High Speed Rails Research Report

These days, companies are working to upgrade trains by means of retrofitting them. Metro-North has become one of those companies failing to modernize their railway system. New technologies, such as high-speed trains, require implementation on a whole other level. The entirety of the railway transportation system will not change without high-speed rails. According to an article from Business Insider, Amtrak, The National Railroad Passenger Corporation, has developed high-speed trains that are ready to be used in 2021, but they are not expected to go much faster. Automatic braking systems cause significant slowdowns, along with the wear-and-tear of the existing rails. In addition to constant slowdowns, the rusting of the old tracks causes dangerous chemical emissions. Our team did extensive levels of research to determine the best model and implementation of high-speed rails for the Metro-North. We utilized ballastless rails to create the optimal high-speed rail model for the Metro-North.

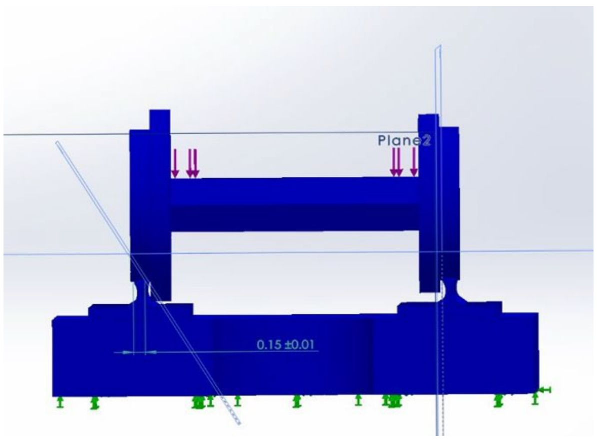
We created a 2D model of both ballastless and ballasted tracks with AutoCAD to compare their structures. The major difference between the two is that ballasted track is made of ballast and sub-ballast, while ballastless tracks are made of asphalt and cement. A large issue with ballasted tracks that high-speed trains create a wake behind them; the wake can displace gravel onto the track and cause damage. Furthermore, choosing harder stones to prevent this raise the maintenance cost significantly. It was very clear that using ballasted tracks for our implementation of high-speed rails were not going to work. It was at this time that we decided to continue our model using ballastless tracks. Next, we created the 3D model of ballastless track with SolidWorks to observe it closer and run some motion study. Using the dynamic study, we saw that the axle would fail before the rail did. In addition to the dynamic study, the factor of safety model was constant throughout the track, deeming the ballastless track suitable for the Northeast.

Ballastless tracks are not widely implemented in the United States' public transport but experiments and implementations in Europe show that ballastless tracks are more expensive upfront but save on maintenance costs. The experimental rails in an experiment conducted in the 80s proved that the ballastless rails succeeded in reducing maintenance in all situations except two (Hanna 7). Reducing the maintenance is the reason for implementing the tracks because over the lifespan of the railway, it will lower the costs of maintenance. This is a great thing for the rail companies because this means they divert less of their budget to the rail maintenance and can instead focus on other improvements or lower fare costs. Although the experiments showed problems, they were explained by the inadequate construction which cut corners by not using a proper subbase and incorrect fastening to cause cracking (Hanna 7). This shows that the failures of ballastless track are not from its design but rather from incorrect construction that causes the issues. The other tracks built correctly did not show the problems of cracking and breaking down. Ballastless track technology proved itself to be reliable and strong by showing success in experiments.

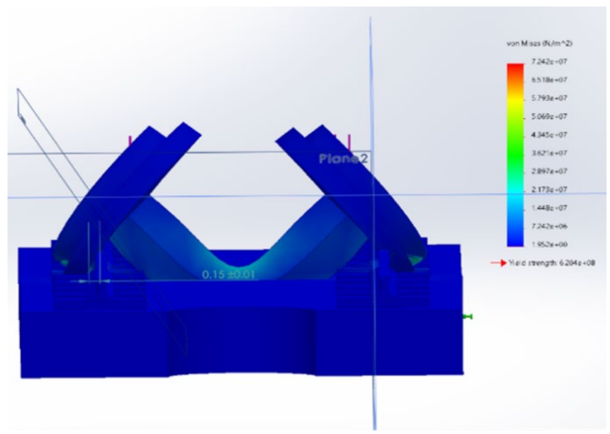
Another important aspect of public transportation is the cost to operate. Ballastless tracks cut away the maintenance of replacing ballast, replacing ties, and surfacing the rail (Hanna 8). By removing all the important maintenance that normal ballasted rails go through, ballastless track proves to need much less maintenance. This reduces operating costs by both reducing delays from maintenance and directly reducing the costs to maintain the tracks. The design itself allows for more loads placed on the track and the track has better tolerances (Système de voie sans ballast.) This is what allows the track to support higher speed trains and since it has better tolerances, there is less grinding from the train wheel which means it causes a reduction in the needed maintenance. Historically, some ballasted track designs had problems with cracking but RailOne has resolved this problem in the RHEDA model by removing the trough (Ballastless Track Systems). This shows that the technology is still developing and the durability of these ballastless rail systems are improving. Reducing maintenance and costs to build the rail are very important to incentivize companies to start using these rails for public transport.

£260m contract covers all the cost of London’s railway for West Midlands Phase 1 and West Midlands – Crewe Phase 2a (HS2 slab track contract awarded). This shows that the installation of ballastless high speed rail is more economical than thought since it only costs them 260 million pounds to pay for a massive portion of London’s railway. The MTA got approve for a 52-billion-dollar capital plan and allocated 1-2 billion to Metro North which means that they allocated a sizable portion for improving Metro North (MTA). According to the MTA, they spend about 50% of their $17 billion budget every year for just paying workers and labor related expenses (MTA). These factors make it favorable for the MTA to consider switching to ballastless tracks so that they can save money on maintenance. Ballastless tracks offer reduced maintenance so the MTA can avoid delays and spend less money on repairing the tracks. The tracks also are affordable for the MTA as proven by another major population center, London, being able to afford implementing them.

The 3D model was created to simulate a train axle and wheels over a section of ballastless track. The static nodal stress model had force applied directly over the axle evenly to simulate a load created by a train. The axle is approximately 5x the diameter as the width of the rail. The von mises forces and most of the deflection occurs in the center of the axle. There are about 2.17x10^7 N/m^2 of this force in the center of the axle. It shows that the track is very strong, and that the axle of the train would fail before the track would be overloaded. The model on the left shows the factor of safety and everything in blue indicates a factor of 1. This means that none of the track is susceptible to failure. The 3D modelling showed that the ballastless track is very reliable and able to sustain loads more than it will meet in real world scenarios.



Factor of Safety



Static Nodal Stress Test

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