## Research Achievements

# Management System for Long Tunnels

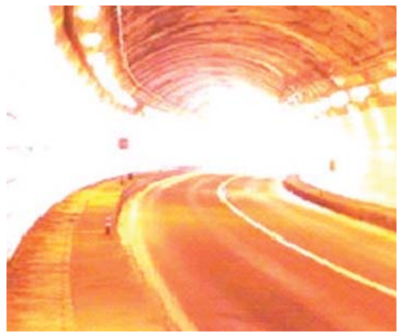
- **Project title :** Management system development for long tunnels based on DAT(Decision Aids for Tunneling) technique
- **Project researcher :** Jun-S. Lee
- **Research periods :** December 6, 2002 ~ December 5, 2005

**Introduction**

The main objective of the proposed research area is in developing a management system for very long tunnels based on DAT(Decision Aids for Tunneling) technique. During the three-year period for the project, we get to set up essential database on various geology, time and cost data which will be applied to the long tunnel in the course of construction. In addition, various simulation techniques on the geologic uncertainty of the tunnel route are also developed based on limited information of the core logs.

**Applications**

- Decision aids for best alternative tunnel route based on time/cost calculation with intrinsically uncertain geologic conditions (DAT technique can be currently visualized on web-based software as well)
- Tunnel management system during excavation
- Digitalized tunnel excavation process (3 dimensional VR & PDA S/W)



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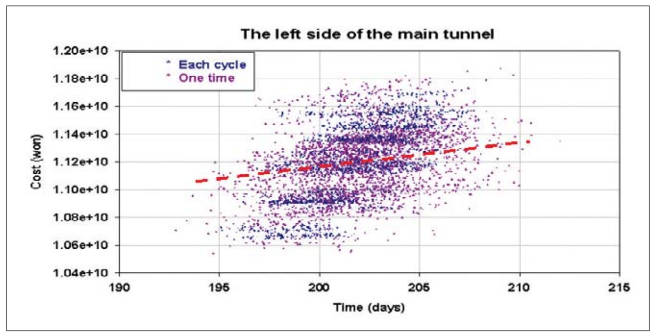


<Tunnel simulation with DAT technique>


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# Korean Rail Technology


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## Dr. Ki-Hwan Kim wins 'Young Engineer Prize'

Dr. Ki-Hwan Kim, head of High Speed Rail Engineering Corps of KRRI won a Young Engineer prize, considered to be one of the most prestigious awards in the field of science and technology. Awarded by the National Academy of Engineering of Korea(NAEK), the 9th awards ceremony was held at the Shilla Hotel, Seoul on March 10.

Dr. Kim's exemplary work on the development of Korean High Speed Rail that set the record speed of 352.4km/h last December was highly recognized and led to the authoritative prize. His relentless performance of a wide range of activities has been going on for eight years now since 1999 to achieve the major breakthrough in the railroad industry.

He also played a key role in the nation's selecting top 10 national projects in 2003 organized by the Ministry of Commerce, Industry and Energy. Moving a step ahead, a proposal has been submitted to the high speed rail project in Florida of the U.S. in an effort to forge into overseas markets.

Designed to discover and support distinguished engineering technicians, the prize was instituted in 1997 by the NAEK.


## Welcome to KRRI and the Korean Rail Technology

Today, the railroad technology is riding on a fast track along with the rapid-shifting development of other industries. I believe that Information sharing and mutual understanding of technology in general may well be the key to growing together amidst the eye-blinking era we live in. And this newsletter of Korea Railroad Research Institute is now born in an effort to meet the global and future demands of the industry. I hope our new approach with this publication helps readers better understand the Korean railroad technology based on our research and development activities. To move a step forward, I am anticipating that KRRI gets associated with other organizations on the same wavelength across the world.

Nam-Hee Chae Ph.D.
President KRRI

NEWS


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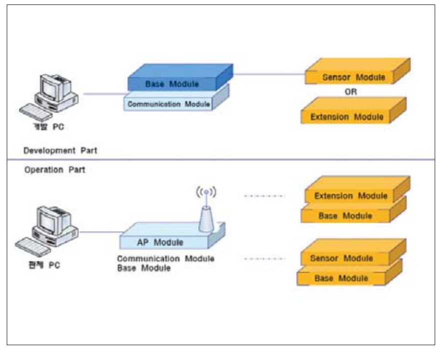


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## 01 KTX observes 1st anniversary

On the event of the 1st anniversary of the KTX operation, KRRI cohosted a commemorative ceremony with Korea Railroad at Lotte Hotel on April 8. Under the major theme of "KTX operation for the past year and the future of the Korean railroad", the international event attracted as many as 200 rail experts who had a heated discussion at the seminar in a bid to set directions toward the future of the railroad industry.
Yamada Hideyuki, principle consultant of Nomura Research Institute in Japan commenced the event with his presentation titled "Shinkansen effects on regional economy" where he underlined that the bullet train does not guarantee regional developments, on the contrary "it could bring about economic ebb of a town given the Straw Effect kicks in (high speed train reduces journey time and functions of small cities get absorbed into big ones)", he added. As an exemplary case, he compared two cities of Kagoshima Prefecture and Kumamoto Prefecture in which both GDP figures stand similar.
Korea went through a spitting image of the case as Dr. Mun-Ku Huh with Korea Institute for Industrial Economics and Trade proved in his speech titled "KTX and regional economy". "While industry-condensed cities with mega economy ended up cutting down on costs of logistics, other regions failed to get benefits." he stressed.
Chun-Seh Lee, High speed rail project team leader of Korea Railroad described their plan to set up a rail network aimed at two hour travel time for any destination in the nation by the year 2020 when he spoke on "achievement of KTX and future plans." According to the plan, the 2nd phase of rail construction will be complete by year 2010 down to Busan and exclusive rails for Honam line will be laid by 2015 envisioning the construction of the so called "Iron silk road".
On the system stability and technology of KTX, Dr. Kyung-Yeol Chung with Korea Institute of Industrial Technology reiterated the importance of forming a special organization for maintenance check-up and overall control of the system.
Dr. Kang-Yun Choi with Korea Railroad Research Institute described the efforts KRRI has been making for smooth operation of KTX including technical consultation. He also promoted some of the projects going on of the institute which include HSR-350x, Light rail transit and Tilting train express.

## 02 KRRI celebrates its 9th anniversary

In commemoration of its ninth anniversary, KRRI is geared to put its independent technology on the front burner and help researchers make the utmost of their capabilities in performance and catch up with the fast changing rail industry.
On the same note, the institute organized a new group named " Prospective Railtech Technology Commercialization Engineering Corps". For the past nine years, KRRI has put forth recognizable and substantial achievements during the relatively short period responding to the fast shifting rail paradigm, said president Nam-Hee Chae during his speech marking the 9th anniversary of KRRI at Grand Hall of Korea National Railroad College. For specific accomplishments, president Chae took technical support for the KTX operation, successful speed recording of the Korea high speed rail HSR-350x and development of unmanned light rail transit adding that research individuals must keep their spirit up as a leader in his field.
He also underlined his initiative to boost the KRRI's role in safety issues by reshaping an investigation team into rail accidents and made sure of increased activities of joint meeting on rail technology associated with other rail organizations where members will bring the current rail issues together.

## 03 KRRI-KMU seal a deal

KRRI signed an agreement with Korea Maritime University on March seeking enhanced exchanges of research and education for the benefit of both parties.
Pursuant to the deal, the two organizations will collaborate on developing elemental technology of railroad and vessel with safety diagnosis technology. The agreement also contains exchange of experts, information and facilities. The joint research will also deal with the emerging issue of "development of logistics system on land and sea".

## 04 Kyunggi Business Administration tobrace "KRRI's USN for railroad"

"KRRI's USN for railroad" was selected as one of societies to be supported by Small and Medium-sized Business Administration of Kyunggi Province in 2005.
The research projects to be funded by the local government body include "development of USN-based intelligent monitoring system for air contamination and control system within subway stations" which are designed for wireless and commercialized measuring system of air quality.
Combined with IT technology, the project is aimed at wireless operation and developing a sensor network which enables a simultaneous control on 100 measuring points.
The two year project of wireless air quality measuring system, when complete, will be applied to subway stations, underground tunnels, buildings and garages at low electric power as below as three voltage.

## 05 KRRI rolls up sleeves to ensure subway safety

In joint cooperation with National Emergency Management Agency, KRRI conducted a special inspection on subway trains and maintenance status of line number 1 and 2 for the first time. The special check-up was intended to ensure the maintenance status of crucial parts of subway including control system and towing motors which could cause major glitches to the subway. Additional inspection has been made on the 20 year old specimen of 448 unit motors.
Safety performance certification center and Rolling stock research department from KRRI , nine depots under Seoul Metropolitan Subway Corporation and Korea Railroad took part in the safety campaign to make sure of stable motors and maintenance of each depot.

## 06 KRRI offers KTX check-up

Principal researchers Dr. Shin-Chu Yang, Sam-Young Kwon, Byung-Song Lee joined an inspection team on safety status of high speed trains from February 17 to March 3 where the three experts checked on the KTX car bodies and facilities.
The overall inspection campaign was headed by the Ministry of Construction and Transportation in an effort to ensure safety of the bullet train on tracks and to prevent any delays in operation. The special inspection force had been called on timed with the first anniversary of the KTX operation as of April 1. Led by Sun-Man Hong, director general in rail sector of MOCT and professor Sang-Hee Park with Yonsei University, the TFT comprises the total number of 20 specialists for operation, car body parts and facilities respectively.

## 07 17th Railroad Forum held

Amid 26 authoritative personnel in the railroad industry present including Dr. Nam-Hee Chae from KRRI and Dr. Yeon-Hye Choi, vice president of Korea Railroad, the 17th railroad forum was held at the Intercontinental Hotel on March 24. The speaker of the forum, Young-Chul Choi, director general of transportation and policy division of Ministry of Construction and Transportation made a speech on "Policy on construction and transportation 2005" in which he underscored focal projects of the year; establishment of rail network crossing north-south and east-west, enhancing reliability of railroad, promoting activities of a combined organization from government and private sector for railroad and rolling stock industry.

# Aiming the speed of 350km/h


Ki-Hwan Kim, Head of High Speed Rail Engineering Corps of KRRI (khkim@krri.re.kr)

**Opening a new era of high-speed train in Korea, we are bracing ourselves to gain a strong foothold in the global rail industry and we did it by developing Korea High Speed Rail(HSR-350x) with our independent technology and breaking the target speed of 350km/h last December 16. This major breakthrough took place followed by the commercial operation of the KTX on April 1 of the same year. We believe that our experience and know-how gained from the development of HSR-350x and the construction of the Kyungbu High speed rail shall be the foundation for the prosperity of the Korean rail industry. In this article, we would like to describe a brief history of the "High-speed rail technology development project" which started in 1996, continued with the first test run on August 19, 2002 and highlighted by the successful run at 350km/h.**

## Start of the trial running

After the completion of series of factory tests, the HSR-350x was transported to Osong-depot on June 28, 2002 in hopes of being tested side by side with KTX trains. At that time, the depot was very busy because KTX trains were running on the test track between Daejeon and Chonan everyday and the construction work was almost done. The HSR-350x finally received permission to run on the test track on August 19, 2002. We would like to express gratitude to those concerned at KNR and KR Network for having given us the chance despite the unfavorable conditions.

During the first year, test running of the HSR-350x had been conducted during nighttime or on Saturdays when there was no commission of KTX trains. Dedicated measurement equipment was built to obtain a variety of data, which were indispensable in monitoring the performance and safety of the HSR-350x. The measurement data were used to fix problems detected found during test running, and the speed of the train increased step by step to reach 300km/h on August 1, less than one year of the 1st running. However, we had to go through some glitches before we accomplished 300km/h. Faults in the battery charger prevented the train from departing for the test. The program for "Anti Slip Slide" of the braking system had not worked properly which resulted in abrasion on the wheel. Major maintenance activities, such as the replacement of the suspension system due to the rolling of the power car and fault correction in motor blocks, were required to make the train ready for the test run.

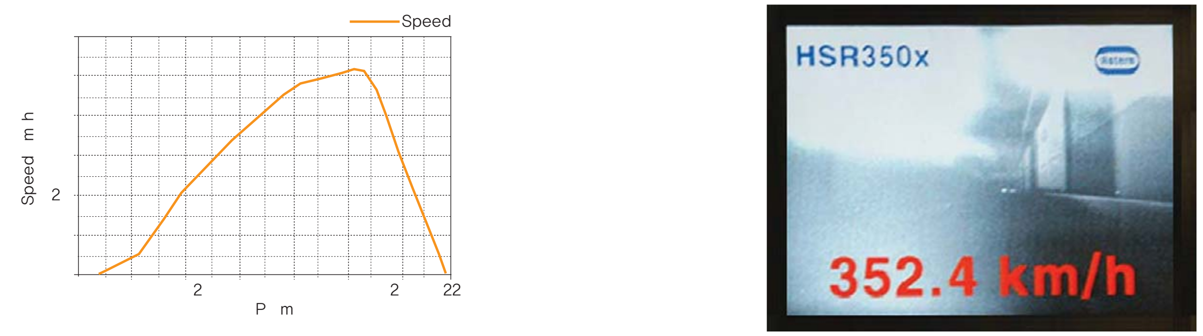


Fig . Speed of HSR-350x at the test section

## Preparation for 350km/h

We needed cooperation with KNR for trial running beyond the speed of 300km/h. The HSR-350x reached 340km/h at night on November 23, and waited 3 more weeks to pick up speed. We had to prove the safety of infrastructures as well as that of the train set. For this purpose, we reviewed documents and reports regarding bridges within the test section to examine the LFT(lateral force transmitter) and pad shoes. Finally we received permission for the 350km/h trial running from KNR. The test was scheduled for the night of December 15, and the test track was selected between Chonan and Osong. We had only one chance for the 350km/h trial on the south-bound track.

Worse yet, it was not easy to secure sufficient distance for braking and accelerating because of the rain fallen during that afternoon. Under all these circumstances, however the HSR-350x finally reached the maximum speed of 352.4km/h at 1:24 am on December 16, 2004. Everyone went "hurrah" and cheered each other at the historic moment of the achievement.

After achieving the target speed 350km/h on its test, measurement data had been analyzed to ensure the running stability, performance of the pantograph, stability of the track and bridges, and the ATC signal. Results showed the safety of the HSR-350x and superiority of its technology.

## Conclusions

The HSR-350x has been developed and tested with our independent technology which gave Korea an honor to possess the 4th fastest train in the world. Now we are trying to build more reliable high speed systems based on fundamental technologies for the development of core components and the train set. With the successful development of a new generation high speed train, we are committed not only to putting the HSR-350x into practical use in Korea but also to venturing into the international market, including China and the Eurasian continent.

# Study on Strength Evaluation Procedure for Bogie Frame of Korean Tilting Railway Vehicles

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This paper has investigated the strength evaluation procedure of bogie frame for the Korean tilting train that is being developed in KRRI. In this study, the loading conditions imposed on the tilting train were derived and the static and fatigue strength of the bogie frame has been evaluated. In order to derive the dynamic loads according to the carbody tilting, the load redistribution effect by carbody tilting, the unbalanced lateral acceleration effect by high-speed curving and the tilting actuator force effect have been considered. Multi-body dynamic analyses have been carried out to evaluate the tilting load cases and the strength analysis has been performed by finite element analyses. From this study, the structural safety of the bogie frame could be ensured.

Keywords : Tilting train, Fatigue strength, Bogie frame, Unbalanced acceleration

## Introduction

The application of a tilting train is one of the most efficient ways to increase curving speed of train on existing tracks or on mountain railway lines with sharp curves. The tilting technology can make a train increase curving speed by rolling or tilting the vehicle body towards the center of curve, thereby reduce the steady lateral acceleration and ensure the passenger comfort and safety at the same time. Therefore, many countries have paid high attention to the development of tilting train. The tilting trains have been operating successfully in many countries such as Italy, Spain, Germany, Sweden, England, Japan and so on. The lateral acceleration felt by passengers in the conventional and the tilting train can be expressed as Eqs. (1)-(2).

Conventional train : $a_f = \frac{V^2}{R}\cos(\varphi) - g\sin(\varphi)$ ...... (1)

Tilting train : $a_f = \frac{V^2}{R}\cos(\varphi+\theta) - g\sin(\varphi+\theta)$ ...... (2)

In the Eq. (1) and (2), ($\varphi$ is cant angle [rad], ($\theta$ is tilt angle [rad], V is train speed [m/s] and R is curve radius [m].

There is no tilting train operating in Korea. Korea Railroad Research Institute (KRRI) is developing Korean Tilting Train eXpress (TTX). The TTX project has been developing all core technologies related to tilting train and infra-technology to establish vehicle system engineering of high speed inter-city vehicle with service speed of 180 km/h as well as maintenance-free technology for conventional railway system.

In general, the bogie of the tilting railway vehicle has to run under very severe operating conditions of tight curves and is subjected to the unbalanced load by the movement of the carbody weight.

In this study, the fatigue strength evaluation procedure for the bogie frame of TTX has been established. In order to achieve this goal, the strength analysis for the bogie frame was conducted in accordance with the international standard UIC615-4 for the conventional loads. The load cases for the consideration of the carbody tilting effect were established in this study. A multi-body dynamic analysis was used to derive the dynamic loads according to the carbody tilting. Then, the combined loads cases obtained by the UIC code and dynamic analysis were applied to the finite element model of the bogie frame and the fatigue strength was evaluated by Goodman diagram.

## Strength evaluation procedure for the bogie frame of TTX

### Bogie frame of TTX

Fig. 1 shows the bogie assembly of TTX. In the bogie of TTX, a tilting bolster is installed to support and tilt the carbody. The weight of carbody is supported by the cross beams of the bogie frame through the links. The carbody is tilted by the roll moment generated by means of a tilting system located between the bogie frame and the tilting bolster as shown in Fig. 2.

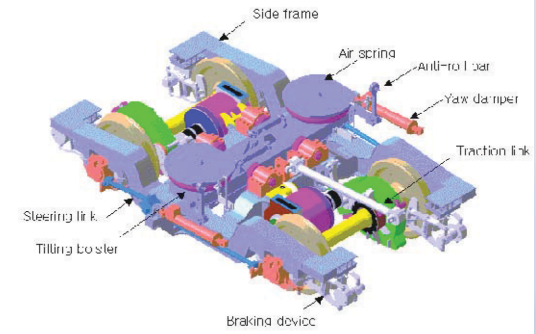



Fig.1 Bogie of TTX.

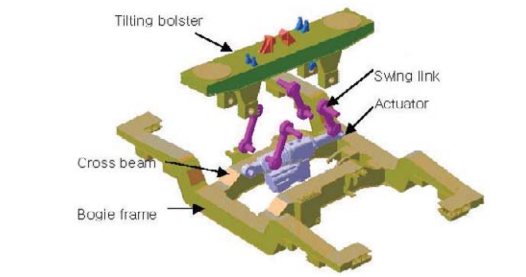
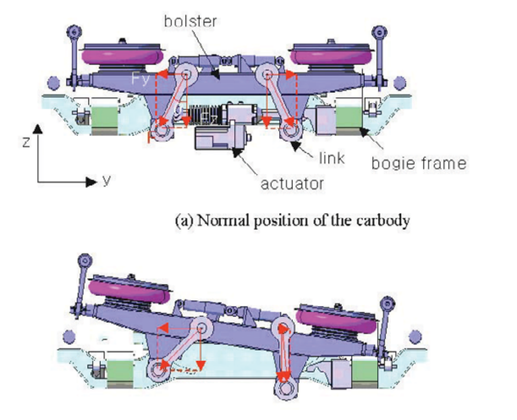



Fig. 2 Bogie frame and tilting mechanism of TTX.




(a) Normal position of the carbody

(b) Tilted position of the carbody

Fig.3 Link angle change according to carbody tilting.

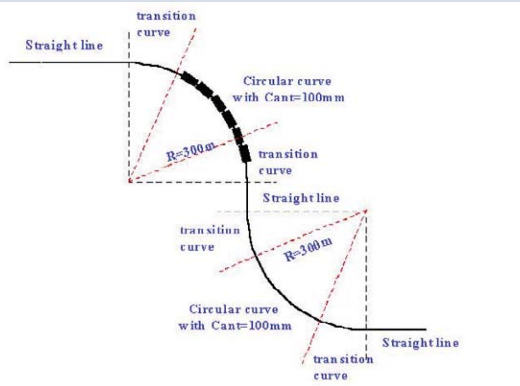



Fig. 4 S-curve track geometry.

There are several standards for strength evaluation of the conventional bogie frame such as KS R9210, JIS E4207, JIS E4208, UIC 515-4 and UIC 615-4. However, there is no standard for the bogie frame of tilting train. Therefore, a strength evaluation procedure for the bogie frame is established in this study. The procedure is as followings ;

1. Set the vehicle information
   - Train weight, motor weight, braking loads
2. Calculate the static loads for the non-tilting running condition
   - exceptional, main in-service and particular in-service loads based on the UIC615-4
3. Calculate loads induced by track twist
4. Combine the load cases for the normal running condition
5. Calculate the dynamic loads for the tilting running condition
   - set the track data and running conditions (position of CG, radius of curve, cant)
   - consider the effects of weight transfer, uncompensated centrifugal force and actuators force
6. Combine the load cases for the carbody tilting condition
7. Finite element analysis for these load combinations
8. Assessment of fatigue strength

The strength evaluation of the tilting bogie is undertaken in combination with the international standard UIC615-4 and the load cases to consider the carbody tilting effect. Because the carbody is seated on the bolster through the air springs, the weight of the carbody and bolster is supported by the cross beams of the bogie frame through the tilting links as shown in Fig. 3. Fig. 3(a) shows the normal position of the carbody. In the normal position (non-tilting condition), the left and the right tilting links are inclined to the vertical axis at 23 degrees.

However, the angle ($\theta$) between the left tilting link and the vertical axis are increased to 45 degrees while the angle between the right one and the vertical axis are decreased to 5 degrees due to carbody tilting of 8 degrees as shown in Fig. 3(b). Consequently, the forces that the links have to support also change according to the variation of the tilting angle.

### Main in-service load cases

Main in-service load case is designed to verify the absence of any risk of fatigue cracks occurring under the combined effect of the main forces encountered during service (vertical, transverse, track-twist). These load cases consist of different load scenarios subjecting bogie frame involving running of straight track, curve negotiation, rolling and bouncing effect and track twist. Table 1 lists the applied loads and the application areas. The load combination is composed of 17 cases.

Table 1. Main in-service load conditions.

| Name of Loads | Loads | Application area |
|---|---|---|
| Vertical load, $F_z$ | $\frac{g}{2n_b}$ $(m_v=1.2C_1-n_b m^{+})$ | link bracket |
| Lateral load, $F_y$ | $0.5(F_z+0.5m^{+}g)$ | Actuator bracket |
| Twisting load, $F_t$ | Track twist of 5‰ | Primary suspension bracket |
| Longitudinal load, $F_x$ | $\mu m_{axel}$ | Traction link bracket |

### Dynamic load cases

In addition to the conventional load combination for bogie frame, the dynamic load cases that can consider the carbody tilting are established. In case of the dynamic load, the following factors were additionally considered.

- Weight transfer from wheel to wheel across an axle by tilting
- Uncompensated centrifugal force by high-speed curving
- Driving force generated by the electromechanical actuators to provide the tilting action.

It is impossible that the three dynamic effects are considered by static state like the static load cases as previously mentioned. Therefore, a multi-body dynamic analysis was performed to evaluate the dynamic load using ADAMS. The most severe operating condition encountered during operation is to run a narrow S-curve (as Fig. 4) with the maximum uncompensated steady lateral acceleration of 2.0m/s2, the maximum tilting angular velocity of 4o/sec and the maximum tilting angle of 8 degrees. The actuator motion and the unbalanced lateral force can be expressed as Eqs. 3-4.

$$M_{act}(t)=\theta_{max}\{STEP(t,0,0,2,1)-STEP(t,4,0,6,1) -STEP(t,7,0,9,1)-STEP(t,11,0,13,1)\} \quad (3)$$

$$M_{act}(t)=0.2gW_c\{STEP(t,0,0,2,1)-STEP(t,4,0,6,1) -STEP(t,7,0,9,1)-STEP(t,11,0,13,1)\} \quad (4)$$

Here, $\theta_{max}$, g, STEP, $W_c$ mean maximum tilting angle, gravitational acceleration, step function and carbody weight.

The carbody tiling action not only lets the angle of the tilting links change but also makes the mass center of the carbody move toward inside of the curve as illustrated in Fig. 5. In Fig. 6, $\varphi$ and $\theta$mean the cant and tilt angle, respectively. The dashed lines from RC1 to RC2 and from CG1 to CG2 are the trajectories of the rotation center and the CG of carbody while tilting from 0 degree to 8 degrees. The maximum lateral displacement of the CG is 32.7mm. Fig. 6 shows the vertical force history imposed on the tilting links during the S-curve running. The resultant force ratio of the left and right link is 2.37 and 2.10 at each maximum tilting position.

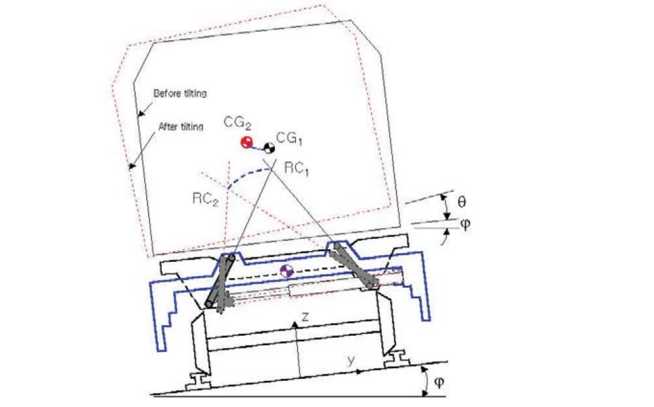



Fig. 5 Movement of the rotation center and the CG.

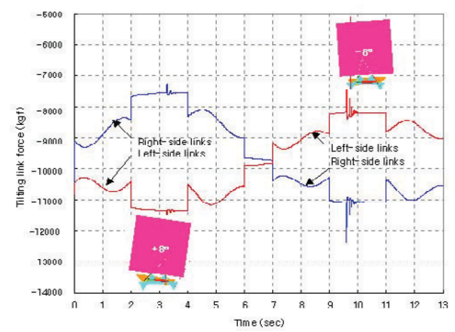



Fig. 6 Vertical load Histories.

## Results and discussion

In Table 2, the node 6367 has the maximum fatigue safety index. The maximum stress and the minimum stress can be found in the load case 15 and load case 12. The node 6367 is located in the welding area between the side plate of the side frame and the vertical plate.

Fig. 7 shows the static load test of the bogie frame under the static vertical load and the finite element analysis results. In the static load test, nineteen strain gauges were bonded on the bogie frame. For the verification of the finite element result, the longitudinal direction stresses ($\sigma$11) measured from the four-stress concentration points were compared with the analysis values as Table 3. From Table 3, it is clear that the experimental results are in good agreement with the numerical one. Fig. 8 shows the Goodman diagram for the main in-service load combination. The result of fatigue assessment for all node points revealed that the bogie frame satisfies the fatigue safety.

Table 2. Analysis result for the main in-service loads.

| Node number | Mean stress (kgf/mm²) | Stress amplitude (kgf/mm²) | Load case with maximum stress | Maximum stress (kgf/mm²) | Load case with minimum stress | Minimum stress (kgf/mm²) | Fatigue safety index |
|---|---|---|---|---|---|---|---|
| 6367 | -1.27 | 8.24 | 15 | 6.97 | 12 | -9.51 | 0.73 |
| 8255 | -1.79 | 7.88 | 3 | 6.09 | 16 | -9.66 | 0.69 |
| 4247 | 8.08 | 6.36 | 12 | 14.44 | 15 | -1.72 | 0.69 |
| 5992 | -0.88 | 7.72 | 14 | 6.84 | 13 | -8.59 | 0.69 |
| 4234 | 8.69 | 6.05 | 12 | 14.74 | 7 | 2.4 | 0.67 |
| 7895 | -1.42 | 7.44 | 11 | 6.02 | 16 | -8.86 | 0.66 |

Table 3. Comparison of the experimental and finite element result

| Gauge points | $\sigma$11 (kgf/mm²) | | Error(%) |
|---|---|---|---|
| | Experimental value | Finite element value | |
| 1 | -7.58 | -7.4 | 2.4 |
| 2 | -7.33 | -7.10 | 3.3 |


Fig. 6 Goodman diagram.

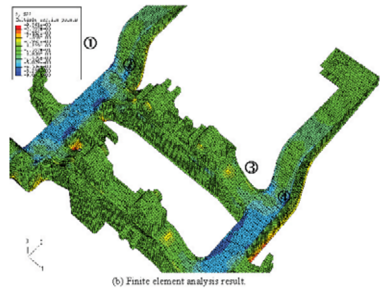



Fig. 7 The test setup and finite element results.

## Conclusions

In this study, the fatigue strength evaluation procedure for the bogie frame of the tilting railway vehicle has been established. The strength analysis for the bogie frame is conducted with combination of the international standard UIC615-4 and the load cases for the consideration of the carbody tilting effect. In case of the dynamic

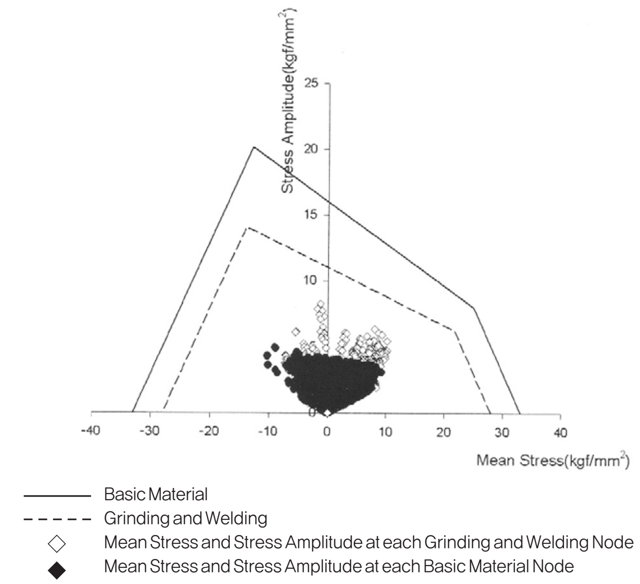



Fig. 8 Goodman diagram.

load, ①weight transfer from wheel to wheel across an axel by tilting, ②uncompensated centrifugal force by high-speed curving and ③ driving force generated by the electromechanical actuators to provide the tilting action were considered. By the dynamic analysis, the trajectories of the rotation center and the CG of carbody while tilting from 0 degree to 8 degrees could be investigated and the vertical and lateral force history imposed on the tilting links during the S-curve running were evaluated for the fatigue strength analysis. For all load cases of the exceptional load, the maximum stress values did not exceed the yield strength. It was clear that the experimental results were in good agreement with the numerical one. In addition, it was obvious that the bogie frame satisfied the fatigue safety under the main in-service and the particular in-service load combination. By the fatigue strength assessment with a combination of the tilting load cases and the main in-service load case, it was clear that the carbody tilting had no major effect to the fatigue safety because the actuator force always acts the way to relieve the deformation and stress concentration which generated by the vertical load.

## >> Light Rail Transit test track unveiled to prospects

Complete and opened to public last August, the light rail test track is attracting a series of visiting delegation from local self-governments of related technology sectors.

The unmanned AGT(automated guideway transit) boasts its ability to test respective functions of rolling stock, electric power supply, signals and track infrastructure providing a perfect site to illustrate the progress of the Korean Light Rail.

Starting with a group of investigators from Daegu Subway Headquarters in August, 2004 those from other regional bodies including cities of Kwangmeyong, Kimhae and Kimpo have made their technical tour to the site. Followed were delegation from Ministry of Construction and Transportation, Incheon Metropolitan Rapid Transit, Busan Urban Transit Authority and the press, Kimhae Light Rail Transit Association and Kimpo City Hall.

Having a ride on the test track, the visitors were keen on checking on reliability and safety of the transit system, construction costs and labor ensuring its technological and economical efficiency. As things stand, KRRI is doing what it takes in policy making and technical support to commercialize their new urban transportation means which has been developed to fit the Korean geography.

Supported by the Ministry of Construction and Transportation, KRRI buckled down on the unmanned AGT Light Rail project in 1999 and poured as much as U$50 million up to year 2005. The light rail vehicle has achieved 5,000km-distance on test track and has attained an international certificate report on safety and assurance test.

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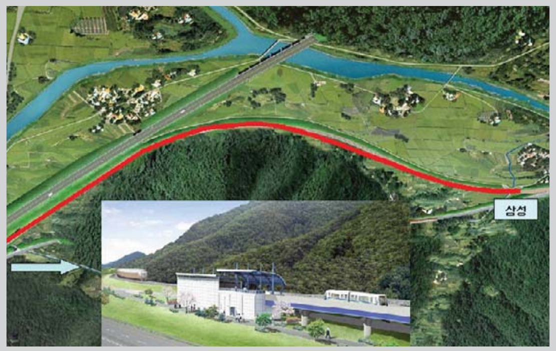

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1. The unmanned light rail transit AGT is running on test track constructed in Kyungsan, north Kyungsang province

2. Bird's eye view on the LRT test track located in Kyungsan, north Kyungsang province

## >> Urban Transit MIS up and running

Joined hands with Seoul Metropolitan Subway Corporation, the urban transit **maintenance information system** kicked off its exemplary operation on March 21 for first at the rolling stock depot stationed in Changdong and Jichuk.

The model operation was conducted to have an advanced information system applied to the field helps attain reliability with measures against occurring problems during the period. The system is initially designed to manage rolling stock and infrastructure of the urban transit in an efficient manner in order to improve safety, minimize life cycle costs and to take the most of economical efficiency.

The system is aimed at developing essential technology to the field teamed up with Seoul Metropolitan Subway Corporation for rolling stock and Seoul Metropolitan Rapid Transit Corp. for infrastructure.

## >> International conference on tilting train opens

The 2005 International Conference on "Railway Technology for Speed-up on Conventional Railroads" was held at Korail Human Resources Development Center on February 24 where as many as 500 people attended from the area of railroad including those from the Ministry of Construction and Transportation.

The tilting train experts gathering dealt with four main issues of technology; speed-up on existing railroads, weight reduction on train vehicles, control system of propulsion & train and tilting control and bogie systems followed by an introduction to various tilting trains currently in operation throughout Europe and their technologies amid the audience's great amount of interest. With a speech entitled 'Tilting trains in Europe', Dr. Ulrich Hachmann with Logomotive, Nuremberg in Germany brought the audience in the tilting technology applied to the European tilting trains along with the German ones now in operation. Aside from tilting trains at their max speed of 200km/h, issues on TGV-Pendulaire and AGV (Automotrice a Grande Vitesse) of France caught the limelight at the seminar where the tilting technology is applied to high speed trains of 360km/h.

Followed by Dr. Hachmann's speech came the KRRI's ongoing rail projects along with major achievements from concept and detailed designs of hybrid composite car bodies and 23m-long unit molding and manufacturing process.

Dr. Isabelle Blanc of Lausanne Institute of Technology of Switzerland delivered a speech on "Life cycle based environmental and manufacturing cost analyses of composite car bodies". Followed were speeches on "Technology for control system of propulsion and train" by Mr. Sang-Yong Kim with

Woojin Company, "Speeding up on conventional railways in Japan" by Mr. Asahi Mochizuki with Toshiba, Japan.

Concluding the event, issues were brought up on "Tilting actuation systems and tilting control systems", "Development of tilting bogie systems of Korean tilting train" by Extel System Wedel of Germany and KRRI respectively.