Eschede derailment investigation report

ewpage Root cause: broken wheel bead History background \start{wrapfigure}[11]{r}{0.35\textwidth} \centraling \vspace{-\intextsep} \includegraphics[width=0.35\textwidth]{files/Eschede/02_MonoblockWheel.jpg} \{Monoblock wheel} \end{wrapfigure} The wheels of this ICE had a new design. On June 2, 1991, the ICE project was launched. One of the objectives of the cutting-edge project is to achieve a new standard in luxury and ride quality for its passengers. The train has solid steel wheels known as single-lock wheels, but Deutsche Bahn, the company that runs ICE, soon runs into trouble with them: Shortly after the trains went into service, they discovered they had a technical problem: the wheels were using in a strange pattern. When this happened, especially when trains traveled at high speed, noise and vibration were generated and transmitted to the passenger car. @documentary:seconds_from_disaster The wagon where this was most evident was the restaurant wagon where the plates were shaking and the glasses were pouring. The problem of vibrations and noise has seriously affected ICE's reputation for comfort. Two months after ice's prestigious launch, under pressure to find a solution, Deutsche Bahn decided to replace its original single-lock wheels with duobam wheels. Monoblock trandicional duoblock wheel or one-piece wheel is made of a single solid piece of steel, but a duoblock or two-piece wheel has an inner wheel surrounded by an outer bedeave. Among sandwiches are rubber sections designed to help absorb vibrations and provide a smoother ride. On August 31, 1992, Deutsche Bahn approved the type 064 duoduated wheel for use on its ICE trains. The new wheel instantly improves the ride and glasses and sauces no longer shake and rattle in the dining car. { } Metal fatigue The wheel edge has completely fractured a metal fatigue. Fatigue occurs when a movement is repeated repeated repeatedly causing a stress break at a metal weakness. A wheel on a train actually flexes slightly as it rotates because of the massive load that is under support for the moving train. These movements are tiny, but the constant bending of the metal can eventually, given sufficient use, cause the destruction of the wheels through metal fatigue. With a duoductal block wheel there is a rubber layer between the wheel and the bean. Soft rubber allows the outer bee to flex much more than on a monoblock wheel. As the separate edge wears off through use, the flexion increases. Without close inspection, the wheel ring can become very thin and a small defect can become a crack that eventually fractures causing the outer bead to separate from the inner wheel with devastating results. Metal fatigue fractures on train wheels usually develop over months or years. Inadequate tests of wheels by Deutsche Bahn After the the wheel in question is taken to the Fraunhofer Institute for Structural Structural and System Reliability (LBF) in Darmstadt, Germany for forensic testing. We studied press releases from the District Attorney's office (Staatsanwaltschaft Lüneburg) and Deutsche Bahn AG, both consisting of expert comments and testimony. The Fraunhofer Institute LBF Darmstadt (sister of FHG-IZfP, NDT Institute of Fraunhofer Saarbrücken) presented 300 pages of expert testimonials and another 300 pages of literary references. \begin{wrapfigure}[9]{r}{0.3\textwidth} \centraling \vspace{-\intextsep} \includegraphics[width=0.3\textwidth]{files/Eschede/01_Fraunhofer.jpg} \caption{Fraunhofer Institut} \end{wrapfigure} A crack inside the wheel ring was responsible. There was no indication of material or production failure. This crack was caused by excessive load and wear. When ICE began operations, there was no certification in place that documented the proper design and reliability. Furthermore, no mechanical fracture calculation was made that could prove the strength of the wheel during its lifetime. According to experts, such wheels should not be operated less than 880 mm in diameter (new condition = 920 mm), subject to annual testing for internal and medium cracks. (An important fact of the NDT!) The diameter of the wheel of the accident was 862 mm. The limit set by Deutsche Bahn is 854 mm. We interviewed prosecutor Jürgen Wigger, who explained that the wheel in question was first put into operation in 1994 and ran 1.8 km until the accident in June 1998. In terms of assessing the liability for the accident, it is significant that during its 4 years of operation, the wheel has never been tested. @website:ndtnet Findings released by the Fraunhofer Institute suggest that poor design and insufficient testing were to blame for the accident. The rubber padded wheels, which had been successfully used on trams, were not suitable for the heavier load of ICE trains operating at much higher speeds. At the time, Germany did not have facilities to properly test such projects, so many of the wheel design decisions were based on analysis and theory rather than test data. The limited tests that were done did not count on the dynamic and repetitive forces that result from prolonged wear, extreme loads and high-speed operation. @nasa:safety_message:derailed The response given to the investigation team by Deutsche Bahn: instead of relying on special metal fatigue detection equipment, it turns out that engineers at deutsche bahn's maintenance facility in Munich were conducting safety checks on ICE's wheels with nothing more advanced than a flashlight. The use of torches will only choose the largest and most dangerous of the cracks. He will not choose small fatigue cracks at an early stage of his life. In terms of detecting possible cracks in the inner side of the edge of a double block wheel is a technique Useless. @documentary:seconds_from_disaster Deutsche Bahn's Munich Depot engineers were also carrying carrying some tests with their high-tech test machines, but the data was considered unreliable because the equipment constantly came with the error messages (false positives). The workshop where the inspection was carried out was equipped with ultrasonic equipment to check the wheels for cracks. There, the train underwent a measurement at 6 km/h. In principle, this equipment allowed the discovery of cracks not visible to the eye because a superficial fracture would reflect sound. However, this equipment was insane for two reasons. First, i could only detect cracks in the tread. It was not possible to detect cracks arising from within, a distinct pos-sibility certainly given the second mechanism explained above. Worse was that the equipment was so sensitive that, in addition to raising an alarm when it found cracks, it also did so for innocuous irregularities on the surface. This resulted in almost 20% of the wheels tested falling into the replacement needs category. This was impossible given the pressure of time in the workshop. That's why the wheels were tested the old-fashioned way: eye (with a lamp) and ear. The latter method consisted of hitting the wheel with a hammer and evaluating the sound of the wheel. However, it is unlikely that this method, often used on block wheels, would be suitable for this type. The rubber ring against which it is pressed muffles vibrations in the steel tire. An obvious conclusion is that no suitable test equipment was present. In the week leading up to the crash of the Eschede train, the wheel that would have become the cause of the accident was highlighted as defective in three separate automated checks. Flawed problem reporting process \begin{wrapfigure}[9]{r}{0.33\textwidth} \centralization \vspace{-\intextsep} \includegraphics[width=0.33\textwidth]{files/Eschede/05_MetalFatigue.jpg <3> <5>} \caption{Metallic fatigue} \end{wrapfigure} The on-board computer maintenance reports of the crashed train contained reports two months before the accident: drivers and other train employees are large up to eight separate complaints about the unusual noise and vibration coming from the bogie that carries the faulty wheel. Deutsche Bahn did not replace the wheel. The single-lock wheels have been used for 40 years, but Deutsche Bahn's duoblock wheel is a new design and has never been used on a high-speed train before. In fact, duolocks are traditionally found in one of the slowest mobile forms of rail transport: the tram. In July 1997, almost a year before the Eschede train crash, the company that runs the tram network in the German city of Hannover discovers dangerous cracks of metal fatigue occurring on its duodofio block wheels, even if they are running at speeds of only 24 km/h. They decide to change the duoblock wheels more often before metal fatigue has a chance to develop. The train hires the other rail operators who run on the wheels of the duo block to inform them of the problem of metal fatigue and is a simple solution. In autumn just months before the accident they notified Deutsche Bahn. According to the tram company, Deutsche Bahn said it had no problems with metal fatigue. It was later revealed that the institute had informed DB management as early as 1992 about its concerns about possible wheel tire failures. It soon became evident that the dynamic repetitive forces had not been accounted for in the statistical failure modeling made during the design phase, and the resulting design lacked an adequate safety margin. The following factors, neglected during the project, were noted: The tires were flattened into an ellipse as the wheel wheel rotated through each revolution (approximately 500,000 times during a typical day in service on an ICE train), with corresponding fatigue effects. In contrast to the monoblock wheel design, cracks can also form inside the tire. As the tyre became thinner due to wear and tear, the dynamic forces were exaggerated, resulting in crack growth. Flat spots and ridges or waves on tires have dramatically increased dynamic mounting forces and very accelerated wear. [@wikipedia:en:eschede; @documentary:seconds_from_disaster] Page 2 You cannot currently perform this action. You signed up with another tab or window. Recharge to update your session. 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