metre length - Destructive test of Titan AV 290 box truss



2 x 1.5 metre pieces - Destructive test of Titan AV 290 box truss

## Structural behaviour of truss systems

This project validates the structural performance of Titan AV lighting truss through experimental investigations and finite element simulations.

VFM Group would like to thank the University of Southern Queensland and the Australian Government Department of Industry, Innovation and Science for their expertise and collaboration.

In sharing this project, we hope to improve the safety and use of lighting truss in Australia. The project may also suggest new designs and materials to enhance the structural and load bearing capacity of truss in the future.

### Put your trust in a truss by TitanAV

At the end of the day these results prove the strength and quality construction of Titan AV truss. For peace of mind, USQ engineers have calculated a minimum 1.5 factor rating into truss load tables. So you can build Titan AV truss structures safe in the knowledge that it's tried and tested.

If you'd like to learn more, head over to our blog at [vfmgroup.com.au/blog](http://vfmgroup.com.au/blog). There you'll find photos and behind the scenes footage of USQ's engineers testing truss. Plus, watch every destructive test in full.



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