DEVELOPMENT OF SHINKANSEN ELECTRIC POWER SIMULATOR SYSTEM

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INTRODUCTION

The Tokaido Shinkansen which links Tokyo and Osaka at maximum speed of 220 km/h is a high speed mass transportation railway system. The maximum number of trains operated per hour is 11 in one way. ("HIKARI" (express type) : 7 ; "KODAMA" (local type) : 4), and the maximum number of trains operated in a day is about 280.

We will operate the new Shinkansen train (series 300) in spring 1992. The series 300 which called "NOZOMI" connects Tokyo and Osaka in 2 hours 30 minutes at maximum speed of 270 km/h.

We made efforts to increase the capacity of the transport. For example, the magnification of time area which operated maximum number of trains and the addition of 4 vehicles to the KODAMA of 12 vehicles type and so on. Nevertheless, the Tokaido Shinkansen has reached the limit of its transport capacity.

Therefore, we started developing the Tokaido Shinkansen Electric Power Simulator System so that we can investigate the deficient capacity of the electric equipments and the electric power in consideration of the regenerative brake system of series 300.

1. CUSTOMARY METHOD

The present investigation of electric equipment capacity and demanded electric energy is based on the train timetable and the train load pattern.

1.1. Outline of the method

(1) Conducting the distribution of trains from the timetable. (Fig.1)
(2) Conducting the load current of each train from the train load current pattern and the train location at the same time.
(3) Calculating the feeding current from the sum total of each load current. (Fig.2)
(4) Investigating the capacity of electric equipments and the temperature of transmission line.

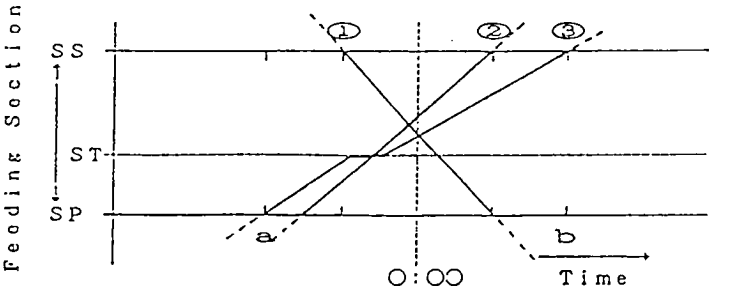

Fig.1 : Extraction of train

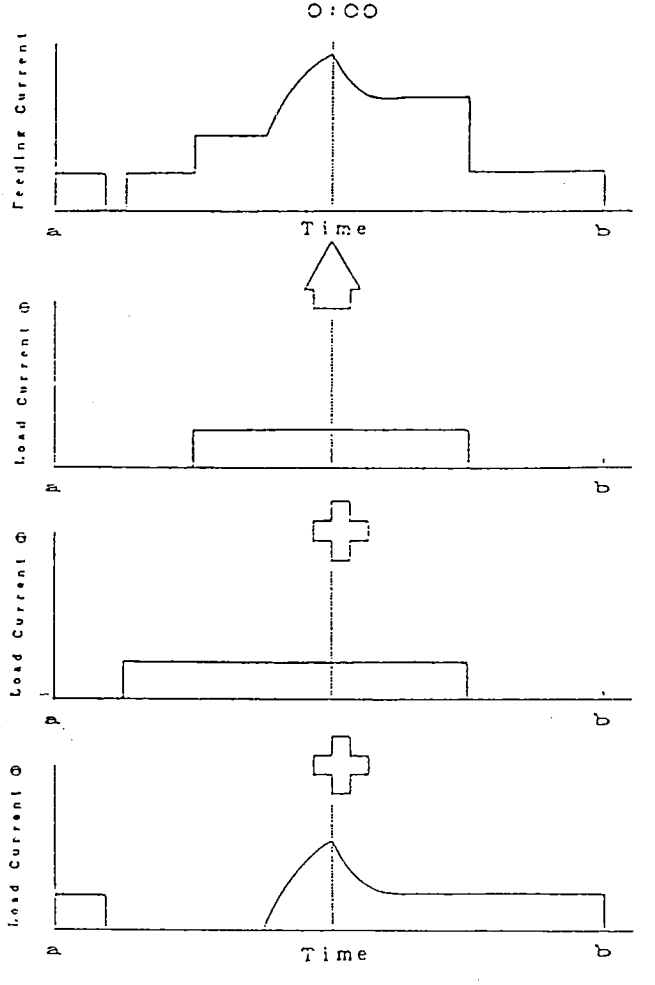

Fig.2 : Piling of load current

1.2 Problem of the method

(1) The character of vehicle is based on the voltage of contact wire AC 25kV constant, so that it can not consider the change of character for the voltage fluctuation.
(2) The Tokaido Shinkansen which is operated high density has the case which many trains locate on the same feeding section. But it can not consider the voltage fluctuation of contact wire for mutual influence between the trains.
(3) The timetable has nothing without the arrival and departure time of the station, so that we can not get the correct locations of the trains between the station.

2. NEW SIMULATOR SYSTEM

Shinkansen electric power simulator system which we are developing now is different from the customary method on the all points. It has almost conditions of the railway (for example tracks, electric equipments, vehicles, signals, timetable, stations and so on.) and all trains run according to the timetable in it.

2.1. Character

The main characters of simulator system are shown in the following.

(1) Considering the mutual intervention between the trains.
  - It considers the voltage fluctuation and the indication of signal every block section for trains so that we can faithfully simulate.
(2) Considering to spend the spare time between stations.
  - It spend the spare time between stations in consideration of velocity, signal, track condition, voltage of contact wire, and timetable so that trains can arrive on time. The time is adjusted by dropping maximum speed.
(3) Considering the change of feeding system.
  - It considers the feeding system when equipments are brakedown so that we can simulate in all case.
(4) Considering the restrictive condition of the operation.
  - It considers the restriction of regulating notch and the slow running when the train load or maximum speed is restricted.

2.2 Construction

This simulator system is mainly constructed of data

file part, simulation part and output of result part. The construction is shown in Fig.3.

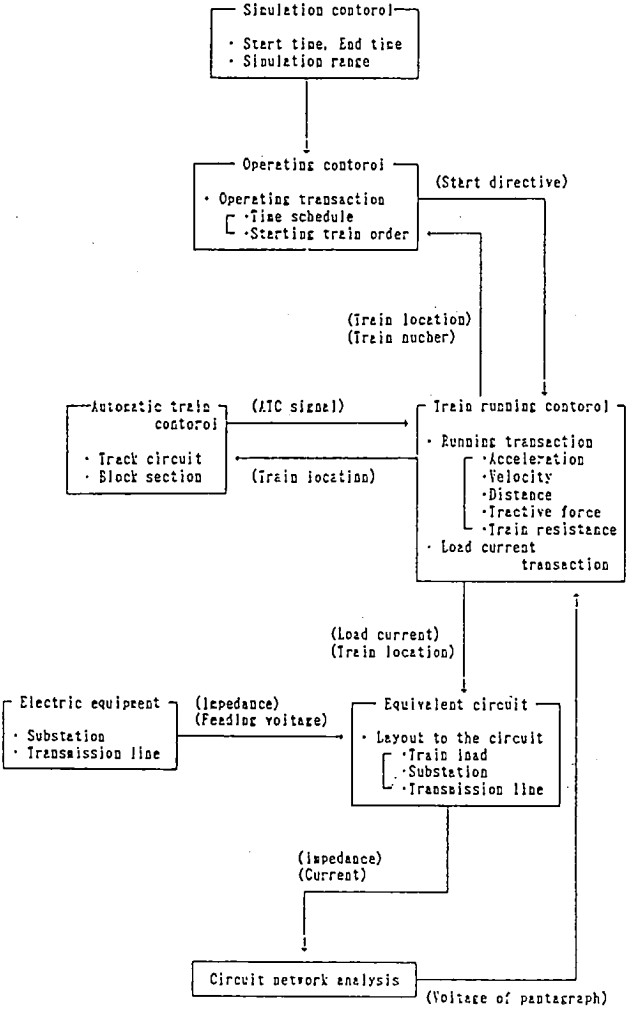

Fig.3 : Construction of simulator system

2.2.1. Data file part

The data file part has various conditions such as vehicles, tracks, signals and electric equipments constant and so on.

(1) Electric equipment data
- Electric equipment location
- Feeding substation and sub-sectioning post equipment constant
- Contact wire and transmission line impedance

(2) Vehicle character data

(3) Track equipment data
- Curve section
- Gradient section
- Tunnel section

(4) Operating condition data
- Track circuit and signal
- Train routing
- Station location

2.2.2. Simulation part

This part has the functions which calculate the operation of the trains and electric circuit network with considering the voltage fluctuation.

(1) Train operation part (Train running control part)
- It calculates the train load current and location with the condition of vehicle character, velocity, signal, track, voltage and so on.

(2) Electric circuit calculation part
- It calculates the voltage and current on electric equipments. And it gives the voltage on the train pantograph to the train operation part.

2.2.3. Output part

The items of simulator output are shown in the following.

(1) Receiving phase-to-phase voltage (instantaneous, minimum, maximum value) on the feeding substations.
(2) Receiving current (instantaneous, maximum, average value) on the feeding substations.
(3) Feeding voltage (instantaneous, maximum, minimum value) on the feeding substations.
(4) Feeding current (instantaneous, maximum, average value) on the feeding substations.
(5) Consuming power (instantaneous, maximum, average value) on the feeding substations.
(6) Consuming electric energy on the feeding substations.
(7) Receiving voltage regulation.

(8) Receiving end voltage (instantaneous, maximum, minimum value) on the sub-sectioning posts.
(9) Voltage of contact wire at the pantograph of trains.

2.3. Simulating method

The outline of simulating method is shown in the following.

(1) Drawing the run-curve each train at the normal voltage (=25kV) of contact wire with the maximum speed controlled for spending the spare time.
(2) Calculating the position and load current of each train at 100ms later.
(3) Arrangement of electric parameters which are the load current and the impedance of vehicle and electric equipment on the electric circuit network.
(4) Calculating the voltage of contact wire at the pantograph with the electric circuit analysis.
(5) Drawing the new run-curve each train at the voltage calculated in (4).
(6) Repeating these parts every sampling time.

This method which uses the minute sampling time does not need the focused loop calculation in electric circuit analysis.

3. CONCLUSION

We have to verify the accuracy of this simulator system. So we are measuring the real train load on feeding substations and sub-sectioning posts. We will use it to investigate the appropriate electric equipment capacity and demanded electric energy.

And we have the plan which the simulator is added new function, for example SVC (Static var compensator).