DESIGN OF RAILWAY UNDER BRIDGE (RUB) BY USING BOX PUSHING METHOD

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ABSTRACT:

The undertaking entitled investigation and plan and execution of cross traffic works in railroads utilizing box pushing procedure (RUB), outlines about the work to be completed for the broadening of existing streets utilizing box pushing strategies for rail under scaffolds. It additionally clarifies about the methodology engaged with execution of box pushing strategy. The plan will be completed according to Indian models, especially Indian railroads norms, IRC, IRS, and IS CODES. In which the plan of significant parts push bed, precast box utilized for the extending are done according to IRS codes. The plan of pre thrown box is finished utilizing STAAD genius, it likewise incorporates the format of support subtleties of two significant structures utilized in this method separated from regular method i.e., push bed (principle bed and assistant bed), pre thrown box. In railroads at whatever point there is a need to make an underpass ,either for waterway crossing, RUB'S(Rail under scaffolds), program of enlarging existing rail route ducts etc.BOX PUSHING TECHNIQUE is utilized. Since the work must be managed without interference to rail traffic, box pushing strategy is generally supported in contrast with customary methods. Present day Intensity of Traffic, both Rail and Road because of the quick advancement, is substantial it can't the bothered, for development of under extensions or Canal Crossings, waste and so forth by traditional for example open cut framework. Box Pushing Technique is created where in R.C.C. Boxes in portions are thrown outside and pushed through the overwhelming banks of Rail or Road by Jacking.

Keywords: Cross Traffic Works, Box Pushing Technique, Rail Under Bridge (RUB),IRC,IRS, IS Codes.

I. INTRODUCTION

1.1 General

In railroads at whatever point there is a need to make an underpass ,either for waterway crossing, RUB'S(Rail under scaffolds), program of extending existing rail route ducts etc..BOX PUSHING TECHNIQUE is utilized. Since the work must be managed without intrusion to rail traffic, box pushing system is to a great extent supported in contrast with ordinary methods. Transportation is one of the primary items in the foundation of a creating nation like India. The greater part of the Indian intra national transportation is finished by railroads. Railroads were first acquainted with India in 1853 from Bombay to Thane. In 1951 the frameworks were nationalized as one unit, the Indian Railways, getting to be one of the biggest systems on the planet. Involving 115,000 km (71,000 miles) of track over a course of 65,000 km (40,000 miles) and 7,500 stations. Sixteen Zones in 2003. Each zonal railroad is comprised of a specific number of divisions, each having a divisional central command. There are a sum of sixty-eight divisions.

1.2 Comparison with Other Conventional Methods

Box pushing strategy is vastly improved when contrasted and the other regular methods like open-cut frameworks, as the open-cut method requires uncovering, burrowing, putting and so forth., which makes burden the development of vehicles and traffic issues., yet while the box pushing procedure does not make any aggravation to the current traffic but rather likewise gives extending of existing street inside a brief timeframe.

1.3The Need of Box Pushing Technique

- Present day Intensity of Traffic, both Rail and Road because of the quick improvement, is overwhelming it can't the aggravated, for development of under scaffolds or Canal Crossings, seepage and so on by traditional for example open cut framework.
- Box Pushing Technique is created where in R.C.C. Boxes in portions are thrown outside and pushed through the substantial dikes of Rail or Road by Jacking.

1.4 OBJECTIVES

To prepare analytical models of BOX PUSHING TECHNIQUE

To analyze by using STAAD PRO software. In the current study, work is carried-out on the methodology of the box pushing technique, which provides widening of existing road at under bridge, warangal dist.

II. METHODOLOGY

2.1 General

- Excavation
- Casting of Thrust Bed
- Fabrication of Front and Rear shield
- Box Casting and placing
- Pushing-shifting-pushing operation
- Miscellaneous works
- Precautions

2.2 Box Pushing Operation

- To push precast box portion, response is acquired from push bed. For this, screed is disassembled at stick take area, stick pockets are cleaned, pins are embedded and Hydraulic Jacks-8/10 nos. are installed between sticks and base piece of the box with pressing plates and spacers.
- A 20mm thick plate is given, running into base chunk of box, before the Jacks to maintain a strategic distance from harm to solid surface.
- Nail stay plates are evacuated and earth is physically uncovered before front line in a manner to get annular clear space of 300mm all-round.
- Anchor plates are refixed in position and uniform weight is connected to the jacks through Power Pack.
- After complete push (greatest 300mm) jacks are discharged, distending nails are gas cut/driven and jacks again pressed with pressing plates and spacers.
- Process is rehashed till front box is pushed to required position.
- Then second box fragment is slewed and got position behind first box section.
- 8 nos. Jacks, every one of 200 Tons limit, are housed between two box fragments notwithstanding 8 nos. Jacks previously gave between push bed and second box portion.
- 3 nos. Jacks, every one of 100 Tons limit, are given in 3 openings made in every sidewall to encourage remedy of line and dimension of box amid pushing.
- Earthwork is presently done before first box section and it is pushed. Jutting nails are gas cut/driven and grapple plates are refixed in position.
- Thereafter, jacks housed between two box fragments are discharged and afterward second box section is pushed.
- Process is rehashed till both the box fragments are pushed to required position.
- Cutting Edge is destroyed and front face of first box portion is thrown in plumb.

2.3 Major Components of Rub:

1. THRUST BED
2. PRECAST BOX
3. FRONT SHIELD
4. REAR SHIELDS
5. PINS POCKECTS
6. HYDRAULIC JACKS

III. RESULTS AND DISCUSSIONS

3.1Analysis and Design of Thrust Bed

This report contains design of Thrust Bed for precast RCC single box to be pushed inside the embankment for "Proposed Road, Near Under bridge in Warangal district.

Phase –I

3.1.1 Design Data

Rail level = 108.907

Formation level = 108.232

Size of box (2) = 7.500x5.650

Top of bottom slab of box= 101.257

Top of box = 107.657

Top of thrust bed (top of screed) = 100.507

Earth cushion (from top of box) = 0.575

Thickness of top slab = 0.750

Thickness of bottom slab = 0.750

Thickness of wall: outer walls= 0.750

Out to out width of box = 9

Out to out height = 7.150

Total pushing length = 22

No of segments = 2

Length of first and second segments = 11.00

Thickness of thrust bed = 0.750

Concrete grade = M25

Steel grade Fy = 500

Bulk density of soil = 2.10 t/mt^3, taken on conservative

3.1.2 Dead Loads

3.1.2.1 Vertical Loads

As normally in railways, total weight of 6750kg/m including track str.is to be taken

Hence for total no of tracks =1x6750 =6750 kg/m

Total weight of P.Way on top of box unit = 6750x11(length of box unit) =74250 kgs =74.25T

3.1.2.2 Earth Filling Cushion

So total UDL on top of slab of box will be =1.208x9(o/o width) x11 = 119.54T

Hence Total Weight at Top = 74.25+119.54

= 193.79 T

Load on Bottom Surface=load on top +self-weight of box

Weight of Box =9.00X0.750X2X2.50 = 33.75

Weight of Vertical Walls =5.650X1.50X1X2.5= 21.19

Haunches =4.00X0.15X0.075X2.50 = 0.11

Total Weight per Meter = 55.05

Weight of One Segment =55.05X11 = 605.5T

Load on Bottom Surface =193.79+605.55 = 799.3 T

3.1.2.3 Earth Pressure

From bottom of the box

Soil parameters ϴ = 28.00 δ = 9.33 Active earth pressure co-efficient ka 0.3344

[B] EARTH PRESSURE [Ref: cl – 5.7 of IRS code for sub str. & Foundation]

Ka=0.3344

Hence earth pressure at top of box =0.58x0.3344x2.10

=0.404 t/sq.mt

Earth pressure at the bottom of box: ht =0.58+7.15

=7.73

Earth pressure at bottom of the box =0.3344x2.10x7.73

= 5.43t/sq.mt

Hence total earth pressure on wall =0.50(0.40+5.43) x7.150

= 20.840t/m

Hence total load on wall =20.840x11.00

= 229.24T

3.1.2.4: Live Load Surcharge:

Ref Design Of Box Para: 3.5

For two tracks pressure at top = 1142.51 kg/sq.mt

For two tracks pressure at bottom = 675.29 kg/sq.mt

Hence total load = 0.50(1.14+0.68) x7.150

= 6.499 t/m

Hence total load on wall = 6.499x11.00

= 71.49 T

Live load for box: as at the time of pushing, there will not be any train

3.1.2.5Total Pressure on Box Segment

THE LOARDS BELOW ARE FOR 1 UNIT OF BOX.

On top surface =193.79 x 1.00 =193.79

On bottom surface =7.99.34 x 1.00 =799.34

On two walls=2.00x229.24x1.00 =458.47

Live load surcharge = 2.00x71.49x1.00 =142.97

Live load of train: one train =1.00x 131.00x 1.00

= 131.00

Total load of train = 193.79+799.34+458.47+142.97+131 = 1725.58

Total force for box = 1725.58 x 1.00 =1725.58

Taking angle for friction between soil and concrete = 25

Jacking force required to overcome friction as per soil mechanics

Handbook = Tan (25)

Tan (25) = 0.466

Hence total Jacking force required = 1725.58 x 0.466 = 804.12

As suchtwo boxes are to be provided, hence Pushing force for which thrust-bed is to be designed

= 1.00 x 804.12 = 804.12

On thrust bed for jacking operation use total 6.00 No's of pockets in a Row.

Hence Max force per pocket = 804.12/ 6.00 = 134.020

The jacking force will be resisted by weight of thrust bed and partly by thrust wallIf due to any reason jacking force required is more, in that case,To share the jacking force in two rows of keys, at the time of jacking two rows of pins will be provided; hence force per pin will be half in that case.

3.1.3.0Thrust Bed and Thrust Wall

3.1.3.1 The thrust will be provided as shown in the fig. Thrust bed has been designed in such a manner that, it can accommodate 1st, Box and after that with provision of pushing, there will be auxiliary thrust. Bed for another two boxes

1.15m for cutting edge+Box+0.90 Jack+0.5 pocket+0.25 gap+0.7 thrust wall = 14.500 m

LENGTH OF THRUST BED = 14.500 METERS

WIDTH OF THRUST BED = 10.200 METERS

No. OF POCKETS = 57.000 on Main th. Bed=42.00 + 15.00 on auxi. THB

SIZE OF POCKET:At Main th-b= 0.500 x 0.50 x = 0.14
At Auxiliary th-bed = 0.500 x 0.50 x 0.55 = 0.14
NO OF KEYS = 2.000 no's

3.1.3.2 Weight of Thrust Bed
Volume of concrete: Main bed=14.50 x 10.20 x 0.75 =11.93
Volume of concrete: Axui-bed =50mm screeding
=14.50 x10.20 x 0.05= 7.40
Thrust wall: 1 = 1.20x 10.20 x0.70 = 8.57
Thrust wall: 2 =1.20x10.20x0.70= 8.57

Keys = 2.00x10.20x0.36 = 7.34
Less pockets =-57.00 x 0.14 = -7.84 = 26.39

Total weight of bed in T = 126.39 X 2.50 = 315.99 Resistance offered by bed =315.99 x 0.466 = 147.25 Additional resistance required=804.12 – 147.25 = 656.87 T This additional resistance will be available from thrust wall provided at rear of thrust be, the resistance available from keys is also calculated.

3.1.3.3Passive Pressure on Thrust Wall

Thrust wall at end has been provided Passive earth pressure co-efficient for vertical face of wall:

Passive earth pr. Co-efficient Kp = 22.45 Passive pressure with cohesion is given by Pp = 0.5 x W x HxH x Kp + 2 c H $[Kp]^{1/2}$

Hence advantage of adhesion at two locations can be taken.

[1] PASSIVE RESISTANCE AVAILABLE FROM THRUST WALL

W=1.80 T/cu.mt, bulk density taken conservatively H for wall in front =i.e. only one thrust wall

H for end wall at end of the Bed= 2.00 [0.80 = 1.20 below the Bed]

Kp= 22.45 [wall above the Bed 7th bed]

L for end walls only = 10.20 mt

C= Kg/sq.cm Ref: Soil report at th-bed level

C= T/sq.mt

P_R= 0.5xwxhxhxkp+2ch $(kp)^{1/2}$

A= passive pressure at rear all =824.49

B= pass pressure at intermediate wall=0

A+B=passive pressure from walls =824.49-------- (I)

(2) PASSIVE PRESSURE AVAILABLE FROM KEYS:

Passive pr. with cohesion is given by

Pp= 0.5xwxhxhxkp+2ch $(kp)^{1/2}$

W= 1.80T/cu.mt

H= 0.60

Kp= 22.45

L= 10.20

Passive pr.at the bottom of the bed = (kp\xwx0.75)

= 1.80x22.45x0.75=30.31T/sq.mt

Passive pr.at the bottom of key =(kpxwx1.35)

= 22.45x1.80x1.35=54.56T/sq.mt

Passive pr.at the bottom of the key = 54.56

Hence average pr.

= (30.31+54.56)/2 = 42.44

Total passive resistance

= 42.44x10.20x0.60 = 259.71

Such 3 keys are provided below the thrust bed.

Passive resistance available

= 2.00x259.71 = 519.43T---- (II)

Total Passive Resistance Available = From Thrust

= $\{(793.49x1.306)/ (2.76x1000.00)\}^{1/2}$

= 536.19 mm

Effective depth of wall = 700.00-50.00-12.5

= 637.50mm

3.1.4.1 Reinforcement Calculation

BM = 793.49 KN-m

Effective depth= 700.00-50.00-10.00 = 640.00

To calculate Mu for given percentage of steel

Fy = 500.00, So 0.87 Fy = 435.00

Pst = 0.51, sopt/100 = 0.0050

Hence Ast= 0.501x (1000.00x640.00)/1000

=3207.63 sq.mm

Fck = 25.00.,Fy/fck= 20.00

B = 1000.00

De= 640.00

Hence Mu=0.87XFyXAsX (1-1.1XFyXAs)/(Fckbd)

0.87xFy xAs

=0.87X500.00X3207.63=1395319.17(1)

1.10X500.00X3207.631.1Fy

As /Fckbd=35.00x1000.00x640.00=0.0788

Hence 1-0.0633 = 0.9212 (2)

x (2)xd =1395319.17x0.92x640.00/10.20=822.67

Hence Mu=0.87XfyX(Pt/100)x(1-1.1xFy/fck(pt/100))xbd

Mu/bdbasedonpst=435.00x0.0050(1.00-1.100x20.00x0.0050) =1.94

Bed +Keys= 824.49+519.43=1343.91>656.87

SO SAFE

This force will be offered by passive resistance from wall, as well as keys and it will act at 1/3 of thrust wall

= 0.33x2.00 = 0.67mt

3.1.3.4Design of Thrust Wall

As Max capacity of the thrust wall is

= 829.49 T

Max force for which wall is to be designed will be

= 824.49T

Max force to be resisted by thrust wall

= 824.49

Hence forces per meter will be

= 829.29/10.20 = 80.83

The equivalent passive force diagram will have the magnitude of above

Hence the ordinate of the resisting force will be

= 1/2 x base x height=80.83

Hence base

= 80.83

And ordinate at bottom of the thrust bed

= 32.33

Ordinate at de away from bottom of thrust bed

= 58.20

Hence max. BM.in the thrust wall taking section at the bottom of the thrust bed :

Rectangle+Triangle

= (32.33x1.20x1.20/2.00)+(0.50x48.50x1.20x1.20x0.67)

= 46.68

Considering jack load as load due to earth pressure, design factor will be 1.7

Hence

DESIGN BM=1.70x46.48=79.354T-m =793.49 KN-m

Mu based on BM = (793.49X1000000)/(1000X640X640)

=1.94

As both sides are equal pst calculated is OK

Pst required =0.501

Hence area of steel=100x64x0.00501=32.08

Hence provide 25mm bars at 140 c/c through steel

Ast provided $=35.06cm^2>32.08\ cm^2$

Pst provided =0.54798%

Inside the wall. Provide 12mm bars at 140 c/c, through steel

Ast provided = $8.08\ cm^2$

3.1.4.2Designfor Shear in Thrust Wall

Max shear in thrust wall will be at effective depth away from bottom of thrust bed=1/2x (80.83+58.20)0.56=38.93T

Check for Shear:

Maximum Shear Forces Are

Max SF in wall = 38.93 T

Ultimate shear = 1.7x10xV

= 661.79 KN

Shear stress = Vs/bd=661.79/1000x640

= 1.03

For M20 grade concrete, from table 15.IRS concrete bridge code

Table 3.Table 15 of IRS Concrete Bridge Code

% of steel	Tc
<0.15	0.31
0.25	0.37
0.50	0.47
1.00	0.59
2.00	0.74

Tc=0.4300 for Pst=0.5479

Vc=0.43x1000x640 = 275.20

bxSv =1000x150 = 150000

(V+0.4-SVc)= 1.43-0.43= 1.00

0.87xFy =0.87x415.00 = 361.05

Asv =150000x1.00/361.05= 417.13

Hence provide 10mm rings connecting 2 bars 150 c/c

As main bars are provided at 140 c/c no's of legs in 1 m strip=7

Hence area of shear steel provided will be =7.00x78.54 =549.78 549.78which is >417.13Hence safe

3.1.5 Design of Thrust Bed

3.1.5.1 Data

Thickness of thrust bed = 750.00mm

Width of thrust bed = 10200.00mm

Concrete grade = M25

Jacking force required = 804.12T

Actually, this is a temporary structure, hence it can be designed without load factors, or less factors can be used, however, as per IRS code following been assumed. FORCE PER METER OF BOX

= loads x factor

On top surface

= 193.79x1.40 = 271.31

On bottom surface

= 799.34x1.40 = 1119.08

On two walls = 458.47x1.70

= 779.40

Live load surcharge

= 142.97x1.70 = 243.05

Live load of train

= 131.00x1.70 = 222.70

Total Load

= 271.31+1119.08+779.40+243.05+222.70

= 2635.54

Factored friction force will be = 2635.54x0.466

= 1228.16

Hence factored force per pin wills be= 1228.16/6

= 204.69

3.1.5.2 Jacking force: will be applied against jacking pin and jacking pin will transfer the load in the side pocket, as a couple take eccentricity 0.3m

Jacking pins provided in the bed in a row are =6.00

Jacking force per pin = 204.69 T

Eccentricity = 0.3000

Max BM for thrust bed = 1228.16X0.300

= 368.449 T m

Hence factored moment = 1.00x10x368.45

= 3684.49 KN-m

Hence moment per meter will be = 3684.49/10.20

= 361.22KN-m

Effective depth of bed = 750.00-87.50

= 662.50

3.1.5.3 Reinforcement Calculation:

BM = 361.22KN-m

Effective depth = 750.00-75.00-

12.50 = 662.50

To calculate Mu for given percentage of steel

Fy =500.00, so 0.87 Fy = 435.00

Pst = 0.2374,

soPst/100 = 0.0024

Hence Ast = 0.237x

(1000x662.50)/100 = 1572.8Sq.mm

Fck = 25

Fy/Fck = 20

B = 1000

De = 662.50

Bd^2 = 438906250

Hence Mu = 0.87 xFyxAs[1-

1.1xFyxAs]/FckBd

0.87xFyxAs =0.87x500x1572.79

= 684164.8(1)

=1.10x500x1572.79

1.1xFy xAs/Fckbd =25x1000x662.50

= 0.0522

Hence 1-0.0633 = 0.9478(2)

(1)x(2)xd =684164.85x0.95x662.50/1.0E06

Moment of resistance = 429.59>361.22

Hence OK

To calculate Mu for given percentage of steel

Fy = 415

so 0.87Fy = 361.05

Pst = 0.2374,

soPst/100 = 0.0024

Fck = 25

Fy/Fck = 16.60

B = 1000

De = 662.50

Bd^2 = 438906250

Hence Mu = 0.87xFy

x(Pst/1000)x[1-1.1 Fy/Fck(Pst/100)]bd

Mu/bd^2 based on Pst

=361.05x0.0024[1-1.1x16.60x0.0024]=0.82

Mu/bd^2 based on BM

=361.22X100000)/(1000X662.50X662.50)=0.82 As both sides are equal Pst calculated is OK Provide percentage of steel=0.2374

Hence area of steel=100x66.25x0.00237=15.73

Along with this steel there will be axial tension due to couple, formed at the pin pocket location, this will also be taken care by additional steel for pure tension inside the

thrust bed.

3.1.5.4 Tension, taken by concrete

Tension Taken By Concrete Will Be=Total Width Of The

Bed Thickness Of Thrust Bed Below Pocket X6.1kg/Cm^2

Area of thrust bed =1020x75 =76500

Less area of pockets=-1x6x2750 =-16500

Total area of plain concrete will be =60000 Tensile force taken by concrete =60000x6.1/1000 =366 T (ref: IRC21, cl303.3)

Total required force =1228.16T factored force, with load factors as per IRS

Hence steel required for force=1228.16-366=862.16 T Hence area of steel required for axial tension

= 862.16x1000x1x10/(0.87x415) = 238.79 cm^2

Hence area required per meter will be 238.79/10.20=23.41 This steel will be divided at top and bottom of the thrust bed.

As eccentricity from top is=0.275

Hence tension steel at top=0.475/0.75x23.41=14.83 cm^2

Hence tension steel at bottom=23.41-14.8

=8.58 cm2

However take 50% at bottom =23.41/2

=11.71

Hence total area of steel required at bottom will be

=11.71+15.73=27.43 cm2

Provide 20mm, main bars, so the spacing will be

= (3.142/27.43)x1000=114.52

OR

Provide 25mm, main bars, so the spacing will be

= (4.909/27.43)X1000=178.93

HENCE PROVIDE 20 MM BARS AT 100 MM C/C

OR

PROVIDE 25 MM BARS AT 160 MM C/C

REINFORCEMENT AT TOP OF THE THRUST BED:

Reinforcement required at top is=14.83 cm2

By providing 16mm steel spacing required will be

=(2.01/14.83)x100=13.56 cm

However provide 16mm bars at 130mm c/c

Fy=500

Pst=0.266

Fck=25

B=1250.00

De=662.50

So, 0.87xFy=435.00

So, Pst/100=0.0027

Fy/Fck=20.00Bd2=548632813

Hence Mu=0.87Fyx

(Pst/100) x [1-1.1xFy/Fck(Pst/100)]bd2

Mu/bd2 Based on Pst

= 435.00x0.0027 (1.00-1.100x20.00x0.0027)

=1.09

Mu/bd2 Based on BM= (479.72x1000000)/(1000x662.50x662.50)

=1.09

As both sides are equal Pst calculated is OK

Pst required= 0.266

3.1.5.5 Distribution Steel

0.12% AS RINGS are provided to form a complete beam,

there is no need of distribution steel

However provide 0.12%

(0.12x100x66.25)/100=7.95

On each face=3.98 cm2

Inside the all, provide 10mm bars at 170mm c/c, through

steel

Astprovided=4.62 cm2>3.98 cm2

Hence safe

3.1.6: Design of secondary thrust bed for pushing of second

box, casted behind first box

3.1.6.1 Force per pin

Thickness of Thrust Bed=750.00mm

Width of thrust bed=10200.00mm

Concrete grade=M-25

Self-weight of box=605.55 T,(ref Para 2.2)

Hence jacking force required =605.55x0.466=282.19

Jacking force required=282.19 T

As length of second box is less=605.55x11.00/11.00=605.55mt?

Force per meter of box on bottom force =605.55x1.70

=1029.44

Factored friction force will be=1029.44x0.466

= 479.72

Hence factored force per pin wills be=479.72/3.00

=159.91

3.1.6.2: Jacking force

Jacking force will be applied against jacking pin and jacking

pin will transfer the load inside the pocket, as couple, hence eccentricity=0.300

Jacking pins provided in the bed in a row are =3.00

Jacking force per pin

=159.91 T

Max BM for thrust bed

=159.91x0.300=47.972 T –m

Hence factored moment = 1.00x10.00x47.97=479.72 KN-m

Hence moment per meter will be=479.72/1.00=479.72 KN-m

3.1.6.3 Reinforcement Calculation

BM=479.72 KN-m

Effective depth=750.00-75.00-12.50=662.50

Total calculated Mu for given % of steel

Hence area of steel=125.00x66.25x0.00266=22.04

Along with this steel there will be axial tension due to couple formed at pin pocket location.

This will also be taken care by additional steel provided for pure tension inside the thrust bed

Total required force=159.91T

Hence area of steel required for axial tension

= (159.91x1000x1x10)/(0.87x415)

=4428.90sq.mm = 44.29sq.cm

Hence areas required per meter will be= 44.29/1 =44.29

This steel will be divided at top and bottom of the thrust bed

i.e.,44.29/2=22.145

Hence total area of steel will be=22.145+22.04= 44.19sq.cm

Provided 25mmmain barsno of bars required=44.19/4.91x1.00=9.00

However provide 25mm bars 10 no's

Reinforcement at Top of Thrust Bed:

The reinforcement required at top is =22.14 sq.cm

Hence provide 6 no's 20mm bars+3 no's 16mm bars

Ast provided

=24.88cm>22.14cm

Hence safe

3.1.7 Detailing in the Keys

The keys are provided for additional safety.

Hence provide steel 10mm bars of 160 c/c as main links connecting to thrust bed, and 9 bars @8mm bars as distribution steel.

3.1.7.1 Design of Keys in Thrust Bed

Pressure at top of key=30.31(ref Para 3.3(2))

Pressure at bottom of key=54.56

Max BM in key=42.44x0.60x0.60/2.00=7.64 T-mts

Hence factored moment=1.70x10.00x7.64=129.86KN-m

Hence moment per meter will be=129.86x1.00=129.86 KN-m

Effective depth of key = 600.00-87.50 =512.50

Reinforcement Calculation:BM=129.86KN-m

Effective depth = 600.00-50.00-12.50 = 537.50

To calculate Mu for given % of steel

FY=500

Pst = 0.106

Fck = 25

B = 1000.00

De = 537.50

So,0.87xFy = 435.00

So, Pst/100 = 0.0011

Fy/Fck = 20.00

Bd2= 288906250

Hence Mu=0.87Fyx(Pst/100)x[1-1.1xFy/Fck(Pst/100)]bd2

Mu/bd2 Based on Pst =435.00x0.0011(1.00-

1.100x20.00x0.0011) =0.45

Mu/bd2 Based on BM =

(129.86x1000000)/(1000x537.50x537.50) =0.45

Hence min steel can be provided, orotherwise depth of key can be reduced.

Pst required = 0.12

Hence area of steel = 100x53.75x0.00120

= 6.45

Hence provide 12mm bars at 160 c/c, through steel

Ast provided = 7.07 cm2>6.45 cm2 Hence safe.

3.1.7.2 Design of Front Cutting Edge:

The front cutting edge has been provided with face plate of 10mm with holdfast at the time of casting of box. With this face plate cutting edge will be welded, and for support to the cutting edge, stiffeners' are provided at 450 c/c at top, and 450 c/c at bottom.

Plate thickness provided at top portion of cutting edge is 20mm thick

Plate thickness provided at bottom portion of cutting edge is 16mm thick

Plate thickness provided at two side portion of cutting edge is 16mm thick

Loads on Stiffener: Plate on stiffeners will transfer the load
from top on to the stiffeners
Load on plates: DL+LL

Intensity of load from design of box =7557.55+4035.03=11.59 T/mt^2
(ref Para 4.0 of box design)

Loads on Stiffener: Plate on stiffeners will transfer the load to the stiffeners

Hence total intensity = 11.59 T/mt^2

Design of Plates at Top and Bottom and Sides:

As the cutting edge is supported on stiffeners and max spacing of stiffeners

At bottom spacing is = 0.450mts c/c

At top spacing is = 0.45 mts c/c

3.1.7.3 Check at Bottom Cutting Edge

BM in cutting edge =11.59x0.450x0.450/10

= 0.23 T-mt

Section modulus required = 0.23x100000/1500

= 15.65 Using 16 mm thick plate Z will be 1/6 bd2

= 42.67 cm3>15.65 cm3

3.1.7.4Check At Top Cutting Edge:

BM in cutting edge = 11.59x0.450x0.450/10

= 0.23 T-mt

Section modulus required = 0.23x100000/1500

= 15.65 Using 20mm thick plate, Z will be 1/6 bd2

= 66.67 cm3

Hence OK

3.1.7.5 Design of Stiffeners at Top, Bottom and Sides Check For Stiffeners:

At bottom spacing is = 0.450mts c/c

At top spacing is = 0.45mts c/c

Hence load on stiffeners will be

At top = 11.59x0.45

= 5.22T

At bottom = 11.59x0.45

= 5.22T

Check At Top

BM in stiffeners = 5.22x1.250x1.250/2

= 4.08T-mts

Section modulus required = 4.08x100000/1500

= 271.70 Using 12mm thick plate, Z will be 1/6 bd2

= 1125 cm3

Hence OK Check At Bottom

BM in stiffeners =5.22x0.600x0.600/2

=0.94 T-mts

Section modulus required =0.94x100000/1500

=62.60

Using 10mm thick plate Z will be 1/6 bd2

=937.50 cm3

Hence OK

3.2 Analysisof Precast Box (Tunnel)

3.2.1 Design data:

Size of box: single RCC precast box:		7.50 x 5.650
Length of each box	=	22.00 mts
No. of segments	=	2.00
Length of box unit-1	=	11.00 mts
Top of bottom slab	=	101.257mts
Proposed road level	=	101.407 mts
Clear length inside	=	7.50 mts
Clear height inside	=	5.650 mt
Thickness of top slab	=	0.750 mts
Thickness of bottom slab	=	0.750 mts
Thickness of end walls	=	0.750 mts
R.L. of top of box	=	107.657 mts
R.L. of formation level	=	108.232 mts
R.L. of rail level	=	108.907 mts
Cushion up to the formation	=	0.575 mts
Out to out of box	=	9.00 mts
Total height of the box	=	7.150 mts
C/c of outer to central wall	=	8.250 mts
Effective height of the box	=	6.40 mts
Effective span of the box	=	8.250 mts
Soil parameters:		
Bulk density	=	2.10 T/cu.mts
Angle of internal friction	=	28.00 degrees,
taken as per soil report		

3.2.2 Design criteria

A: the design has been done as per railway standards and the following codes

Indian railway bridge rules

Loading: H.M.LOADING (which is safe for 25 T loading)

IRS bridge substructures & foundation code

B: STRUCTURAL MATERAILS

Reinforced concrete	=	box 35
Reinforcement: high yield bars Fy	=	500

N/mm2

METOD OF DESIGN: LIMIT STATE AS PER IRS LATEST CODE OF PROVISION.

3.0: Recapitulation of loads on box for analysis purpose

TABLE: 1 Load on Box for Analysis Purpose

Load case	Dead loads	On top slab	On bottom slab	Left wall top	Left wall bottom	Right wall top
1	Dead wt of concrete	1875.0	4784.09			
2	Super imposed loads	2773.5	2773.5			
3	Earth pressure +DL surcharge			1190.92	5685.78	1190.92
4	Live loads	4035.0	4035.0			
5	L.L. Surcharge			1142.51	675.29	1142.51
6	Longitudinal forces			9016.22		2817.57

3.3 Design of Precast Box

3.3.1 Table of B.M at Corners and Mid Span for Members All B.M. are in KN-m, with load factors as per IRS codal provision

As per IRS code moments are to be considered at face of support,

3.3.1.1 Recapitulation of Bending Moment

(1) Table of B.M. at corners and mid span for bottom slab All B.M. are in KN-m, with load factors as per IRS codal provision

TABLE N0: 2 B.M. at Corners and Mid Span for Bottom Slab

TABLE N0: 2 B.M. at Corners and Mid Span for Bottom Slab

Nodes	Lc.no		Max Design moments
Corner moments		Moments are at face of support	
Left of member :1	11	881.31	881.31
Right of member:2		644.28	
Corner moments	Vertical walls: at face of support		
Left of member :3	11	1095.00	1095.00
Right of member:4		851.50	
Mid Span Moments	MAX as per output		
Member no:1	11	978.66	978.66
Member no:2	11	819.00	
Member no:3	11	339.00	
Member no:4	11	475.00	

(2) TABLE for shear forces at corners: All the shear forces are in KN-m, with load factor as per IRS codal provisions

TABLE N0:3 Shear Forces at Corners

Nodes	Lc. No		Max design shear
Recapitulation of max SF for corners	Top & bottom slab(at face of wall)		Design Shear
Left of member :1	11	873.70	873.70
Right of member:2	11	649.90	
SF at	2.25 m from support		
Left of member :1	11	493.00	493.00
Right of member:2	11	269.00	

From the above data, Final DESIGN details of precast box are as follows:

3.3.2Reinforcement

3.3.2.1 Reinforcement Calculations for Bottom Slab

Mu/bd2 based on Pst	=	2.30
Mu/bd2 based on B.M	=	2.30

As both sides are equal Pst calculated is ok

Pst	=	0.582
Ast provided	=	47.36 cm2
Pst	=	0.686, hence ok
Asv	=	351.80

Hence provide 10mm rings connecting 2 main bars 150 c/c As main bars provided 170 c/c no of legs in 1 m strip will be

= 6 nos

Hence area of shear steel provided will be =6 x 78.54 =471.24>351.80

Check for shear after 2.25 m from support

SF at section	=	493.00KN
Shear stress V/bd	=	0.71
Asv	=	180.86

Hence provide 8mm rings connecting 2 main bars @150 c/c As main bars are provided 170 c/c no of legs in 1m strip =6 nos

Hence area of shear stress provided will be =6x 50.27=301.62>180.86

3.3.2.2 Reinforcement Calculation at Mid Span for Bottom Slab

Mu/bd2 based on Pst=2.092

Mu/bd2 based on B.M=2.092

As both sides are equal Pst calculated is ok Pst=0.524

Ast provided=47.36 cm2

Pst=0.686, hence ok

Hence provide 20mm bars 170 c/c,through steel +25 mm bars at 170 c/c

Ast pro =47.36 cm2 hence ok

3.3.2.3 Reinforcement Calculation at Mid Span for Top Slab

Mu/bd2 based on Pst= 1.751

Mu/bd2 based on B.M= 1.751

As both sides are equal Pst calculated is ok Pst= 0.432

Hence provide 20mm bars 170 c/c, which are from vertical +20 mm bars at 170 c/c of top slab steel Ast pro =36.96 cm2 hence ok

3.3.2.4Reinforcement Calculation at Mid Span for Vertical Wall

Mu/bd2 based on Pst =1.016

Mu/bd2 based on B.M =1.015

As both sides are equal Pst calculated is ok Pst=0.243

Ast provided=28.8 cm2 hence ok

Hence provide 25mm bars 170 c/c, which are from vertical +25 mm bars at 170 c/c of top slab steel

Ast pro = 28.88cm^2 hence ok

Design of vertical wall: as per cl. No:15.7.1.1 ,of IRS concrete bridge code, if axial force is less than 0.1 fckAc,the wall shall be treated as slab, and shall be designed accordingly.

Hence provide 16 mm bars @ 170 c/c through steel + 0mm bars @0

Ast pro =11.83 cm^2

3.3.3 Calculation for Steel along the Box with Pushing Force on Box

3.3.3.1 Vertical Loads

TABLE: 4 Vertical Loads

S.NO	LOADS DUE TO	LOAD
1	AT TOP OF BOX UNIT	273.24
2	AT BOTTOM OF BOX	878.79

3.3.3.2 Earth Pressure

(REF: cl-5.7 of IRS code for sub structure and foundation)

Ka, as calculated in design of box = 0.3344

Total load on the wall = 229.24 T

Total pushing force required will be 878.00 T

4.4.3.3: Serviceability Limit State: Crack Width Calculations

(Ref: cl: 15.9.8.2, of IRS code)

Design crack width =3 acrem/(1+2 (acr-cnom)/(h-dc)) =0.1784 mm<0.20 mm

(ref table: 10, of IRS concrete bridge code)

IV. CONCLUSION OF RESULTS

- With the box pushing technique, there is no interruption to the traffic moving around.
- Better quality control due to the provision of precast boxes.
- Quantities will be less as compared to the conventional method of construction.
- The cost of construction is less as compared with the conventional method.

4.1.1 Precast box

- For the 7.5m span, we got the wall thickness as 750mm.
- For 6.4m clear height, we got the wall thickness as 750mm.

4.1.2 Thrust bed

- We have provided thickness of thrust bed 750mm for length of box 11m.
- The reinforcement details of precast box (tunnel), thrust bed is shown in the Drawing sheet.
- Various unexpected situations are likely to occur during the box pushing operations. Since the safety of running trains is directly affected, proper planning and implementation is essential for smooth completion of work. Advance analysis of site, likely problems that may arise and planning to tackle the same will help the executive for speedy and safe completion of the work.

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