

C&U Bearings

The evolution of bearing development:

Using Romax Spin for democratized bearing simulation



C&U produce over 1.5bn bearings every year, and provide their customers with a world class resource for bearings that deliver best-in-industry quality and value. They serve a wide variety of markets from automotive to wind, household appliances, construction equipment and mining, with a range that includes over 30,000 bearing styles ranging from 1.0mm ID to 6000mm OD.

The C&U group has a strong global presence, employs over 19,000 people, and has demonstrated consistent growth, exceeding 3.0bn USD revenue in 2020. C&U Americas is based in Michigan, and supports Canada, Mexico and US customers with sales, distribution, and technical analysis and testing.

C&U offers both a full catalogue of industry standard bearing types and part numbers as well as fully customized designs, developed interactively for the customer's specific needs. In both cases, C&U's global engineers support the customer to ensure successful use in their application. A specific product on which C&U is focused is wheel hub unit bearings. Angular contact ball bearings are typically used for these applications, since they offer an ideal combination of life, rigidity, and efficiency. Wheel hub unit bearings allow the rotation of the vehicle's wheel, tire, and braking surfaces while supporting combined radial and axial tire patch loads.



Client

C&U Americas are a subsidiary of C&U Group, one of the top 8 bearing manufacturers in the world and the largest bearing producer in China.

Challenge

Finding a unified process for the development of non-uniform angular contact wheel bearing units, without relying on developing custom code which can be difficult to maintain and hard to use.

Solution

A workflow incorporating Romax Spin for dedicated, application-specific bearing analysis.

Benefit

A democratised process which allows even non-expert users to get the required results, and which moves bearing analysis earlier in the design process.

Steven Chinitz, Senior Engineering Manager for Wheel Bearings at C&U, comments: “One of the challenges with custom bearing design, and particularly with wheel hub unit bearings, is to develop and implement a globally common process for customized bearing designs.” Traditionally, vendor-specific design and analysis tools are developed to analyse double row angular contact bearing sets, using statics, Hertzian contact stress/deformation analysis and equivalent load bearing life tools to calculate contact stress, life, etc. The first step is to gather vehicle parameters combined with vehicle duty cycles to develop a design duty cycle. Next, the duty cycle load, with the help of the custom design and analysis tools, are iteratively resolved to gain static equilibrium. Those results are then used to evaluate bearing life, life adjustment factors, contact stresses and contact patch overhang etc.

“However, building home-grown tools to complete this process takes a long time,” Chinitz continues. “That’s why we turned to Romax. They have dedicated tools which are designed to run these applications and solve these problems – and they do it really well. Why reinvent the wheel? Ultimately, we use Romax instead of home-grown code or other software tools for a few reasons. Firstly, because it performs reliable and accurate bearing analysis. Secondly, because it is very fast and flexible when it comes to using different options for modelling and analysis. For example, calculating different versions of life modifications and stress calculations using home-grown tools requires coding changes, but in Romax, we simply tick a different box. Thirdly, we can consider details which are simply not

feasible in traditional code, such as the effect of housing and shaft flexibility on the system. Bearings are often asymmetric, and bodies can be somewhere in between rigid and flexible. With homegrown tools, it’s difficult to predict this, but with Romax it is very easy to do. We have observed good correlation between our own tools and the results we get from Romax, showing that we can use Romax for these analyses; it is just as accurate and much, much easier. Overall, Romax significantly facilitates our bearing design operations.”

Building a democratized process

However, whilst C&U saw the benefits in using Romax as part of their process, they still had challenges relating to the particular bearing application. Chinitz explains, “Wheel bearings have just enough inherent idiosyncrasies that it’s easy to get things wrong, either when defining the input loads or modelling the double row system. We ended up solving this with a template model of a double row angular contact wheel bearing analysis, in order to remove ambiguities in the process, and an Excel based pre-processor, in order to consistently translate customer inputs for use in the Romax template model. It’s harder to make user errors when you are following a fixed template. These methods ensure consistent translation of the wheel bearing application into Romax, and reduce the risk of user input error. The objective of this was to establish a global standard process, and to enable people with little Romax experience to still build correct models.”

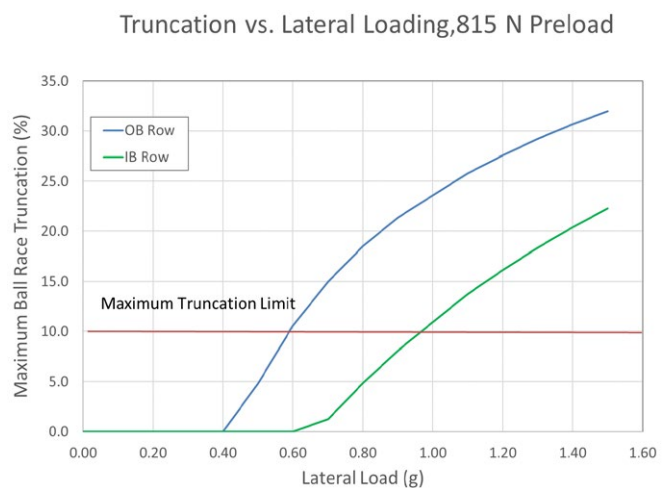
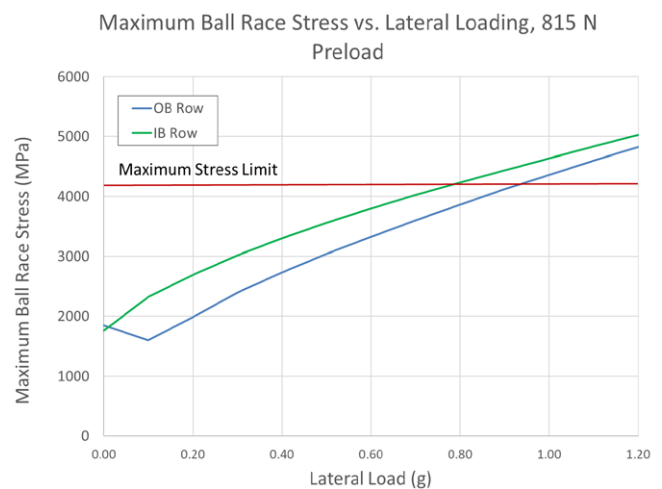
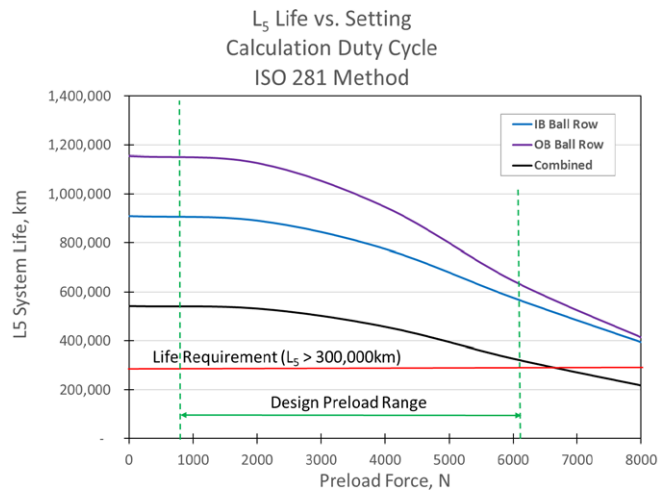
The Excel pre-processor performs the weight transfer calculations to determine the tire patch-based duty cycle, and then a complete input deck is exported to load in to the Romax model. This standardised input format includes both the bearing design details, the wheel bearing application details, the vehicle parameters, and finally the duty cycle. C&U use Romax to do the overall layout, build and position the shaft, power components, and the bearing (two individual angular contact ball bearings, one for the outer row and one the inner). Romax is then used to resolve the bearing system and do the system analysis, to give the equivalent loads, life adjustment factors, and other outputs. The lubricant and appropriate contamination code and EP additive information is added and the dynamic load rating is performed. Two duty cycles are used: the first has no loading and is just to validate the preload results, the second is used for the gearbox assembly in its real application.

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Senior Engineering Manager for Wheel Bearings,
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Once the system is modelled and analysed, C&U prepare their reports: the Romax Bearing Data report for a record of the current bearing input information; the ISO 281 and ISO/TS 16281 Summary and Details report for the bearing life results; and the Bearing Advanced Analysis Summary report for the detailed bearing analysis results, truncation and stress analysis. Chinitz explains, “Typically, we use a combination of these three reports, and combine them together into a concise tabular format. We are looking into using Romax’s custom reporting feature to get from Romax results to the reports we want to use within a presentation more quickly.”

C&U output from Romax the following information, typical areas of focus for wheel bearing analysis: resolved row radial and axial loads on each of the two bearing rows, deflections of the bearing rows, system angular deformation/stiffness, life, contact stress, contact patch truncation (variety of life models depending on the conditions of interest), and life versus preload (the model may be rerun at various preload steps, to generate a graph of life vs preload). C&U can then use this information to create graphs including: bearing preload vs life, bearing stiffness, contact stress vs vehicle turning acceleration, and contact patch truncation at each of the 4 rolling element to raceway contacts within the bearing vs lateral (i.e. turning) acceleration.



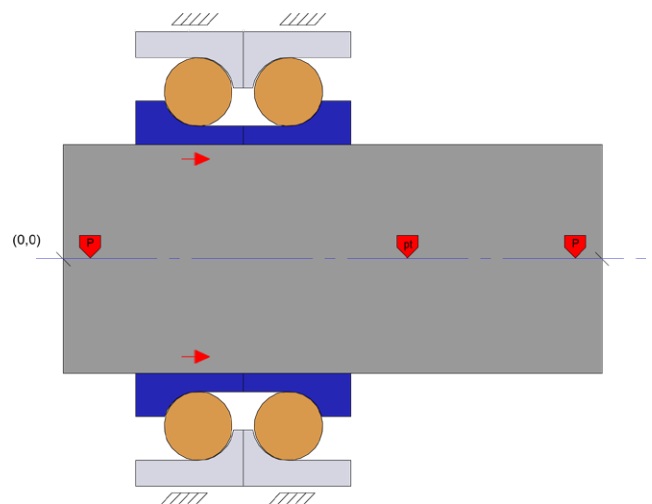
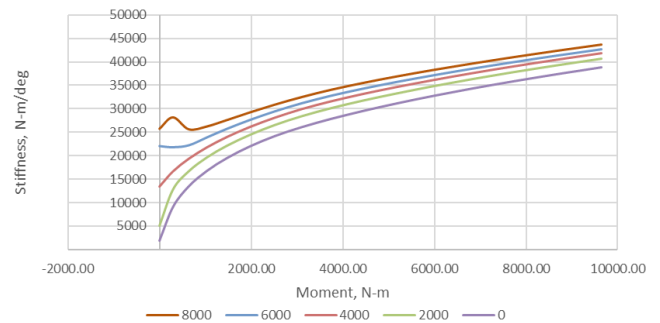
The Romax value

Chinitz explains, “Specialist commercial tools such as Romax Spin have proven themselves to be a very worthy investment since they mean we can avoid developing and relying on custom code. Using them, we have developed a process which ensures proper coordination between the product design expert and the Romax expert. We can easily compile the data we need to give to the Romax user, which leads to more robust, well-defined workflows and improved communication and collaboration across our teams. Ultimately, this has enhanced our design process: it moves us out of estimation, towards doing real design up front, rather than having to re-design when it can be too late.”

Now that C&U have established this process, they are looking to ways to enhance and increase their use of Romax software. One avenue they are exploring is the potential to automate their usage of Romax, considering batch running using Excel. They are also looking at using Romax’s custom reporting capability, to come up with a consistent template and style for reporting post-processing. Finally, they are considering trialling more capabilities, for example using Romax efficiency modelling for wheel bearing applications and exploring the modelling of asymmetric systems.

Chinitz concludes: “The new aspects which we are exploring with Romax will help improve our output and delivery to customers, make our processes more efficient, and, potentially, improve the accuracy of our simulation. By including deformable asymmetric FE housings, we hope to more closely simulate the actual application conditions of the wheel bearing. We look forward to working with Romax on these in the coming months.”

Moment vs Stiffness for Various preloads (N)



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Our technologies are shaping production and people-related ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

Hexagon’s Manufacturing Intelligence division provides solutions that use data from design and engineering, production and metrology to make manufacturing smarter. For more information, visit hexagonmi.com.

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