ITC INFOTECH

Business-friendly Solutions

Design of Experiment for Crush Can Development using Simulation

EXECUTIVE SUMMARY

Safety is a primary concern in today's world - whether it is personal, financial or community oriented. One of the biggest drivers of safety concerns which directly impacts day to day life is the world of automotives.

When considered in its most raw version, it is unsurprising that a box composed of metal and plastics travelling at speeds higher than 40 miles per hour, is going to be a cause for deep concern for everyone involved both in and around its periphery.

Over the last few decades, the onus on engineers has increased considerably to build cars that can not only drive at incredibly high speeds, but also provide extensive safety features.

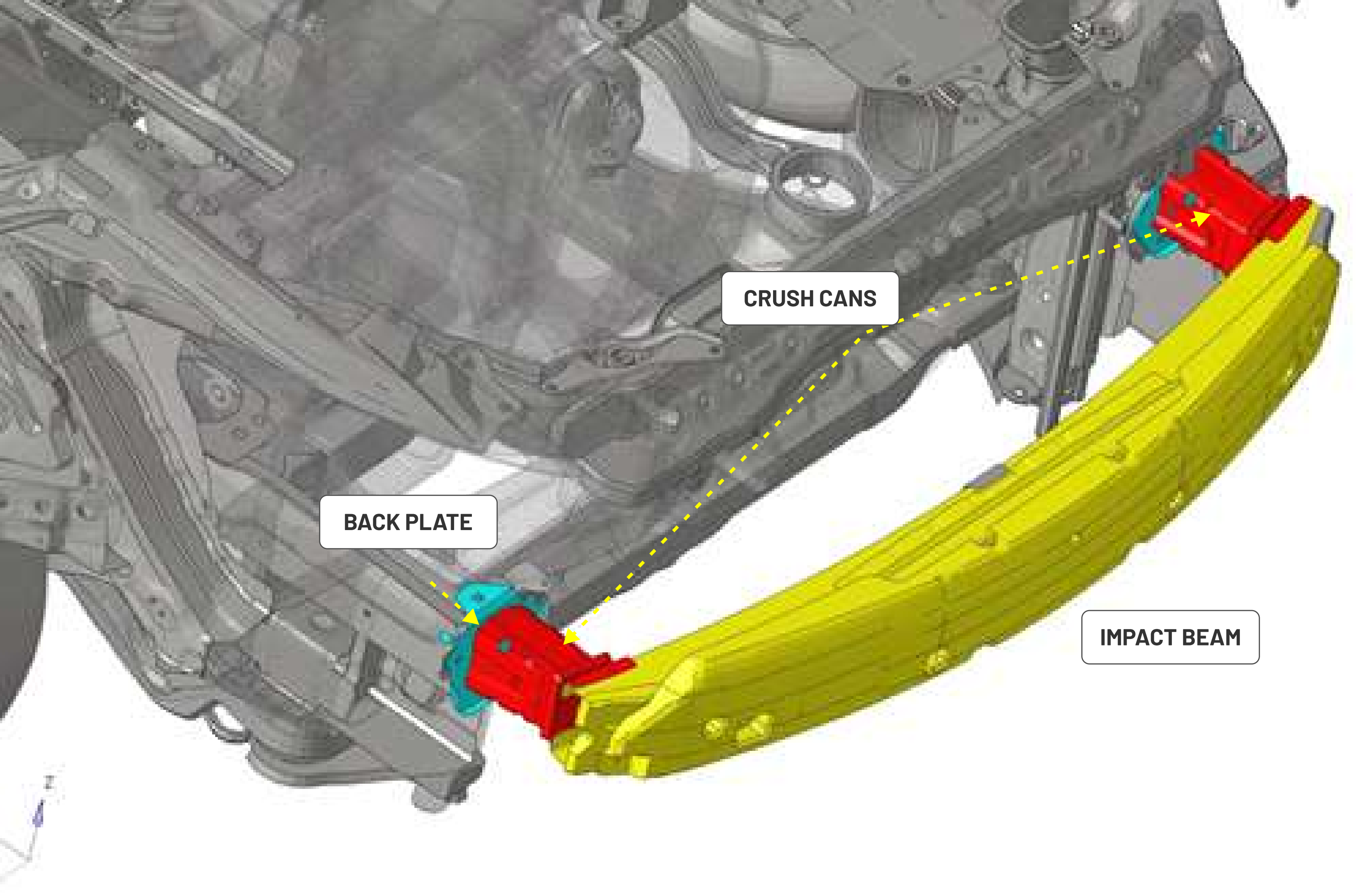
There are innumerable areas that can be improved, however the yardstick for safety constantly evolves as well. Apart from active and passive safety systems, the crash worthiness of a vehicle itself is one of the most important factors to be considered in the safety domain.

CRASH SYSTEMS BASICS

Frontal crash system of a vehicle includes various countermeasures aimed at energy absorption, dissipation, and also channeling energy away from the occupant region. It takes into account components such as impact cross beam, crash beams, longitudinal members, crash Cans, crash foams etc.

RESULT OF SIMULATIONS

In a series of simulations, after perfecting the crash cans for their maximum usage as a load bearing component, the final product achieved behaved with the desired crush pattern featuring pre-requisite energy absorption. The factors which influenced the simulations were – thickness of the cans, material family and geometric changes. Other changes incorporated included introducing notches.



A CLOSER LOOK AT THE CHANGES INTRODUCED

Originally, the full frontal simulation for front crash system yielded very low absorption in terms of energy(KJ) and the load path travelled further than expected, with larger volume of energy still left to be dispensed. Section forces were extracted in the load path parts in order to gain a comparative idea about the requirements of energy absorption. Based on these inputs, a strategy was introduced to mitigate the problem at hand.

SOLUTION APPROACH

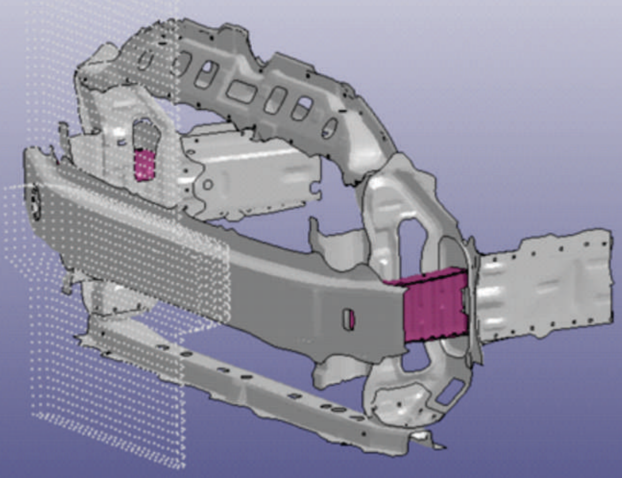
A DoE was carried out which included varying parameters with subtle modifications. These included:

- Thickness
- Material graded
- Mesh pattern
- Minute geometrical deviations
- Introducing enablers, notches and triggers
- Revisiting geometrical shape.

WHY THE EXERCISE WAS CRUCIAL

The crash management systems - both front and rear, along with the impact foams form the crux of the defense system against the onset of impact. They are essential in facilitating crash energy absorption and minimize plastic deformation to underlying critical parts.

The parts that constitute this system undergo controlled, progressive local deformation themselves, impeding intrusion in the compartment. They also channelize energy away from fragile, relevant parts to structural, crushable components, thereby promoting accurate energy absorption.



THE METHODOLOGY THAT WAS IMPLEMENTED

Crush cans were selected for the test, out of all individual systems – as they were easier to manipulate, yet they had maximum impact in elastic energy absorption. Full frontal impacts with rigid wall and deformable barrier were performed with DOE parameters in various permutations/combinations, building on the incoming results. The table below signifies how two sets of parameters are pitted against each other.

	DOE	Parameter B	Crush Can Geometry Updates						With Foam	With reinforcement	with multi chambers	Integrated Crush Box	Impact absorber
Srl	Parameter A		ITR01	ITR02	ITR03	ITR04	ITR05	ITR06	ITR07	ITR08	ITR09	ITR10	ITR11
1	Thk 01												
2	Thk 02												
3	Thk 03												
4	Thk 04												
5	Mat Update 01												
6	Mat Update 02												
7	Mat Update 03												

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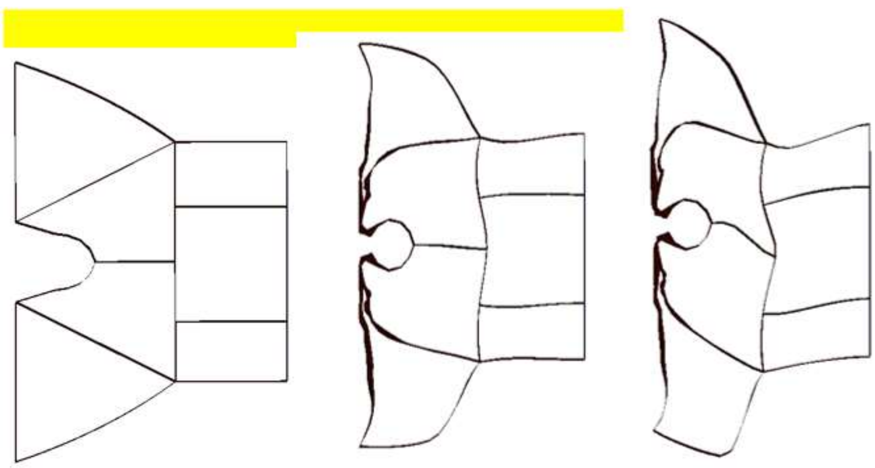
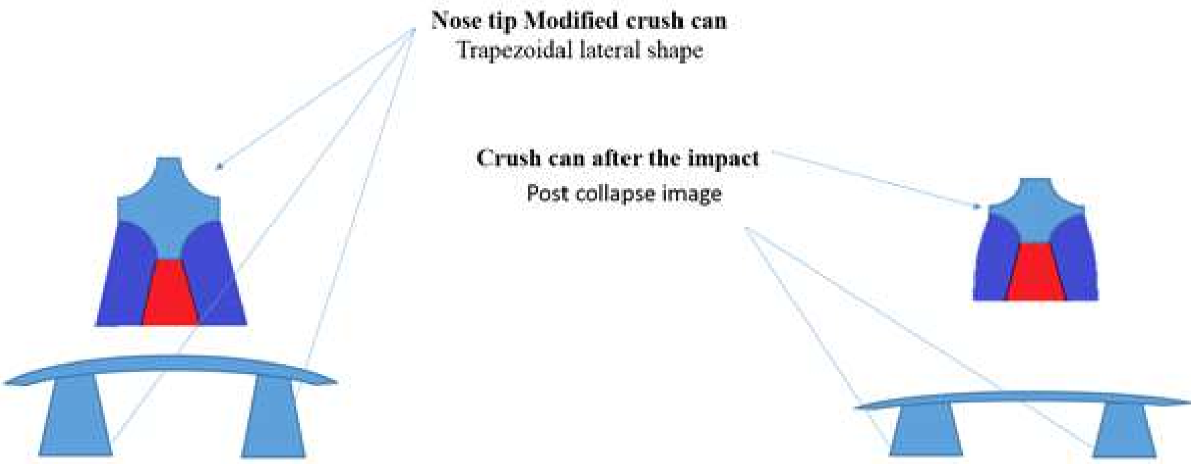
The following images depict iterations from a random DOE series.

ITR XYZ with multi chambers

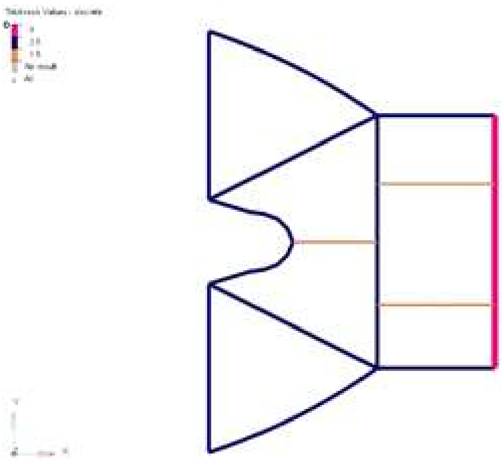


At t=0 **At t=0.5T** **At t=T**

ITR ABC with Modified nose tip



ITR MNQ with thickness variation



THE ROLE OF SOFTWARE

Altair Hyperworks 2017 was predominantly used for this DOE as a preprocessor and postprocessor.

Hypermesh 2017 was very flexible in incorporating changes. Hyperview and Hypergraph were extensively used for gathering and tabulating outputs with chosen filters.

LS Dyna was the base solver for this dynamic explicit analysis which is considered one of the best available for large deformation-small time event. MPP which invokes parallel processing on multiple CPUs was incorporated to shorten the simulation time.

CONCLUSION

With growing concern over vehicle safety, this method is changes the design of crush can without an actual change to the physical model.

It provides us a variety of design options along with their deformation patterns and hence selection of the right design becomes easy for a designer.

Because of this design of experiments, the designers and analysts get an idea about the crush pattern for future studies and different vehicle variants. It saves a lot on the cost of testing and the turnaround time.

By effectively leveraging simulation techniques, engineers were able to generate their desired outcomes, without compromising performance or safety.

AUTHOR

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Amit Kashyap is a mechanical Engineer with 8+ years of experience in vehicle crashworthiness using various explicit codes like LSDyna, RADIOS etc. Has worked extensively on crashworthiness of full vehicle simulation for ECE and FMVSS regulations and automotive sub-systems like Instrument Panel, Seating systems and chassis systems. Has key competencies and working experience in finite element analysis, safety, crash analysis, static structural analysis, BIW safety simulation and forming simulation. He has worked with domestic and international customers like Tata and European OEMs.