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Tilting Train Technology

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Abstract: *As a train goes into a curve, it produces substantial centrifugal force towards the outside of the curve. By tilting the train, this centrifugal force is balanced by a force into the inner curve and passenger discomfort is reduced. Modern tilting trains allow operators to achieve higher speeds on existing curved routes without costly track improvements or the need to consider completely new high-speedlines. Signals from an accelerometer that measures train speed and curvature are analyzed by a computer, which tilts the individual cars as the first car goes onto the curve. Tilting Train consists of tilting mechanism that enables to increase the speed on regular tracks. In the upper part of tilting trains that is in which the passengers are seated can be tilted sideways. During the motion of the train if the train has to steer to left in a left turning the coaches of the train will be tilted to the left in order to compensate the centrifugal push to the right and conversely during the right turn.On every type of tilting trains, the tilting systems shall perform three main functions: first, they have to identify accurately and without delay the initial position of curve transitions, then second, they have to tilt the car body according to the tilting algorithm provided for the system and finally they have to verify that the provided amount of tilt corresponds to the tilt demand..*

Keywords: corrosion, crack width, crack depth, crack frequency, chlorides, carbonation

I. INTRODUCTION

A train and its passengers are subjected to lateral forces when the train passes horizontal curves. Car body roll inwards, however, reduces the lateral acceleration felt by the passengers, allowing the train to negotiate curves at higher speed with maintained ride comfort. Trains capable of tilting the car bodiesinwards in curves are called tilting trains. Tilting trains can be divided in two groups: the naturally tilted trains and the actively tilted trains Natural tilt relies on physical laws with a tilt center located well above the Center of gravity of the car body. In a curve, under the influence oflateral acceleration, the lower part of the car body then swings outwards. Active tilt may have car body center of gravity and rotation center at about the same height. This form of tilt does not normally have an impact on the safety of the train, since the center of gravity does not essentially change its (lateral) position. Active tilt relies upon control technology involving sensors and electronics and is executed by an actuator, usually hydraulic or electric, without actuation there is no significant tilt action. The first tilting train in regular public service was the 381 series electric multiple unit train operated by Japanese National Railways (JNR), which entered revenue service from 10 July 1973 on the Shinano limited express between Nagoya and Nagano on the Chūō Main Line. This technology was not fully implemented worldwide, as the marginally increased curve speeds did not justify the extra expense and technology in many cases. The British Advanced Passenger Train (being operational from 1984 to 1985) was the first to successfully implement active tilt, enabling significantly increased speeds on tight rail curves.
Active tilting is the mechanism most widely used today

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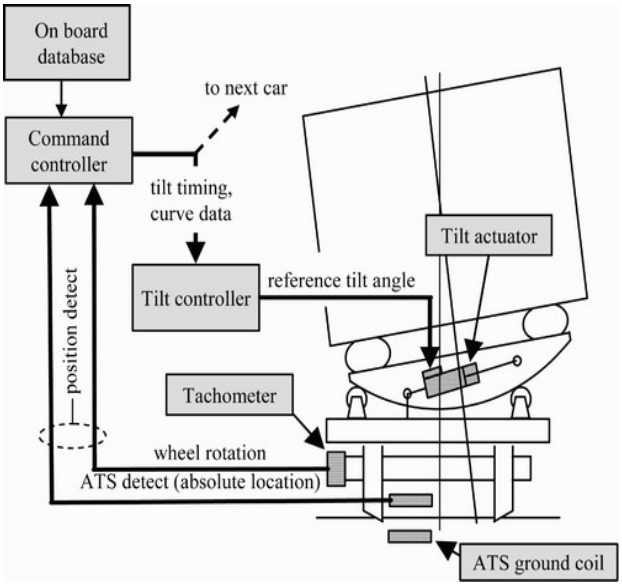
II. HELPFUL HINTSTS

WORKING:-

Fig.. shows how this solution is applied to control natural tilt. An on board computer stores data and the location of the curves. The control system is able to start the tilting motion before entering the curves by means of preview control using the on board database [5]. This reduces the tilting delay significantly and thereby also the low-frequency lateral acceleration that may otherwise cause motion sickness in sensitive passengers. Modern tilting trains are profiting from state-of-the- art signal processing which sensesthe line ahead and is able to predict optimal control signals for the individual carriages. Complaints about nausea have by and large become a thing of the past. Some tilting trains run on narrow gauge railways. In Japan there are many narrow gauge lines in mountainous regions, and tilting trains have been designed to run on these. In Australia the service between Brisbane and Cairns by the QR Tilt Train claims to be the fastest narrow-gauge train in the world, running at 160 km/h (99 mph)



a. Advantages of Tilting Train

- The control system is very simple if needed at all.
- Inverse tilting cannot occur.
- The system is simple and reliable.
- The system has low initial and maintenance costs.
- Running time benefits.
- Speed setting for good comfort and low risk of motion sickness.
- The choice of tilting as function of track cant and cant deficiency.
- Control of car body rolls motions.

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• Track geometry guidelines.

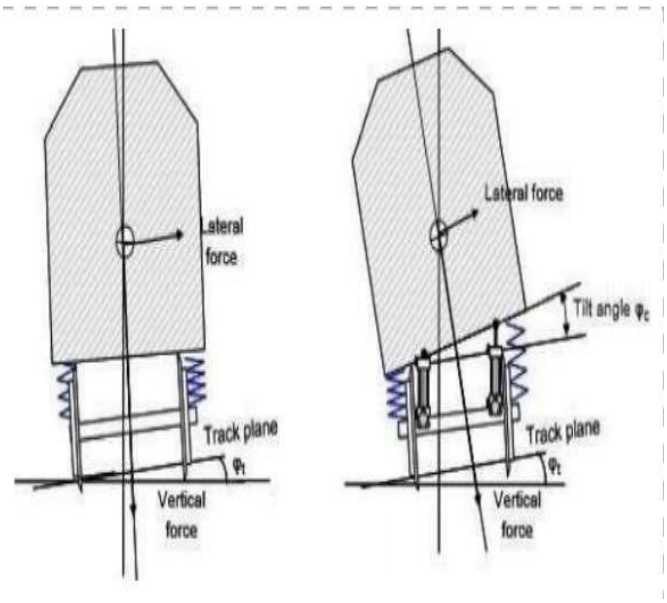
b. Disadvantages of Tilting Train

* Tilting train technology has more expensive in the absence of other technologies.
• The lateral movement of car body lower section reduces the possible car body width where it is most needed.
• The high position of the rotation centre gives a lateral movement of the car body mass centre, which increases the risk of overturning.
• The car body's moment of inertia will delay the tilt motion.
• A low-frequency lateral acceleration, caused by imbalance between track plane acceleration and the compensation by tilting will thus appear in transition curves.
• This low-frequency lateral acceleration may be both uncomfortable and motion sickness inducing

III. PRINCIPLE

The basic principle of tilting trains is to roll the car body inwards during curve negotiation in order to reduce the lateral acceleration perceived by the passengers". Working Principle of Tilting train A train and its passengers are subject to centrifugal forces when the train passes horizontal curves. Roll inwards reduces the centrifugal force felt by the passengers allowing the train to pass curves at enhanced speedwith maintained ride comfort.

Trains capable to tilt the bodies inwards is often called tilting trains. The tilting trains can be divided in two groups; the natural tilted trains, and the actively tilted trains. The natural tilt relies on natural laws with a tilt center located well above the center of gravity of the car body. On a curve, under the influence of centrifugal force, the lower part of the car body swings outwards. It should be noted that natural tilt has a negative impact on safety due to the lateral shift of center of gravity of the car body.



The active tilt relies on active technology, controlled by a controller and executed by an actuator. Thebasic concept of tilting trains isthe roll of the vehicle bodies inwards the curve in order to reduce the lateral force perceived by the passenger.

IV. CONCLUSION

• Although tilting mechanisms are expensive in the absence of other technologies.
• The minimum time taken by a train from Mumbai to Madgaon is 9h 20m.

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• "Tilting Trains will result in being able to cover the Mumbai - Madgaon distance in seven hours. This can further be brought down if steep curves are realigned in a tilting manner."
• Tilting train has an important role in high speed and safe railway transport system.
• Hopes that tilting train mechanisms will be a part of Indian railway service in near future.
• High speeds can be achieved by tilting mechanism to reduce journey time with excellent comfort, safety and satisfaction by innovative technological aspect of Tilting Trains.
It is possible to give some conclusions on how the risk of motion sickness shall be limited in tilting trains.
These conclusions can be given despite lacking knowledgeof the main cause to motion sickness.
• Tilting Trains cause more motion sickness than non-tilting ones. The largest differences are vertical acceleration and roll velocity. Minimizing the roll angle will not only limit roll velocity, but also vertical acceleration. However, reduced roll angle may be in conflict with requirements on comfort (increased quasi-static lateral acceleration).
• Car body tilting has today become a mature technology accepted by most operators, but not favored by many. There are different reasons behind this fact that non-tilting trains have increased their speed in curves, reducing the potential for travel time reduction by tilting trains to approximately 10 - 15 %. The attractivenessis also impacted by low reliability and motion sickness on certain services. The risk of motion sickness and the running time benefit compared with nontilting trains are addressed in the present study

REFERENCES

[1]. "New study shows how to eliminate motion sickness on tilting trains", IcahnSchool of Medicine at Mount Sinai, August 2011
[2]. Rickard Persson, "Tilting trains Enhanced benefits and strategiesfor lessmotion sickness"
[3]. K. Sasaki, "Position Detection System Using GPS for Carbody Tilt Control" , Quarterly Report of RTRI. Volume 46No 2, pp 73-77, Japan, 2005
[4]. International Railway Journl
[5]. UIC – High Speed Division - First Report on Tilting Train Technology –
[6]. The state of Art – Paris, June 1998.
[7]. M. Testa – R. Roberti – Requirements on Infrastructure Maintenance and TrackGeometry By Higher Curving
[8]. Speed – UIC- UNIFE-ERRI Interactive Seminar, Paris May 1999.
[9]. F.Cheli – G. Diana – F.Resta – Numerical model of a Tilting Body Railway Vehicle
[10]. Switzerland Technical Research Institute- Switzerland Projects
[11]. https://www.irjet.net/archives/V4/ i12/IRJET-V4I1296.pdf
[12]. https://link.springer.com/article/10. 1007/s40864-015-0007-8
[13]. https://en.wikipedia.org/wiki/Tilting_ train
[14]. https://www.researchgate.net/ publication/279501934_Tilting_trains_ Technology_benefits_and_motion_ sickness
[15]. https://www.scribd.com/document/ 86512428/d8
[16]. https://www.scirp.org/reference/ referencespapers?referenceid=398244