Damage Evaluation of Railway Structures Based on Train-Induced Secondary AE Parameters

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A difficult task for the maintenance of existing railway structures is to evaluate using non-destructive methods the structural integrity of invisible structures whose foundations are in the ground. If visual methods are used, it is generally necessary to excavate the subgrade soil surrounding the foundations. With railway structures this kind of excavation is impractical, because it is expensive and it may also affect the operational safety of trains.

If active inspection methods such as ultrasonic testing or X-ray radiography are applied to the foundations, the input power has to be strong enough to cope with the problem of the high damping effect of a concrete mass and soil around the foundations, which is also impracticable.

Therefore, we have developed a passive inspection method taking advantage of secondary AE (Acoustic Emission) generated in the sections of structures that may be subject to damage, which is induced by trains in service (see Fig.1). In fact, the train-induced AE technique has the potential to evaluate damage occurring not only in the super-structures but also in the sub-structures as the considerable load exerted by the train can overcome the high damping caused by the mass of concrete in the foundation and the surrounding soil.

To verify the adequacy of the proposed method, a fundamental study into the characteristics of secondary AE has been conducted based on AE experiments with model piles. To improve the applicability of the secondary AE technique, a considerable amount of in-situ AE monitoring using railway bridges as test objects has been carried out (Fig.2). Based on these experiments, some practical indices to quantify the degree of damage to the structure, such as RTRI, Caml and Ib-value have been proposed.

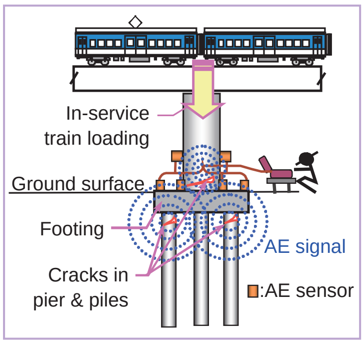

Fig. 1 Proposed AE inspection

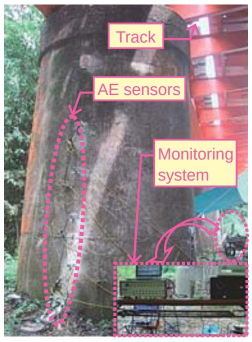

Fig. 2 In-situ AE monitoring

Development of an Assisted Steering Bogie System for Reducing Lateral Forces Exerted on the Track

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Japanese narrow gauge lines, exhibit many tight curves with short transition curves because they have been laid mostly in mountainous regions or along coastal areas. To shorten travel times for passengers it is therefore very important for trains to be able to run faster through curves.

However, running faster in curved sections tends to increase the lateral forces exerted on the track at the point of contact between wheel and rail. Many problems arise from the increased lateral force in curved sections such as derailments, or wear of wheel and rail.

Because of this, many types of steering bogie have been tested in Japan. For example, a bogie angle linked steering truck that changes the attack angle corresponding to the bogie angle has already been developed and used in commercial service. This system is very effective in circular curves, but its performance in transition curves is relatively poor because the curvature of the transition curves gradually changes, and the steering angle of the wheel-sets does not change at the same time as the curvature.

Given this situation, the authors studied a system that supplements the active steering force of the ordinary bogie angle linked steering mechanism and carried out running tests on the RTRI's test track. We call this an "assisted steering bogie system".

We examined two types of assistance actuators that were arranged on the steering beam and the axle boxes (Fig. 1). Hydraulic cylinders are used to drive the assistance actuators of this system, and they are controlled by a Direct Drive Volume Control unit with pressure control. The actuators assist the steering force in the transition curves, and they are then released so that they have no effect on other sections of track as this could obstruct the motion of the bogie angle linked steering.

The results of the studies show the effect of the assisted steering bogie system and its ability to reduce the lateral force by almost half on transition curve sections (Fig. 2). We are considering whether to extend the use of these steering bogie systems to practical applications with a fail-safe function and much improved performance on curved sections.

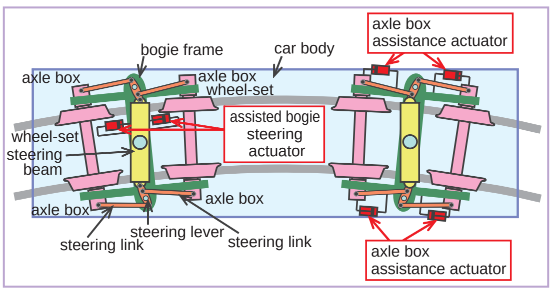

Fig. 1 Components of assisted steering system

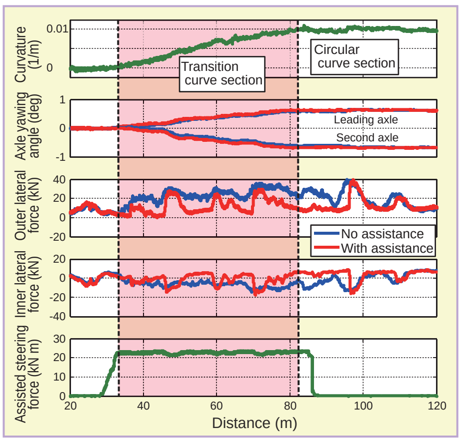

Fig. 2 Test result of assisted steering