

Various Approaches in Japan to Low Cost Interchanges on Expressways

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**Kiyoshi Dachiku, JICA Expert
National Highway Authority of India (NHAI)**

1. Features of Intersections & Interchanges

Interchanges are safer and **efficient** tools to exchange traffic between two expressways 3-D with uninterrupted flow of traffic. Whereas **intersections**, which basically exchange traffic 2-D, involve conflicts between different directional traffics.

Interchanges, however, usually require large spacious land and many structures to grade-separate different directional traffics.

PROBLEM: Large spacious lands and high cost of construction.



Typical Interchange (IC)



Typical Intersection

2. Current Issues on Expressways

Nowadays many countries are facing with various issues in developing expressways such as

- a) Financing
- b) Acquiring lands
- c) Environmental clearances

To design interchanges at low cost with minimum land keeping required functions

Is crucially needed.

Required Functions for Interchanges

1. **Safety**-by elimination of crossing and turning conflicts
2. **High traffic volume**-by uninterrupted one-way traffic
3. **Toll collection**-by collecting toll at interchanges as many countries are using the toll road system.



3. Selection of Interchange Types by Functions

Tolling commands the traffic to stop for toll payment. Based on the necessity of tolling, types of interchanges can be classified into two broad categories,

a) **Service Interchanges**, where tolling is carried out at such a connection as between a toll road and a non-toll road. **One-point tolling types** are preferred.

b) **System Interchanges**, where tolling is not necessitated at such a connection within an expressway network. **Spread-ramp types** are preferred.



**Service Interchanges
(one-point tolling types)**

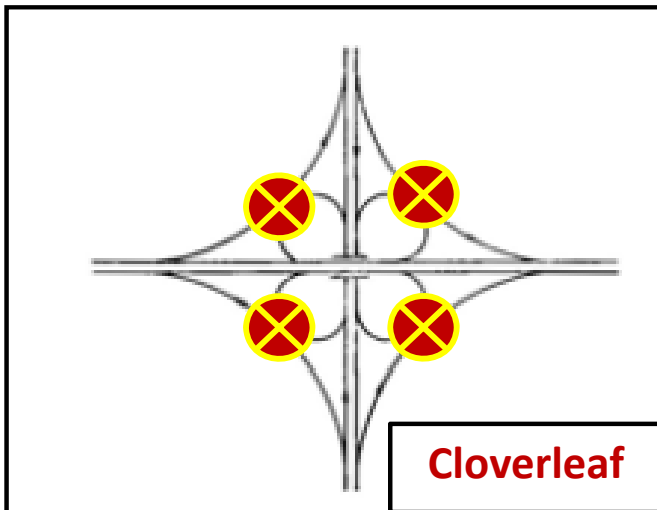


**System Interchanges
(spread-ramp types)**

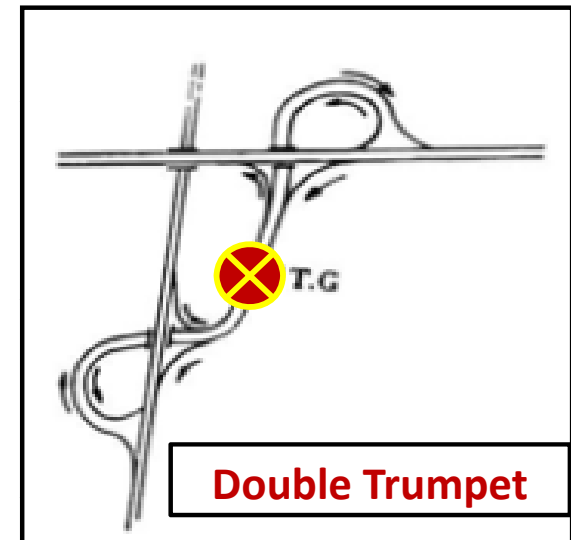
4. Comparison: Merits of One-Point Tolling Types

a) Tolling Aspects

There are eight directions of traffic flow between two expressways, and to connect them, eight ramps are needed. In case of the cloverleaf interchange, eight ramps are all spread and tolling needs four separate locations.



Double Trumpet type interchange has all the ramps concentrated at one point.



One-point tolling brings;

◆ **Less number of toll booths**

By concentrating all toll gates at one location, the number of toll booths becomes smaller.

4. Comparison: Merits of One-Point Tolling Types(2)

◆ Higher security

Large sum of money is transacted at toll booths. Security is the prime concern there. One-point security is better than being separated.

b) Operational Aspects

◆ Efficient operations

Efficient operation requires flexible opening/closing of adequate number of toll booths responding to fluctuation of traffic flow. One-point tolling makes it simpler and efficient.

◆ Effective maintenance

Tolling equipment also requires regular inspection and maintenance. These works can be efficiently implemented.

◆ Quick response to troubles

Various troubles and accidents may happen at toll barriers, where traffic is concentrated. Controlling traffic, shooting troubles, attending road users' grievances, attending accidents, disseminating information, etc., can be quickly and efficiently implemented.

4. Comparison: Merits of One-Point Tolling Types (3)

c) Smaller Land and Lower Cost

One-point tolling type has a land enclosed by ramps, which provide adequate space for a toll office and a maintenance office. Only two grade separators are required for a double-trumpet interchange.



◆ **Required land and construction cost is about half.** One-point tolling type requires smaller land and fewer number of structures compared with ramp spread types. Generally speaking, required land and construction cost is about half.



Typical Service Interchanges



Standard Double Trumpet



Double Trumpet (Separate Highways)



Double Trumpet (Outside Toll Office)



Double Trumpet (Skew Crossing)

Typical Service Interchanges (2)



Trumpet + T



T + T



Double Trumpet (minimum land)



Double Trumpet + One

Typical System Interchanges



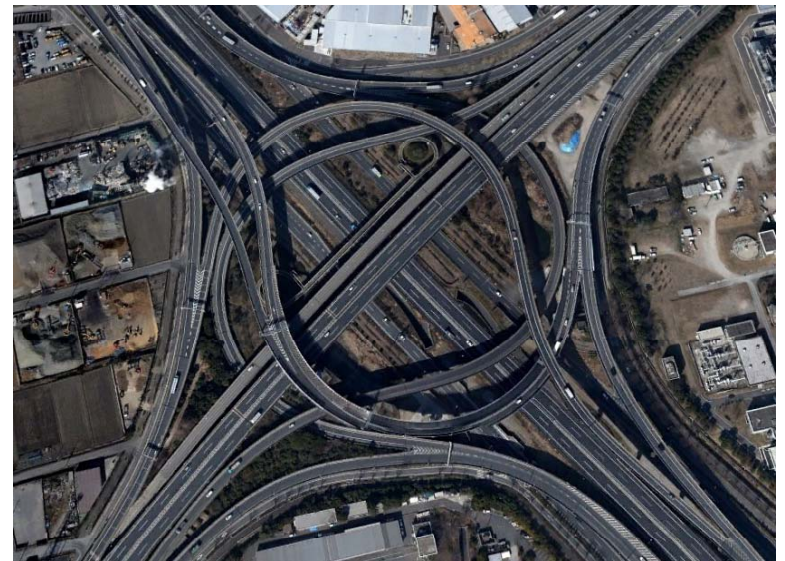
Directional



Y Directional



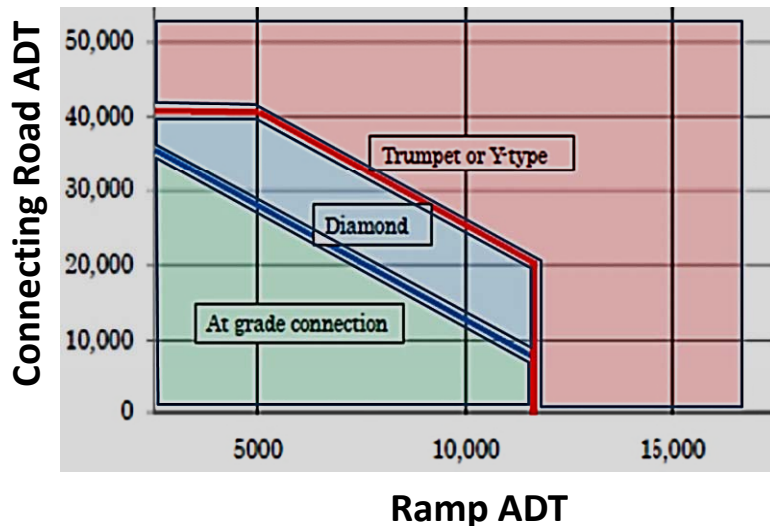
Cloverleaf (collector & distributor)



Directional

5. Combinations with At-grade Intersections

When the traffic volume on the connecting road is small, an at-grade intersection or a Diamond type Interchange shall be considered to minimize the cost. The selection of the type shall be determined by the traffic volume on the connecting road and the expressway ramp.



At-grade intersection



Diamond Interchange

Typical Combinations with At-grade Intersections



Trumpet + At-grade



Trumpet + Partial At-grade



Trumpet + Diamond



Diamond

Typical Combinations with At-grade Intersections (2)



Standard Diamond



Right-side Diamond



Left-side Diamond¹³

6. Multi-purpose Use (with Rest Facilities)

a) Combining Rest Facilities

Attractive wayside amenities become more than just a place to rest. They have become a place of destination of travel for people to enjoy shopping, eating foods or viewing beautiful sceneries. Such a new leisure creates a new life-style of the people.

By combining rest facilities with an interchange, land and cost of construction can be minimized.



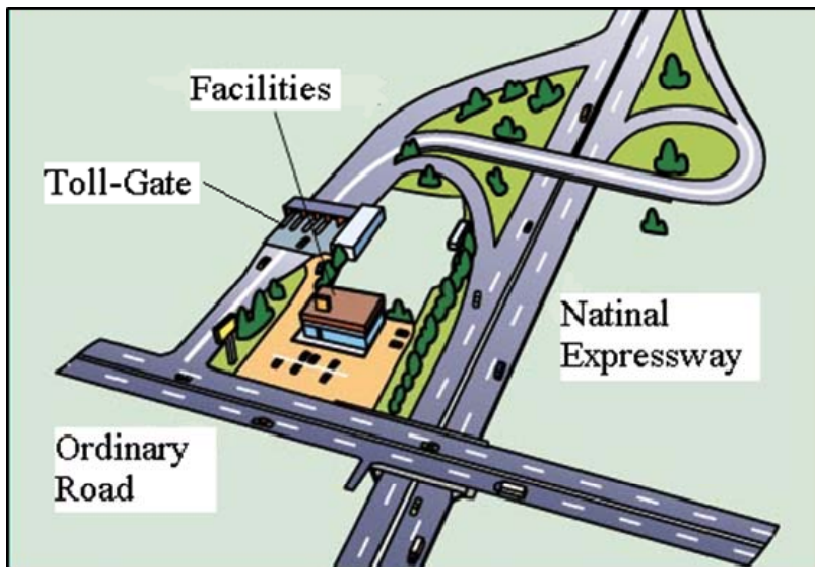
Rest Facilities with a great view



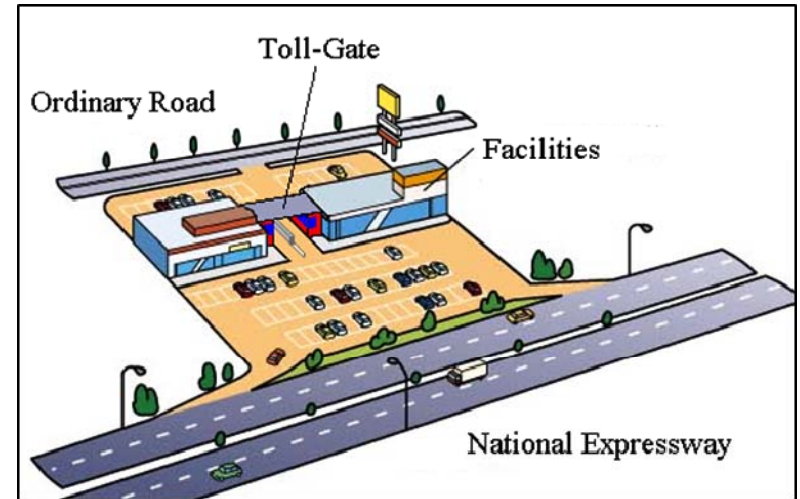
Rest Facilities with shopping malls

Rest Facilities (2)

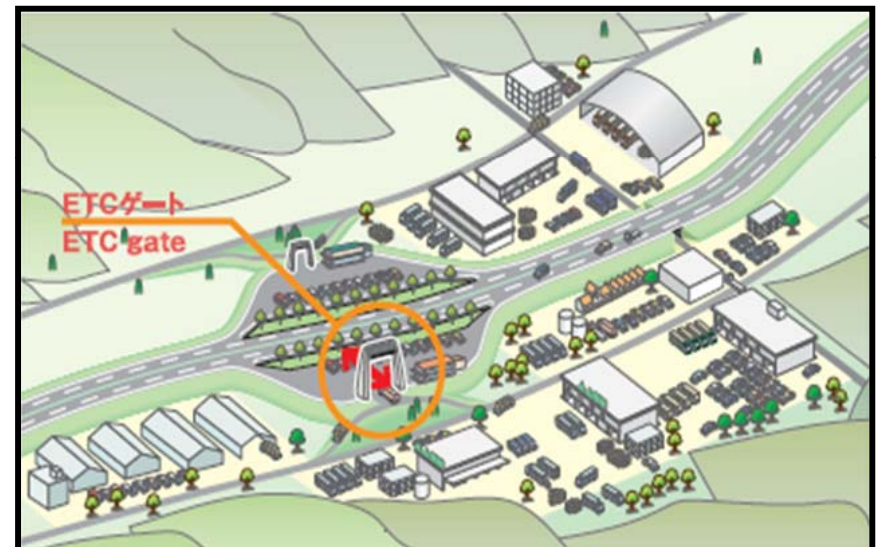
Although expressway rest facilities are for expressway users, outside customers are also welcomed by integrating them into interchanges.



Rest Facilities on ordinary road



Rest Facilities on both sides



Rest Facilities connecting resorts

Rest Facilities (3)

When Interchange cum Rest Facilities is very attractive as “UMIHOTARU” on Trans-Tokyo Bay Expressway, it becomes a tourist attraction. Many people visit this manmade island every day to enjoy marine scenery and seafood dishes.



UMIHOTARU on Trans-Tokyo Bay Expressway



Designed as a gorgeous ocean liner



Popular tourist destination

Rest Facilities (4)



Rest Facilities with a great view



Rest Facilities with a great view



Rest Facilities with a great view



Rest Facilities with a great view₁₇

6. Multi-purpose Use (with Bus Stops)

b) Combining Bus Stops

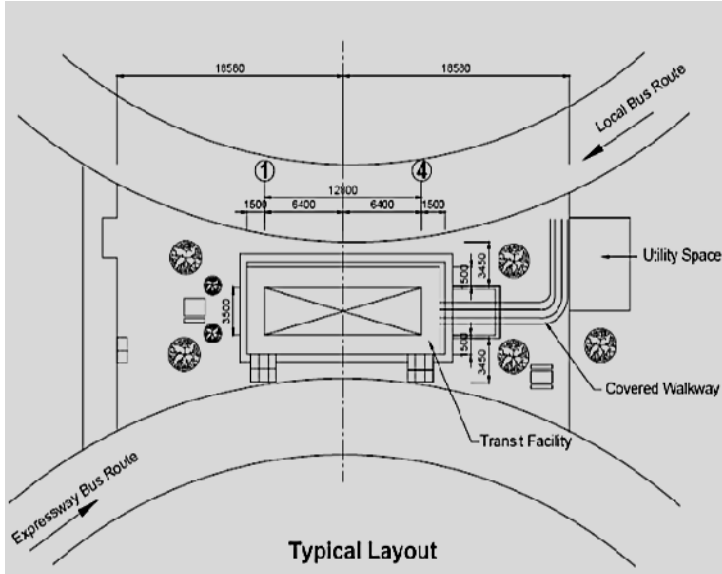
When the length of the Japanese expressway network reached 4,000km in early 1980's, **various businesses using expressways were born** and they have grown with the expressway network. **One of those businesses is expressway bus services.** There are currently about 300 companies operating about 4,000 expressway bus routes all over in Japan carrying about 110,000 passengers annually (2009).



Bus stop faces both expressway and ordinary highway

Bus Stops (2)

The bus stop is facing both the expressway ramp and the ordinary road. Passengers on expressway busses can get off here and passengers from ordinary roads come here to get on.



Bus stop faces both expressway and ordinary highway



Bus stop



Expressway Bus

6. Multi-purpose Use (with Truck Terminals)

b) Combining Truck Terminals

Door-to-door parcel delivery service is another newborn business with the advent of expressway network in Japan.

Before this business came into being, parcel delivery service was offered by Public Post Services. Nowadays, private parcel delivery services companies have become as such large.

Expressway Companies have built and integrated truck terminals into some strategically important interchanges.



Truck terminal adjacent to interchange



Door-to-door parcel delivery service is another newborn business

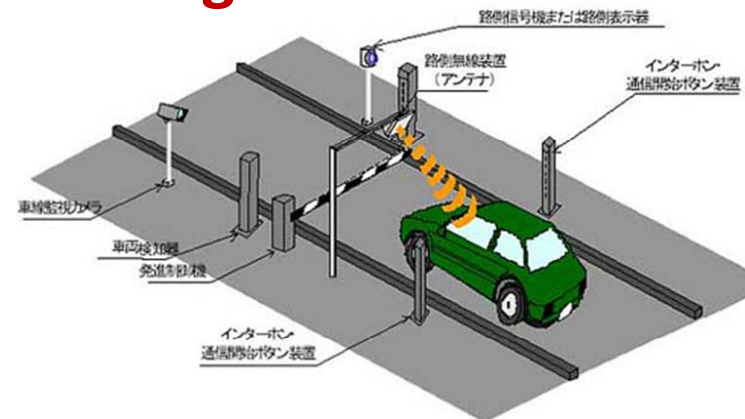
7. Utilization of Electronic Toll Collection (ETC)

The advent of Electronic Toll Collection (ETC) has been changing the configuration of interchanges these days. **By introducing All Electronic Tolling (AET), no toll booths are required on toll plazas** making the configuration of interchanges very simple. Such interchanges are named **“Smart Interchanges”** in Japan.



Smart Interchange

AET is possible when all vehicle drivers are well informed about the system and all violators are caught by Video Tolling (VT), which reads license plates and charge the violators with extra penalty later on. **Currently, there are 65 smart interchanges in Japan and the number has been increasing.**

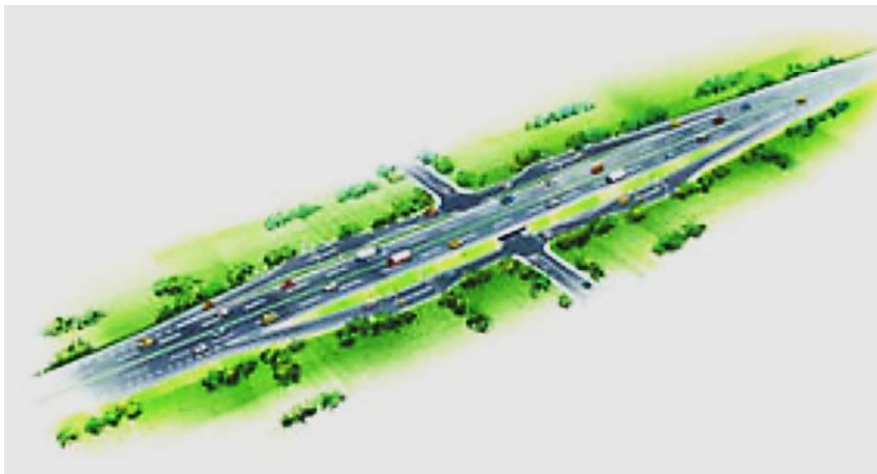


Equipment for Smart Interchange

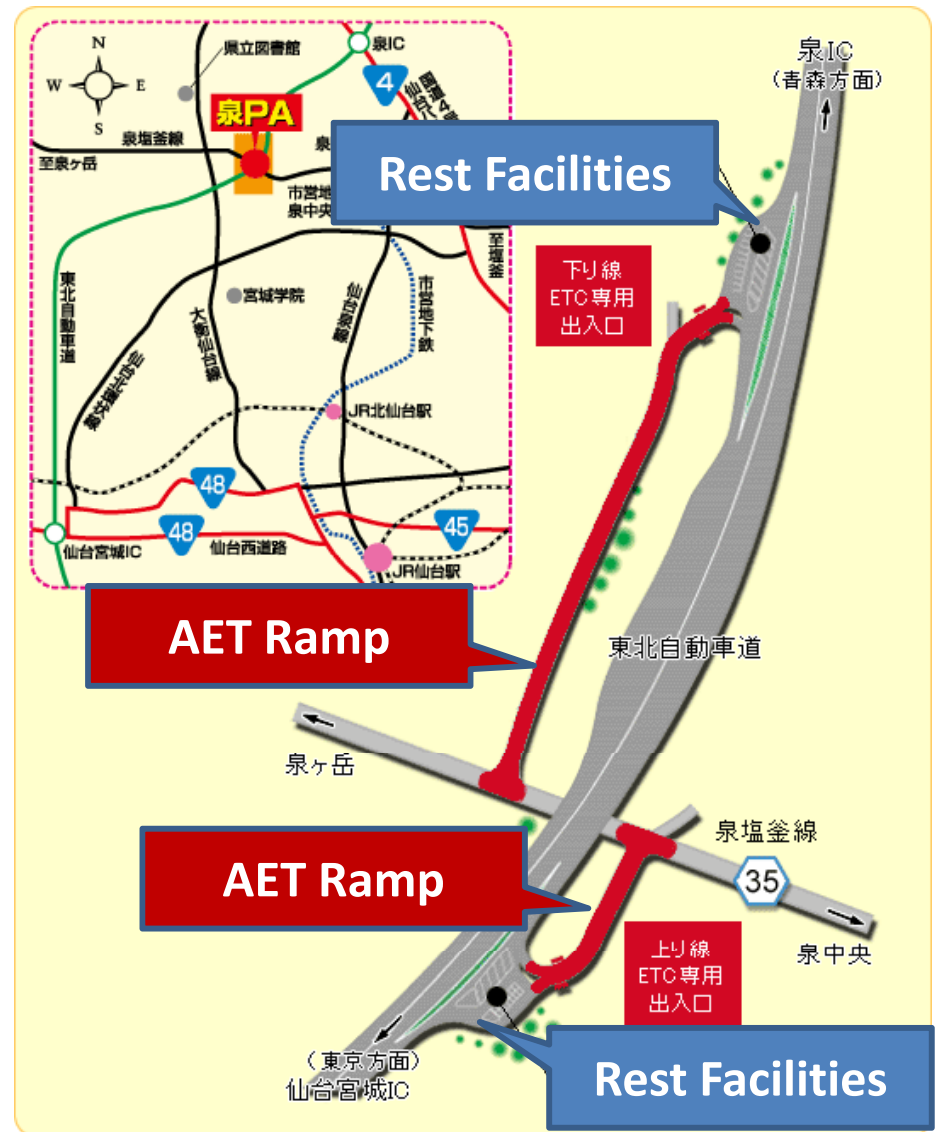
Smart Interchanges (2)



Rest Facilities



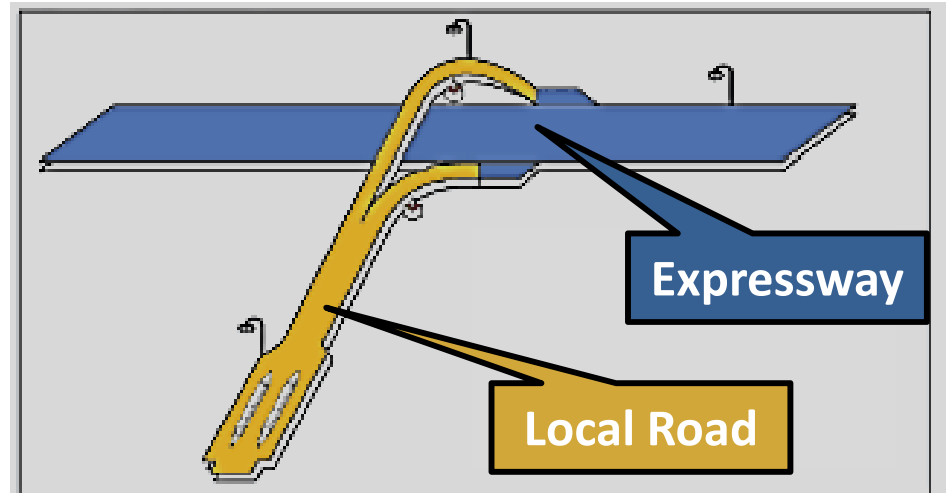
New Diamond Interchange



Rest Facilities with extended ramps

8. Region Revitalization Interchanges

When local community desires to connect their important regions such as industrial parks, resort areas, etc. with expressways, **they can initiate connecting interchanges by financing them.** By connecting to the expressway directly, the transportation of the region will be enhanced and the value of the vicinity areas will become higher. **This will help to revitalize the region.** There are about 50 such interchanges in Japan.



Ramps are finance by local bodies



Transportation convenience is crucial for industrial parks

Examples of Region Revitalization Interchanges (2)



Connecting to Industrial Park park



Connecting to Local Airport



Connecting to Ski Resort



Connecting to Local Toll Road

Examples of Urban Interchanges in Japan



Examples of Urban Interchanges in Japan (2)

