

Design of Flyover Bridge

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Abstract: This venture manages the Design of a review separator in a crossing point. The site is at Mind space junction, which is confronting real movement issues because of the development. I have done a movement overview and composed all the basic parts for this review separator. The review separator contains of a deck section, longitudinal supports, cross braces, deck shaft, wharf and foundation. It is of 425m length around 0.5km. Auxiliary outline of one traverse was made for all the above parts Piece is figured by working anxiety technique according to the underwriting of IRC: 21-2000, Clause 304.2.1. Cantilever section is intended for greatest minute because of cantilever activity. Cross braces are planned for the most part for sturdiness to longitudinal supports. Elastomeric strengthened bearing plate is used. Longitudinal braces are figured by Courbon's technique. The deck bar is outlined as a cantilever on apier. The Pier is intended for the pivotal dead load and live load from the piece, braces, deck pillar. Establishment planned as balance for the protected load bearing in the dirt. Every one of the components are planned by utilizing M25 review cement and Fe415grade steel. Plans depend on working anxiety and Limit state strategy according to IRC: 21-2000 and IS: 456-2000.

INTRODUCTION

The venture territory is having high density of movement stream. General society felt awkward to cross the bustling street & therefore the flyover is basically required at the intersection. For simple activity stream of farming good sand modern products without movement blockage flyover or over scaffolds is fundamental to conquer the activity clog required. Our venture manages the Design of a review separator in a crossing point. The area is at Mind space intersection at Hitech city, which is confronting real movement issues due to the construction. We have done an activity study and composed all the basic parts for this level separator. Every one of the drawings is drafted via Auto-CAD 2013 and investigation by STAAD professional vis8.

Presentation

Introduce pattern of advancement:

Our country being basically an agricultural nation. 90% of populace is relying on it and 10% of populace relying on mechanical exercises. For passing on the item materials, for example, nourishment grains, mechanical merchandise the streets are basic. The streets and extensions are critical for growth of economy of the nation. Presently our nation is being created by creating streets and extensions.

Sorts of streets and scaffolds:

In our nation there are such a variety of sorts of streets are being developed,

- 1) Cart streets
- 2) Minor locale streets
- 3) Major locale streets
- 4) Sate expressway streets

5) National expressways streets

As needs be the courses spans, flyover, are being developed as specified beneath, For little truck street and minor region streets, little ducts spans, little flyover are built with least class A heap. For significant region street, state parkway street, national highway streets, real scaffolds and flyovers are being developed for simple stream movement. The flyover or over extensions are to be planned Class A stacking and AA stacking.

Advantage cost proportion:

The yearly cost of above proportion is calculated by taking 10% of enthusiasm at 1% of devaluation on the brought about consumption of the venture and regulatory costs of the venture. Presently the proportion between the cost systems overcomes of circuitous wage with the end goal that street charge is to be computed for sensible periods. For any venture these proportion ought to be 1:1

2. LITERATURE REVIEW

Dzolev et al, This paper displays the investigation of strengthened solid Girder Bridge planned by EN1998-2, with the assurance of the accomplished pliability in plastic pivots at the objective relocation for the composed seismic activity, for bound and unconfined solid cross segments, with and without the impacts of geometric nonlinearity. . In this paper, investigations were led for RC Girder Bridge with limited and unconfined solid cross segments [1, 2] with and without the impacts of geometric nonlinearity. In view of the sucker bends, it can be reasoned that, for a similar level of even relocation, bring down estimations of base-shear are acquired if P-impacts are connected. Gotten target displacem end and accomplished nearby flexibility likewise vary whether concrete is displayed as restricted or unconfined, giving higher esteems for bound cement.

Rajeev Sharma (2015), this paper manages the evaluation examines for the current, RC connect utilizing non-linear static examination. For the seismic evaluation of the scaffold a 3 traverse connect is chosen which is situated on the hindon stream at Ghaziabad (Uttar Pradesh). This region is exceptionally defenseless against the seismic movement since it lies in the Zone - 4 .so , the high extent quake might be happens in this region (may be more noteworthy than 7 greatness). . For doing the seismic assessment of the extension at the season of quake open sees programming is utilized. The open sees demonstrate is utilized to portray the different exhibitions of the scaffold.

3. ACTIVITY SURVEY

Activity study was made on 03.01.2017, in the extend site from 6.00 pm to 7.00 pm. This

Time was chosen on the premise of the past activity contemplate as a normal of pinnacle hour. All the four arms of the site were watched and the quantity of vehicles passed was changed over to PCU's (Passenger auto unit).

Activity PROJECTION:

The traveler auto unit of a vehicle type has been observed to be depends up on the size, and

Speed of the vehicle sort and condition. They are not subject to the stream and street width. According to IRC: 92-2000, the movement volume constrain is 10000PCUs/hour. The limit of intersection was

Assessed at 6547 PCS's/hour. The plan time frame is taken as 30 years. One year would be taken for the development. So movement is projection. So activity is anticipated for a long time, and after that the outline is made and it was 11068.

A. Movement Scenario at Mind Space Junction

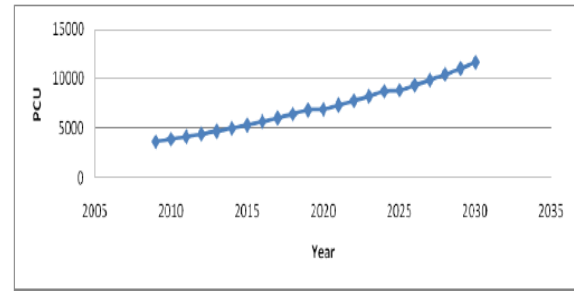
1. Center (Mind Space Junction) convergence on NH is one of the basic areas that convey a high volume of activity. The speed review led on this extends of the interstate likewise showed a pinnacle hour normal speed of 19 kmph. The investigation has commanded a flyover to be worked at this intersection. Area and proposed introduction of flyover is exhibited in Figure 2 and Figure 3.

2. from the movement examination did, it can be seen that a flyover is commanded at this area.

Table 2-1: Projected Traffic at Mind Space Junction

S.No	Year	PCU
1	2010	6,867
2	2015	9,299
3	2020	11,893
4	2025	13,816
5	2030	14,632

Figure 2-1: Projected Traffic at Mind Space Junction



4. ENGINEERING SURVEYS & INVESTIGATIONS

A. General: Different building studies have been completed for the correct arranging and outline of the review separator at the proposed intersection. Following reviews have been completed:

1. Topographical review
2. Trial pit/subsoil examinations
3. Geotechnical examinations for establishments
4. Material review

B. Land Surveys

The fundamental goal of the topographic review was to gather the basic ground components of the proposed intersection utilizing Total Station to build up a Digital Terrain Model (DTM), to deal with outline prerequisites of review isolated office, recognizing ranges of limitation and their cures. The information gathered will bring about the last outline and is additionally utilized for the calculation of earthwork and different amounts required. As initial step of the field ponder, satellite symbolism maps of the area were gathered and analyzed completely to have firsthand data about the range and to settle on the conceivable change choices. It additionally assisted in concluding the degree of land overview.

1. Point by point Survey of Topographical Features

Geographical study utilizing all out station has been completed to gather adequate information to frame the computerized territory demonstrate and to set up the guide of the physical components of the region. Following existing components have been caught amid the study:

1. Building lines, sort of structures (shops or houses, number of stories), trees and Right of Way limit if accessible at site by nearness of limit stones.
2. Road edges, centerline, shoulders/pathways, middle and so forth
3. Identifying every religious place, its areas, limit lines and clear measurements of compound dividers and passages.
4. All administration lines both above and subterranean, for example, OFC links, water and sewer funnels, gas channels, electrical

posts and links, utility poles and lines and so forth.

5. Location of movement islands, middle, rotaries, dividers and so forth.
6. Location of street side channels, unmistakably distinguishing the sort (open/close), width of deplete, including the start and end of channels.
7. Positions of transformers, pole, towers and so on
8. Apart from the over, the names of meeting streets and different points of interest are additionally recorded and fused in the drawing.

C. Trial Pit/Subsoil Investigations

1. for Pavement Design

Objective: The target of the examinations is to give premise to outline of asphalt for the administration streets keeping in see the organization and attributes of the current asphalt/sub level. The extent of work, subsequently, incorporates accumulation of data in regards to the current asphalt covering piece and qualities and existing sub review sort and sub-soil conditions. particulars of soil at site to empower legitimate asphalt plans were completed. All examinations were executed in compliance with IRC, BIS codes and MORT&H particulars. Test pits were brought the street extend at determined areas for the assessment of physical properties of the sub level soil to empower asphalt plan. The span of the test pit was kept as 1m x 1m x 1m. The agent tests of unearthed soil from every trial pit at profundity interims GL to 0.25m, 0.25m to 0.5m, 0.5m to 0.75m and 0.75m to 1m were gathered in water/air proof sacks and appropriately pressed and were sent to the lab for the required research facility tests on these examples. The accompanying tests were completed to find out the properties of the sub-level, base and sub-base layers of the current street including thickness of various layers of asphalt.

Table 3-1: Laboratory Test Results for Sub grade Area Soil

TP No	Depth (m)	Sieve & hydrometer analysis				LL	PL	Optimum Moisture Content %	Max. Dry Density g/cm ³	CBR value %	G
		Gravel Content %	Sand Content %	Silt Content %	Clay Content %						
1	GL-0.25	5	53	42	0	N	F	10.2	1.88	8.5	2.63
1	0.25-0.50	2	57	41	0	N	P	9.5	1.91	8.4	2.64
1	0.50-0.75	4	58	38	0	N	P	9.3	1.88	8.6	2.62
1	0.75-1.00	2	59	39	0	N	P	9.4	1.92	8.5	2.63
2	GL-0.25	4	53	43	0	N	P	9.7	1.87	8.2	2.61
2	0.25-0.50	3	52	43	0	N	P	9.5	1.92	8.4	2.6
2	0.50-0.75	7	48	45	0	N	P	10.1	1.92	8.7	2.65
2	0.75-1.00	7	58	35	0	N	P	9.3	1.975	8.7	2.63
3	GL-0.25	5	56	39	0	N	P	9.5	1.89	8.2	2.64
3	0.25-0.50	4	55	41	0	N	P	9.1	1.89	8.5	2.62
3	0.50-0.75	2	55	43	0	N	P	9.9	1.9	7.7	2.65
3	0.75-1.00	3	54	43	0	N	P	9.6	1.86	8.1	2.64
4	GL-0.25	0	54	46	0	N	P	9.8	1.88	8.3	2.64
4	0.25-0.50	0	58	42	0	N	P	9.2	1.89	7.9	2.63
4	0.50-0.75	0	57	43	0	N	P	9.3	1.92	8.3	2.63
4	0.75-1.00	2	60	38	0	N	P	9.1	1.94	8.6	2.62
5	GL-0.25	3	55	45	0	N	P	9.7	1.875	8.3	2.64
5	0.25-0.50	3	53	44	0	N	P	9.7	1.86	8.2	2.63
5	0.50-0.75	0	62	38	0	N	P	9.1	1.93	8.8	2.62
5	0.75-1.00	2	52	46	0	N	P	9.6	1.86	8.4	2.64

Soil Testing for Embankments

Extra tests were performed on recognized obtain zone materials, situated at sensible separation from the venture site to guarantee reasonableness of fill material and steadiness of bank. Examinations to find get zones for soil went before the testing modified. Test pits were unearthed in get territories from where material for

bank was gathered. The profundity of each test pit did not surpass the imaginable profundity of the obtain pit by more than 15 cm according to proviso 10.3.2 of IRC -19. Tests of soil to be utilized as a part of dike were tried in the research center for the accompanying properties

1. Sieve Analysis
2. Liquid Limit/Plasticity Index
3. Moisture Content - dry thickness relationship utilizing adjusted Proctor's Compaction
4. Soaked CBR at Modified Proctor Density

The tests specified above are being done as per the systems set down in IS 2720 "Strategies for Tests for Soils." The test consequences of soil tests are exhibited according to Seems to be: 1498-1959. Notwithstanding tests as of now said, tests of soil to be utilized as a part of the best 50 cm of the bank might be tried in the research center for assurance of C.B.R. Incentive at 100 for every penny standard Proctor Density and Optimum Moisture Content, absorbing the examples water for 96 hrs. Tests of comparative materials should be formed at various densities by giving distinctive number of blows in particular 25, 45, 55 and 65 following adjusted Proctor's Compaction test system in a C.B.R shape and drenched C.B.R. tried at various densities to create Density Vs C.B.R bend. From this bend C.B.R. at 98% altered Proctor Density should be worked out. The C.B.R at 98% adjusted Proctor Density should be utilized for the outline of asphalt according to IRC: 37-2001 "Rules for the Design of Flexible Pavement".

D. Geo Technical Investigations for Foundation of Structure

The geotechnical examinations were completed to value the subsoil layers and their properties to encourage finishing the establishment sort, profundity, size and arrangement. Subsoil condition is dissected alongside assessment of field and research facility information for assurance of fundamental physical and synthetic normal for the in-situ soil strata. Drill openings were taken at four areas inside the extend where wharf/establishments are arranged. The drag logs subtle elements, test results and suggestions are given in Appendix 1 (Geotechnical Investigation Report).

Objective: The target of Geo-specialized Investigations is to assess the accompanying:

1. To discover the sub-soil strata at establishment areas
2. To ponder standing Ground Water Level

3. To ponder the physical and building properties of soil strata and shake strata (if experienced).

To assess admissible safe bearing limit and settlements of soils/shake to plan establishments for structure.

1. To suggest sort and profundity of establishment
2. To prescribe enhancements to the powerless soil strata assuming any.

Extension and Methodology of the Work. The extent of work incorporates taking drill openings at the proposed flyover area and leading the accompanying Field (in situ) examinations and Laboratory Tests.

Field (In-situ) Investigations.

(i) Drilling drill gaps of 150 mm breadth to a most extreme profundity of 25m or least of 3m in shake if shake is experienced before.

(ii) Collecting aggravated and undisturbed soil tests at customary profundity interims

(iii) Conducting field-testing, for example, Standard Penetration Tests according to IS 2131-1981 at each 1.5m profundity interims or wherever strata change is seen to decide N esteems and also relative thickness and solidness of the dirt strata.

(iv) To study and record the standing Ground Water Table Level.

(v) To determine the sub-soil strata and ground geology.

Every one of the points of interest of geotechnical examinations are exhibited in the geotechnical report.

E. Material Survey and Analysis

As a major aspect of material examination, wellspring of development materials like sand, totals and so on have been distinguished. The endorsed quarry subtle elements have been gathered from the CPWD. Data on the wellspring of development materials and their properties were likewise gathered from the destinations where development work is under advance.

1. Concrete, Bitumen and Steel

Concrete and steel with IS affirmation are accessible in wealth from the neighborhood showcase or can be obtained from the producers. Bitumen of 80/100, 60/70, 30/40-infiltration grades, Crumb Rubbiser Modified Bitumen - 55 review and Polymer Modified Bitumen SBS 70 review.

2. Water Quality

Water utilized for development should be consumable. Consumable water is accessible around 1 km away the intersection area.

F. Distinguishing proof of Utilities

Amid site thinks about, the nearness of following utilities in the territory of proposed improvement has been recognized.

Table 3-2: Details of Existing Utilities

S.No	Utilities	Number
1	Lamp post	33
2	Transformer	7
3	Telephone pole	1
4	Tree	36
5	Man hole	22
6	Electric pole	51

5. IMPROVEMENT PROPOSALS AND DESIGN STANDARDS

A. General

The intersection provides food for exceptionally congested and packed activity for the duration of the day particularly amid crest hours. In view of the aftereffects of the reviews and examinations portrayed in section 2 and 3 a course of action best suiting to the activity design is proposed for enhancing the circumstance. Proposition is advanced giving due thought to limit arrive obtaining. All the site requirements have been taken care while figuring the change plot. The primary target is to enhance the current situation massively and make the development of activity reasonable to the conceivable expand, however a completely strife free circumstance can't be figured it out.

B. Geometric and Structural Design Standards

Geometry of NH 24 has a gentle bend in this extend and consequently the lifted structure likewise takes after a geometry having mellow bend. As this venture street falls inside urban cutoff points, important IRC plan benchmarks with due thought to the most recent mandate and rules of MOSRTH/IRC were taken after, beyond what many would consider possible, while defining the outline norms. Other National and International principles were likewise alluded to wherever discovered significant. Principles for the different parts are informed underneath.

1. Geometric Standards

IRC: 86 – 1983, "Geometric Design Standards for Urban Roads in Plains".

IRC: 92-1985, "Rules for the outline of trades in Urban territories"

Configuration Speed: The decision configuration speed of 100 Kmph is embraced for the flyover and at level streets. Carriageway Width. In view of the activity necessity according to projections, four path Configuration is proposed for the flyover and two path

widths is proposed for the administration streets. Foot cum deplete of 2m is proposed. Camber of 2.5% is proposed for carriageway of flyover and additionally benefits streets. Super Elevation: A most extreme super rise of 5.6% is embraced.

Flat Geometry: A configuration speed of 100 kmph is proposed for the flyover and at level streets. The base level bend sweep proposed is 800m. The sweep past which super height is not required is 1800m. Vertical Geometry: Vertical arrangement is outlined in light of the arrangement of IRC SP: 23. Outline of vertical geometry has two parts, viz. plan of angles, and outline of vertical bends. Vertical bends were outlined utilizing a base "K-esteem" of 74 for peak and 42 for droop for speed 100 kmph. An angle of 3% is proposed at the area of required ranges. Care was taken to restrict the begin and end inclinations of the vertical bends inside the decision slope.

2. Street Signage and Markings

Appropriate signage and markings are essential for wellbeing and direction of the drivers. Intersection change drawings should give cautioning and administrative suggestions at proper areas. The signs are of reflector sort to be noted effectively around evening time. All street signs are in similarity with the arrangements of IRC 67 – 2001-Code of Practice for Road Signs and IRC SP 31 – 1992 - New Traffic Signs. Roadside lighting is accommodated the flyover and also benefit streets. Light posts are settled at the edges of flyover. The street markings are in similarity with IRC 35 – 1997 Code of Practice for Road Markings with Paint and other IRC Standards.

C. Auxiliary Design Standards

The fundamental outline gauges received for the auxiliary plans are according to the necessities set down in the most recent releases of IRC codes of practices and standard particulars and rules of Ministry of Road Transport and Highways. Extra specialized references are utilized wherever the arrangements of IRC/IS codes are discovered deficient.

6. DESIGN REPORT

A. General

Nitty gritty plan of the proposed flyover has been done in view of the information gathered amid different studies like geographical overview, geotechnical study and furthermore as determined in the movement contemplate discoveries. Aside from various overview results, the urban condition of the zone additionally assumed a

noteworthy part in choosing the traverse length, kind of superstructure, state of substructure and so on. Most recent forms of significant standard codes of practices distributed by Indian Roads Congress (IRC) and MOSRTH standard particulars have by and large been followed in concluding the outline idea and in the plan of different basic segments.

B. Basic Arrangement of Flyover

The 4 path hoisted structure is proposed to have an aggregate width of 17.0 m comprising of 7.5 m carriageway for every bearing of activity, 0.5 m wide crash boundaries on either external closures and 1.0 m wide middle at the inside. The arrangement of the current street is taken after for the flyover structure too. Vertical freedom shifting from 5.8m to 6.8m is accommodated the required ranges at the intersection appropriate. The compulsory traverse comprises of two quantities of 40 m each. Post-tensioned I-braces with cast in situ deck section is proposed as superstructure.

The braces should be dispersed at 2.2 m separated with cross stomachs at underpins. The cross stomachs should be laying on POT-PTFE course. RCC pound headed docks with shaft flaring towards top bit and straight part underneath are proposed. Dock top should be cantilevered out to suit the supports. RCC trestle projections are proposed. Strengthened earth dividers are proposed to hold earth behind the projection and on sides of incline parcel. The establishment framework comprises of exhausted cast in situ heap gatherings of 1.2m measurement with normal establishing levels around 25 m underneath the current ground level. Six quantities of heaps are proposed for the projections and 8 numbers are proposed for docks.

C. At Grade Roads

The at-level streets on either side of the flyover should be of two path arrangement with carriageway width of 7.5 m. Pathways and channels having width 2m are given on the external edges. Ordinary course of action of flyover and at level street is given in the past area.

D.Design Methodology

1. Geometric Design Standards

The geometric outlines of the change proposition have been done after applicable principles of IRC. The embraced outline principles from the code are given in Table5-1.

Table 5-1: Geometric Design Standards

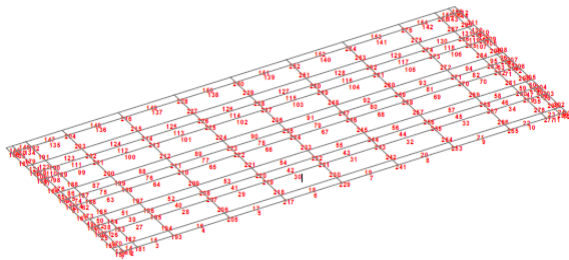
S. No	Description	Str
1	Design speed (Kmph)	100 Kmph
2	Lane width	3.5 m
4	Service Road	7.5m
5	Footpath cum Drain	2m
6	Cross-slopes Structure portion Road portion	Carriageway Carriageway
7	Maximum super elevation	Plain terrain
8	Minimum horizontal curve radius	800m
9	Radii beyond which super elevation not required	1800m
10	Gradient	Max. gradient
11	Vertical curve 'K' values Crest curve/Sag curve	Crest 74 Sag 42
12	Vertical clearance	5.8m to 6.8m

Proposed Geometry

Flat Geometry. An outline speed of 100 kmph is embraced for the flyover proposed at Mind space Junction. The nitty gritty Horizontal Alignment Report is given beneath in Table 5-2.

Figure Grillage display for superstructure examination

Figure 5-4: Grillage model for superstructure analysis



Outline of PSC Girder. The outline of PSC brace is done in view of acknowledged hypotheses.

7. BILL OF QUANTITIES COST ESTIMATES

A. Bill of Quantities

Total item wise quantities for flyover are calculated as per the detailed drawings. Separate heads for all different items of work is included in the BOQ. The major work items considered are:

- (i) Earth work
 1. Excavation
 2. Approach sub grade
 3. Landscaping
- (ii) Pavement works
 1. Granular sub base
 2. Wet mix macadam
 3. Bituminous works
 4. Wearing course over Deck slab
- (iii) Concrete
 - PCC leveling Course
- (iv) Reinforced Cement concrete
 1. Foundation
 2. Substructure
 3. Superstructure – Deck slab & Cross girders
 4. Crash barrier/median/footpath/Parapets
- (v) Pre-stressed concrete

1. Longitudinal girders
 - (vi) Steel
1. Reinforcement
2. Superstructure
3. Substructure
4. Foundation
5. Pile liner plate

CONCLUSION WITH RECOMMENDATIONS:

On the basis of above Geotechnical investigation the following recommendations are suggested:

The subsoil strata have been described in detail in clause 1.0.

The safe load capacity of proposed Normal Bored Cast in situ RCC pile may be adopted from the following table for design purposes.

Dia of Pile (m)	Cut-off Level below existing ground (m)	Length of Pile below cutoff (m)	Safe Load Capacity of Pile (T)		
			In Compression	In Uplift	In Lateral Thrust
1.0	2.0	15.0	256.1	92.8	13.9
1.0	2.0	18.0	319.1	127.6	13.9
1.0	2.0	20.0	365.3	153.4	13.9
1.2	2.0	15.0	332.3	111.4	18.7
1.2	2.0	18.0	398.5	161.3	18.7
1.2	2.0	20.0	452.0	191.4	18.7

However before embracing the above estimations of safe load limit of heap establishment for configuration purposes, these ought to be affirmed through Pile Load Tests at site according to Seems to be: 2911. 1.5 The ground water table was experienced at 21.0m profundity beneath existing ground level in the boreholes amid exhausting exercises at site. The deliberate ground water level may change because of variety in climatic conditions and in the rate of surface dissipation. Be that as it may, for configuration purposes the ground water table might be considered at 15.0m profundity underneath existing ground level as the ground water level may ascend in substantial stormy season/because of unexpected reasons. The aftereffect of synthetic investigation of subsoil test demonstrate that the pH esteem, sulfate content, chloride content are inside passable point of confinement and the RCC work arranged with Ordinary Portland Cement should not be decayed when put over/inside site subsoil. The aftereffects of synthetic examination on ground water show that the pH Value and Sulfate Contents are inside reasonable limits, the chloride content is on higher sides consequently according to Seems to be: 456, at the season of putting the solid it ought to be guaranteed that aggregate sum of chloride (Cl) of all constituents of cement should be according to Table 7 of IS:456-2000. 1.6 The layer savvy properties of subsoil strata might be embraced from table no.1 and 2.0 of condition.

CONCLUSIONS

In this venture movement review was directed to know the hourly Passenger Car Unit (HPCU) at FOUR ROADS Intersection, Hyderabad. From study the estimation of HPCU of the crossing point is 6547, by

considering future taking the plan time of 30 years, the estimation of HPCU is discovered 65273. From the above outcome it is proposed a review separator at that circuitous. In this review separator the principle parts comprises of Deck section, longitudinal support, Cross brace, bearing plate, Pier and Foundation. The geometric plan of the review separator was finished by utilizing IRC Code Books. The Deck piece is composed by utilizing IRC: 6-2000 codal arrangements. Here after in advance we need to consider the examination, longitudinal brace, estimation, steel prerequisite and cost of Analysis and Design of flyover. All measurements are in mm

Plan OF RETAINING WALL:

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Stature of dike over the ground level = 4.4m

Unit weight of soil = 20 kN/m³

Point of reaction = 30°

Safe bearing limit of soil = 245 kN/m

Co-efficient of contact = 0.5

Utilize M25 cement and Fe415steel

Outline of toe chunk:

Give 16mm Dia bars at 220mm c/c

Plan of Shear key:

Give 16mm Dia bars at 200mm c/c.