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CE 451

Transportation Engineering II

(1)

Books:

* Railway Engineering : Rangawala
* Railway engineering : Agarwal

Highway Design & Railways

Introduction

Main Domain :

⇒ solid contents 3 pipeline এর মাধ্যমে transfer করি

⇒ Space related ধারণা না থাকলে যুগের আগের ভাল চলাচল যাবে না

Tasks of a transport engineer:

4 elements are linked. সব আলোচনাই এই 4টা domain এর মধ্যেই হয়

* Functional Design → Geometric (alignment)
                    → Structural (pavement depth, materials)

→ operation efficient না

→ management নাই

Objective

Importance

ASCE (6 divisions among 18 transportation related)

Course management

Shamsul hague sir lecture from website

Introduction to railways

[2 class test (average of 2)]

History:

* Rutway → পাথরের মধ্যে Groove তৈরি করে carry করার system

→ purpose: goods (mostly coal) carry করার জন্য

* Steam Engines:

→ 1804 first steam engine

→ 1863: first underground railway } coal mine এ use হত

* First electric railway

The Quest for speed:

low speed

- Disadvantages : • frequency কম

• time বেশি লাগত – directly connected না. connectivity বাড়ানোর জন্য length বেড়ে যায়, ফলে time বেড়ে যায়

• ticket পাওয়া যায় না

* France → TGV (Shape নয় উপর research হচ্ছে)

* Shanghai → Maglev train (431 km/h)

↳ Floating বলে None বলে. directly connected না, so bird train ও বলা হয়

* Maglev principle : sideway prevent করার জন্য Guide system চালু হয়। as turbulent flow হলে magnetic direction ও change হয়ে যায়।

⊞ Classification of Railways :

* Intercity (Dhaka - Ctg)
  - → Long distance travel করে
  - → frequency কম

* Urban
  - → at grade — short haul
  - → elevated — frequency বেশি
  - → underground

* Sub-urban area
  - city to rural area

Comparison with roadway - (যখান থেকে দেখছি না)

Advantages:

* additional compartment add করতে বাড়ি demand বেশি হলে
* operation cost কম কারণ friction সবচেয়ে কম rolling → so easily move করা যায়, heavy load নেয়া যায়, per ton of load cost কম হবে
* high speed
  - at fixed route and easier operation
    ↓
    railtrack → শুধুমাত্র rail যায়

Why Railway Engineering ?

1.2: Different Modes of transport (Agarwal)

(1) Land transport
  - Rail (bulk road & passenger বেশি হলে)
  - road (light commodity & ॥ কম হলে)

(2) Waterways (time factor issue না হলে use হয়)

(3) airways (short period of time → তাড়া করতে হলে)

* cheapest - waterway & costly - airways w.r.to time

Table 1.2 : Rail vs road transport

Feature	Rail	Road
Tractive resistance		
⋮		
Suitability		

* Operation cost कम आहत fuel cost कम so pollution कम हुव ।

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Problem of Road based & horse/engine driven travel system :

- discomfort due to uneven riding surface
- rutting problem (গর্ত হয়)
- low speed
- poor riding quality
- low hauling capacity

Track based travel pattern was introduced :

Main advantages / Hallmarks of MRT :

- reliable হয় যখন time schedule ঠিক থাকে
- congestion হয় যখন no. of vehicles বেড়ে যায়,
- demand responsive sustainable mode (present & future problem take care করতে পারে)

Sustainable System

MRT responds to demand by increasing riding capacity in following ways :

- handicapped person দের জন্য seating service বাড়ানো হবে

Problems of having single track route

Component, Alignment

Permanent way :

- particular railway track

Components :

* Sleepers - Kind of tie . ২টা rail কে connect রাখবে, alignment ঠিক রাখবে

* Fasteners - rail to slipper and rail to rail connectivity দেয়

* Ballast - পাথরের layer . stable base দেয়ার জন্য

. (load → rail → slipper → ballast → subgrade soil)

* Drainage quality poor হলে → Blanket দেয়া হয়

* Bearing capacity " " → Ballast & sub-ballast of soil দেয়া হয়

What are the advantages of using rails in the railway ?

* track based এর advantage + rolling friction কম + steering problem নাই

- to improve riding quality / comfort
- to increase speed
- to carry more pay load
- to make it energy efficient

Functions of components :

* Rails
* Sleepers
* Fasteners
* Ballast
* Subgrade

* Variations দেয়া যায় for high speed rail.

* Slipper to slipper certain distance রাখতে হয় - কারণ spacing 0 হলে ballast এর মধ্যে penetration maintain করা difficult হয়ে যায়।

Alignment of Railway :

- ensures safety and speed

Requirements of Ideal Alignment :

- 1st phase - connectivity
- 2nd phase - shortest route

Selection of Alignment :

* Gauge - parallel distance between rails

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Factors affecting Selection of an Alignment

Gauge of Railway

- inner face to inner face clear distance

Types of Gauges

Choice of Gauge

Reason for non-uniformity

Problems associated with non-uniformity

Dual-gauge tracks

Double gage

Factors affecting selection of an alignment

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④

Lecture 4

Surveys, Rails

Surveys

Traffic Survey

- actually demand আছে কিনা সেটা জানব

Rails

- main function train এর axle load bear করা

- 3 parts : (Cross-section আজকে পাবে)
  - Head
  - Web
  - Foot / base

Requirements of an Ideal Rail

Types of Rail

BH Rail

- CG উপরে উঠে যায়, so base এ stress বেশি হয়, wear and tear বেশি হয় (Disadvantages)

* DH rail এর top এর আকৃতি সাধারণ base এর ও wear and tear হয়। ফলে আর Reversible থাকে না।

Choice of Rail Section

- 45 kg rail বলা থাকলে বুঝায় 1 m rail এর weight 45 kg.

- 560 * 52 করলে যে axle load পাব সেটা lower rounding করতে হবে as এটাই maximum axle load.

Choice of Rail length

** Total weight বলে দিলে Rail length দিয়ে ভাগ দিয়ে per m weight বের করতে হবে to determine axle load.

Welded Rail

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Geometric Design

Track Resistance

(1) Frictional resistance

(2) Resistance due to wave action

(3) Resistance due to wind

(wind এর velocity কম্পা না থাকলে train এর velocity র সমান উচ্চ নিতে হবে)

(4) Resistance due to gradient

Lecture-9

⊞ Terms related to Gradient design

Ruling gradient

- Steepest gradient in a rail network

⑤ Resistance due to curves

Grade Compensation on curves

Problem 2 :

⇒ 1 in 239 (upper rounding করতে হবে as slope mild হলে safe)

$g = \frac{1}{200}$

$D = 2^\circ$

$$\frac{W}{g_1} = \frac{W}{g_2} + 0.0004\,WD$$

$$\Rightarrow \frac{1}{200} = \frac{1}{g_2} + 0.0004 * 2$$

$$\therefore \quad g_2 = 238.1 \approx 239$$

Hauling Power of Engine

Problem 2

* coefficient of friction দেয়া না থাকলে reasonable value assume করতে হবে।

* Tractive effort = 13.2 tonne [22X3X·2]

* Straight level track (3 resistance থাকবে, তাদের 2টা থাকবে না)

*. W = 1115 tonne (axle load included) [13.2 = Σ3 resistance]

* Max^m permissible pay load বলতে (1115 − 22X3) হবে answer. ↓ additional যে load চাপানো হচ্ছে

* না বললেও straight level টির W বের করতে হত for determining V.

$$13.2 = \Sigma 4 \text{ resistance}$$

Reduction in speed = (80 − 48) kmph = 32 kmph

** 1 decimal পর্যন্ত রাখতে হবে ans.

Problem 3

- no. of compartment 20
- $W = 20 \times 20 + 150 = 550$
- Eqn এর L.H.S. = 15 tonnes
- 1st resistance (Rolling resistance) দেয়া আছে,

$$3 \text{ kg/ tone} \times 150 = 450 \text{ kg}$$
$$= .45 \text{ ton}$$

Wagon resistance $2.5 * 400 = 1000 \text{ kg}$
$= 1 \text{ ton}$

∴ Rolling resistance = 1 + .45 = 1.45 ton

$15 = \sum$ resistance

⇒ Rate of slope = 1 in 56 হবে না
1 in 57 হবে (higher rounding
as mathematically 56.5 steep gradient
পর্যন্ত চলতে পারবে;

Problem 4

Lecture 10

Superelevation :

* $e = \frac{GV^2}{gR}$

* Max^m superelevation (allowable value) জানা থাকতে হবে।

BG – 16.5 cm

MG – 10.2 cm

Optimum Speed

Surface roughness এর কারণেই নির্দিষ্ট speed এর বেশি / কম এ curve negotiate করতে পারে।

Terms related to superelevation

* Max^m permissible Cd value গুলো জানতে হবে।

* 10 cm (Practically) + 7.6 cm = 17.6 cm (Theoretical) বেশি হয় v পার হলেই absolute max^m v.

* 10-7.6cm at least provide করতেই হবে, তখন 60 km/hr ই absolute max^m.

Negative Superelevation

- outer point → higher elevation than inner point

* Branch line less important, so less speed allow করব।

* যে line এ speed কম, সে line থেকে calculate শুরু করতে হবে।

- 5 − 7.6 = −2.4 cm (A B point এর নিচে)
  ↙ Practical ↙ Theoretical

* Negative superelevation allow করব only branch line এ.

- Main line এর (+)ve superelevation = 2.4 cm + 7.6 cm = 10 cm ← Theoretical

  absolute max^m V হবে

* Branch line এর 40 টাই absolute max^m.

* Branch line → negative superelevation দিব।

Problem:

- Restricted → absolute maxm
- 5.523 cm mathematically হইবার।

* Branch line এর max (-)ve হল main line এর (+)ve maxm superelevation.

- Speed restriction → absolute maxm speed

* Branch line এর speed restriction 30 and main " " " " 60 হলে,

field → কত superelevation দিব?

→ range → যে কোন superelevation দিতে পারি.

(design problem – decision making)

Branch line এর speed 35 এর কম হলে, Main line এর speed 65 এর বেশি হবে।

Lecture - 4

* Maxm axle load = 29.12 t

⇒ 29 বলে 52 এর চেয়ে কম আসবে, then chart অনুযায়ী next higher এ যেতে হবে and load always 29.12 এর চেয়ে কম হতে হবে।

Lecture- 6

Sleepers :

Functions

Design of sleepers

Desirable properties
↓
function যে যাতে perform করতে পারে

Track Circuiting

⇒ Sleeper and ballast insulator বিজোড় থাকে otherwise short circuit হয়ে যায়,

Shape of sleepers

- rail inwardly tilted achieve করা হয়

sleeper দ্বারা

*# Adzing of Wooden Sleepers

- 1:20 slope in wooden sleeper

Types of sleepers

Wooden Sleepers

- Advantages (Requirement এর respect এ)
- Disadvantages

Steel sleepers

*# Comparison of Sleeper types (table prepare করতে হবে)

Spacing of sleeper

- environmental issue এর কারণে wooden sleeper এখন use করি না।

* per unit rail length - একটা rail segment এর নিচে কতগুলো sleeper দিতে হবে।

Min^m Density

BG - M+7

MG - M+3

Problem

⇒ M+7 = 15+7 = 22

13.15 m → 22

1 Km → ?

upper rounding হবে

** Figure দিতে হবে।

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- Class test (At 1 pm)
  - Geometric Design - I, II (Lec - 7, 8)
  - Curve (Lec - 9)

Table 7.1 : Spacing of sleepers for a fish-plated track (Book : Railway engineering)

Spacing

Between joint sleepers (a)

Between joint sleepers and the first shoulder sleeper (b)

....

* Math আসলে a, b, etc. বের করে figure এঁকে দেখাতে হবে।

Lecture - 7

Ballast

Functions

Desirable properties

Materials

1. Broken Stone
2. Gravel / Shingles
3. Coarse Sand
4. Brickbat / Khoa / Moorum
5. Compacted earth

Required properties

Depth of Ballast Cushion

Load Dispersion lines

⇒ laterally certain level পর্যন্ত, decrease করে increase করার পর্যন্ত

* $d = (S - W)/2$

↓

min^m depth of ballast

** d যদি বড় লাগে তখন inferior quality use করতে পারব যাতে d attain করতে পারি, d যদি কম লাগে তখন high quality use করব যাতে d depth provide করতে পারি, Quality সমন্বয়ে ensure করব যাতে d depth provide করতে পারি; (Short note আসলে এই কথাটা লিখতে হবে)

Example

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⊞ Requirements / Design considerations for the components of an Ideal Rail section : (Shamsul Haque Sir lecture)

Head

Web

Foot

length of rail

- Advantages of longer rail

Mode of distresses of rail (Shamsul Haque's Sir lecture)

① Wear of rails

- (a) causes of vertical wear
- (b) wear at ends of rail
- (c) wear at sides of the head of rail

- Methods of reducing wear of rails

What is corning of wheel and tilting of rail?
(Imp. for exam)

Check Rails

Coning of wheel

- Gage side of rail → Inner Side
- Field side of rail → Outer "

* Guide এর কাজ হল শুধু derailment ঠেকানো,

Tilting of rail

* Schematic figure of tilting of rail and coning of wheels (Imp.)

Advantages of coning of wheel and tilting of rail

* Web link → Wheels and bogies

- Fig 1
- Fig 2
- Fig 3
- Fig 4

Lecture-7
Ballast & subgrade

* Slide 17 - Typical cross section (Imp. for exam)

Formation

Embankment

Embankment geometry

Failure of embankment

Techniques to improve Embankment stability

Lecture -10

Points and Crossing

* Defn of Point (Switch) (Imp.)

** Parts of Right hand turnout (Fig) (Imp.)

(Straight movement allow / not
Right hand " allow / not (different combinations)
left " " allow / not)

Parts of a turnout

How switches work

- Animation link ১ দেখতে পারি

Types of crossing

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Lecture - 11
Signal & Interlocking

Signal

History

Type (flow chart - imp. for exam)

Semaphore signal

- Wikipedia page - only figure

* Horizontal - red
* 45° - proceed with caution
* Vertical - green

* Cautionary sign - V shape notch and stripe

* Fail-safe design - যেকোন mechanical failure হলে always horizontal হয়ে যাবে।

Warner Signal

Operation (Table - imp. for exam)

Types of control

Absolute block

- Red → one yellow → two yellow → green

Automated/actuated

Interlocking

Fundamental principle

Types of interlocking

* (- only নামগুলো লিখলে হবে)
  explanation লাগবে না।

Lecture 12

Maintenance, Station and Yards

Maintenance

Fastenings

Requirements of Ideal fastening

*# Types (Table - imp. for exam)

** Examples দ্বারা ব্যাখ্যা করতে হবে
or write short notes on this examples.

Arrangement of Spikes
- Staggered করে হবে as তাহলে line এ কোন fibre split হয়ে যাবে।

Bearing Plates

Elastic fastenings

Maintenance

Calendar system

Modern maintenance

Yards

Station

Criteria for Site selection

Types of station *(Typical Fig. করতে হবে)
- Halt station
- Flag "
- Wayside "
- Junction station
- Terminal "