



GOVERNMENT OF NEPAL
MINISTRY OF PHYSICAL INFRASTRUCTURE AND TRANSPORT
DEPARTMENT OF ROADS, BRIDGE BRANCH

STANDARD SUPERSTRUCTURE DRAWINGS FOR ROAD BRIDGES

- ***4.0m Simply Supported RIGHT Span, Cast-in-situ,
Reinforced Concrete Slab-Deck
SKEW ANGLE : $>22^\circ$ to 35°***



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REFERENCE 'NOTES'

- The NOTES given in Drgs. No: "1/7 to 4/7 of R.C. Slab-Deck cis 4.0m-SS Span (>22°-35°SKEW)" are applicable for the Superstructure covered by Drgs. No. 5/7 to 7/7 of R.C. Slab-Deck cis 4.0m-SS Span (>22°-35° SKEW), and must be followed strictly.
- The above referred NOTES are in addition to the NOTES given in the said Drgs. No: 5/7 to 7/7.
- All dimensions are in millimeters, unless stated otherwise.
- No dimension shall be scaled from the Drawings; only written dimensions shall be followed.
- Any doubtful Dimensions/Descriptions shall be brought to the attention of the Engineer-in-charge for any corrections (if any) before execution of work.
- Number of reinforcement bars shall not be counted from the Drawings. Only given spacing and/or specified numbers of bars, shall be provided.
- All materials and workmanship shall be in accordance with these NOTES and those in the stated Drawings and shall be generally in accord with the applicable Specifications and relevant Standards/Codes of Practice specified therein and Sound Engineering Practice.
- This Bridge Superstructure is designed for One Lane of IRC Class 70R Loading, Two Lanes of IRC Class A Loading, and One Lane of IRC Class A Loading, whichever governs, in addition to a Footpath Live Load corresponding to 500 kg/m² of Footpath area as per Clause 206.3 of IRC - 6 (2014).

- The Contractor shall be responsible for constructing and maintaining all parts of the structure in stable, acceptable and serviceable condition, ensuring no part under construction is unduly stressed and unsafe.

10. CONSTRUCTION SEQUENCE:

Entire Deck (i.e. the Superstructure comprising the cast in situ Reinforced Concrete slab Deck) shall be concreted in one operation in one day for one span. This entire Deck must be cast in-situ on staging in span on one single day.

11. CEMENT

- High strength Ordinary Portland Cement 53 Grade, conforming to IS: 12269 or 43 Grade conforming to IS: 8112, capable of achieving the required design concrete Strength and Durability, shall be used.
- Cement shall be obtained from approved Manufacturers only.
- Cement content in the Concrete Mix for Reinforced Concrete shall not be less than 350 kg/m³ and not more than 450 kg/m³.

12. COARSE AND FINE AGGREGATES:

- Maximum size of Coarse Aggregate used shall be 20mm. Fineness Modulus of Sand (Fine Aggregate) shall not be less than 2.3. Both these Aggregates shall be of Approved Quality, from Approved Sources, and of Approved Gradations, etc. conforming to IS: 383 (1970).

13. ADDITIVES:

- To suitably improve workability and increase initial setting time of concrete and cement grout, Admixtures conforming to IS: 9103, and ASTM C-494 Type F water-reducing, high range admixtures, shall be permitted in appropriate dosages, subject to their satisfactory proven use.

14. REINFORCEMENT:

- All reinforcing steel bars shall be High Yield Strength Deformed type and Thermo Mechanically Treated, having specified minimum 0.2 per cent proof stress of 500 MPa conforming to IS: 1786.
- Minimum lap-length of reinforcement bars shall be 65d where d is the dia. of the smaller diameter bar to be lapped (unless otherwise specified).
- Not more than 50 percent of reinforcement crossing a section shall be lapped at that location.
- All laps in reinforcement shall be properly staggered and minimum distance between the laps shall be 1.33 times the lap length.
- Bending of reinforcement bars shall be as per IS 2502.
- Legend for reinforcement bar-marking

First two digits refer to "bar diameter" in mm.
Next two digits refer to "bar-shape" mark.
EXAMPLE: Bar designated as: 2005 means 20 mm dia bar of shape '05'

15. WATER:

Water for concrete and for its curing shall be of potable quality and presence of any salts, sugars and pollutants like chlorides, sulphates, algae, etc., shall be well within their limits specified in the relevant Specifications.

16. CONCRETE AND CONCRETING:

- WATER-CEMENT RATIO**, by weight, shall not exceed 0.40 for Reinforced concrete.
- MINIMUM CLEAR CONCRETE COVER** to reinforcement bars shall be 40mm.
- CONTROL OF SURFACE EVAPORATION**

Use the graphical Figure below to estimate and control the loss of water through surface evaporation in the laid concrete:

One or more of the following actions shall be taken to reduce the surface evaporation rate to no more than one kilogram of water per square metre of surface area per hour:

- Construct Windbreakers to effectively reduce the wind velocity (to suit) in the area of concrete placement. The construction of windbreakers or enclosure should not proceed without approval of the Engineer with respect

to their structural design relative to safety, stability, adverse loads, and vibrations in the falsework.

- Install stationary Fog Sprayers upwind of the concreting operation to effectively increase the relative humidity in the area of concrete placement.
- When necessary, effectively reduce the temperature of concrete (to suit) by cooling one or more of its components as well as lightly spray wet the shutters and the tied reinforcements. Ice, if added to the mix-water, shall be completely melted prior to using that water.

iv. GRADES OF CONCRETE

The structural concrete involved in this Bridge Deck shall be suitably designed as High Strength Concrete Mix having 28 days minimum works Cube Crushing Strength in Compression on 150 mm Standard Cubes as follows:

• for the entire cast in situ (cis) Reinforced Concrete Slab-Deck	35 MPa (i.e. M-35 Grade Concrete)
• for the Reinforced Concrete in~ – Road Kerbs, Parapet Bases and Parapet Posts	35 MPa (i.e. M-35 Grade Concrete)

v. CONSTRUCTION JOINTS:

- As far as possible there shall be no Construction Joints in casting this Slab-Deck. However, if a Construction Joint is absolutely necessary, it shall be planned in advance and the placing of concrete carried out continuously from Joint to Joint.
- A Construction Joint should not be located near the centroid level of the section as here transverse SHEAR stress is highest. The Joint should be nearly perpendicular to the principal lines of tensile stress and in general be located at points of minimum Shear and minimum Moment – as far as possible.
- Where dowels, reinforcing bars, or other adequate ties are not provided at Construction Joints, 'keys' should be formed at reasonable spacing by embedding water-soaked beveled timbers while the concrete is still soft.

- These keys should be sized to suit the details, or as directed by the Engineer, and these key-forming timbers shall be removed when the concrete has initially set.

- In resuming concreting work, the surface of the concrete previously placed shall first be thoroughly cleaned of dirt, scum, laitance, loosely projecting aggregates and any other soft material, using stiff wire brushes, and – if deemed necessary by the Engineer – by sand blasting.

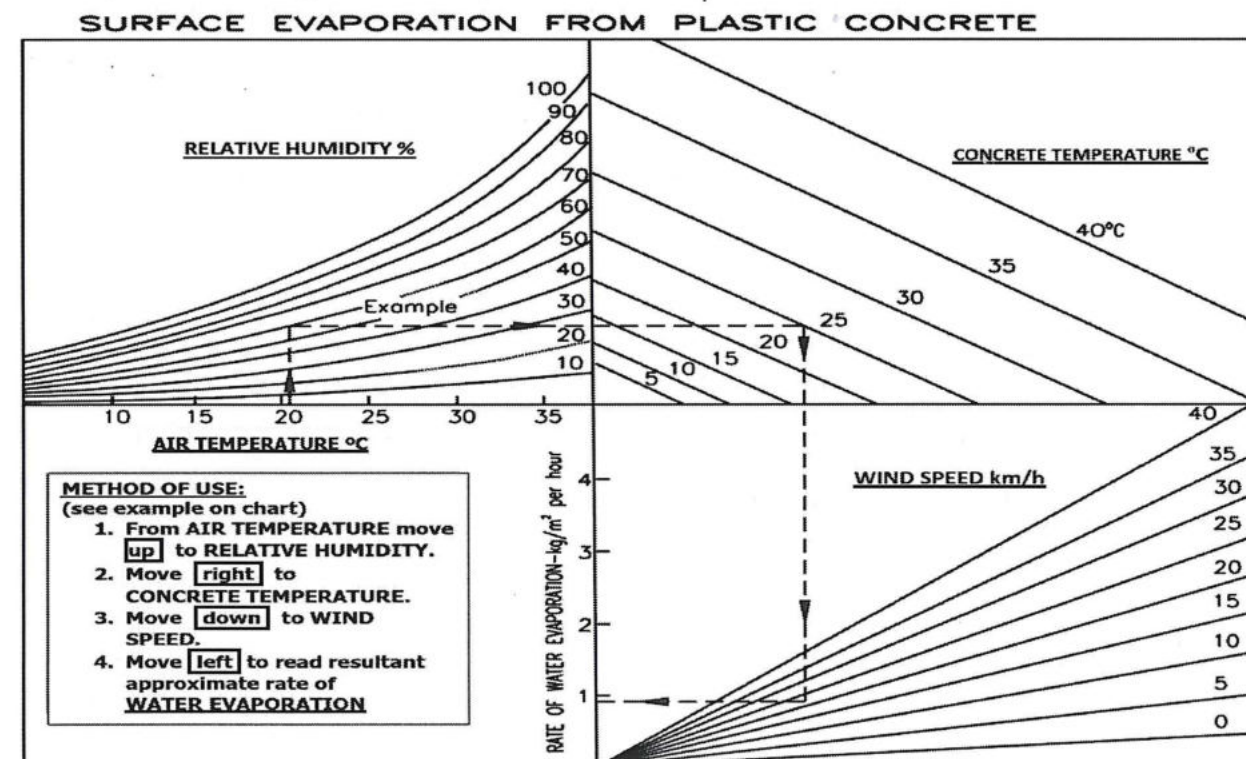
- The concrete surface shall then be thoroughly soaked with clean water (just before further concreting) and the free water, etc. air-blown away, and the cleaned concrete surface painted with a thin layer of cement slurry, and only then further concrete poured.

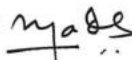
- 'Wire-mesh' and other similar items do not provide a proper construction joint, and they shall not be used.

vi. COLD JOINTS:

- When a planned 'continuous' placement of concrete in any structural member is interrupted or delayed, for any reason, for a period long enough for the previously partially placed concrete to take its initial set, the Engineer may declare such a joint as a Cold Joint and the Contractor shall immediately remove the previously partially placed concrete from the Forms.
- However, where feasible, the previously partially placed concrete may instead be suitably and carefully hacked and its hacked end brought into 'low shear low moment' zone as far as possible, and given shear key depressions after bringing it nearly perpendicular to the principal lines of tensile stress (for example: brought to vertical or nearly vertical in a beam with principal bending reinforcement horizontal) and thereafter same treatment shall be given to it as to a Construction Joint and only then the concreting resumed (making sure all reinforcements are as per the approved Drawings and the Shuttering has been brought to line and plumb tightly).

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GOVERNMENT OF NEPAL MINISTRY OF PHYSICAL INFRASTRUCTURE AND TRANSPORT DEPARTMENT OF ROADS, <u>BRIDGE BRANCH</u>			
STANDARD SUPERSTRUCTURE DRAWING FOR ROAD BRIDGES			
Road Carriageway Width: 7.50m. plus 2 Footpaths		Overall Deck Width: 11.00 m	
Effective Simply Supported <u>RIGHT Span</u> (centre to centre of Bearings) : 4.0 m R.C. Slab-Deck, >22°-35° SKEW		<u>LIVE LOAD</u> : IRC 1 Lane of 70R or 1 or 2 Lanes of Class A, whichever governs, and Footpath Loading	
Drg. No.: 1/7 of R.C. Slab-Deck cis 4.0 m-SS Span (>22°-35° SKEW)			
Drg. TITLE: REFERENCE NOTES (4 Sheets): Sheet 1/4			
<u>Design:</u> STDD.	<u>Mentored by:</u> Dr. V. K. Raina Bridge Techl Expert, DoR/ World Bank		<u>Date:</u> May 23, 2015
<u>Drawn by:</u> Bicky G. Shakha 	<u>Accepted by:</u> Saroj K. Pradhan (DDG, DoR) 	<u>Revisions:</u>	
<u>Checked by:</u> Naresh P. Keshari Engineer, DoR 	<u>Approved by:</u> Madhab K. Karki (DG, DoR) 		

vii. **CURING AND PROTECTION OF YOUNG CONCRETE:**

a) All structural concrete shall be cured for a period of time required to obtain the specified strength, but for not less than fourteen consecutive days (and nights) beginning immediately after 'initial setting' of concrete (which is when it loses its surface sheen).

b) Curing (Membrane-curing or Water-curing) of laid concrete shall be carried out as generally explained below:

c) **Membrane-Curing the Concrete:**

c.1. Except for at Construction Joints and surfaces sealed by Forms, liquid membrane curing compound can be used (for curing the concrete) as follows:

c.2. On bridge deck top surface and other exposed surfaces, liquid membrane curing compound shall be applied soon after Initial Setting and as the Surface Sheen has disappeared and the concrete is still slightly damp (not wet).

c.3. On shuttered i.e. formed vertical surfaces, Forms shall be stripped as soon as practical (generally after 24 hours of casting) and liquid membrane curing compound applied immediately except in the areas that require rubbing or finishing during the curing period.

c.4. These areas shall be kept water-wet until their finishing is completed, whereafter the liquid curing membrane shall be uniformly applied on them also when their surface is damp.

c.5. White-pigmented liquid membrane curing compound shall be used for all surfaces where the structure temperature during curing period is likely to reach about 35°C or more.

c.6. For bridge decks which are to receive an asphaltic overlay, residual curing membrane (after curing) shall be removed prior to the overlaying.

c.7. Removal methods and results should be approved by the Engineer.

c.8. The membrane curing compound used shall be of longer lasting duration and in accordance with the requirements specified for curing membrane material, AASHTO M 148 or the equivalent IS Specification.

c.9. The curing membrane shall be applied in two applications one immediately following the other.

c.10. The rate of each application of curing compound shall be as prescribed by the manufacturer, with a spreading rate per application of at least one litre of liquid per five square metres of concrete surface.

c.11. If the concrete has dried up or has become dry, it shall be thoroughly wetted with water and the curing compound applied just as the surface film of water disappears and the surface is damp.

c.12. During curing operations any unsprayed surfaces shall be kept cured with watered Hessian cloth, and sprayed with the curing compound when Surface is damp (not wet).

c.13. Any curing membrane material on Construction Joints and/or on reinforcing steel shall be completely removed before the following concrete pour.

c.14. Hand operated spraying equipment shall be capable of applying constant and uniform pressure to provide uniform and even distribution of the curing membrane at the rates required.

c.15. The curing compound shall be kept thoroughly mixed at all times during usage/application.

c.16. No traffic of any kind shall be permitted on the curing membrane until the curing period is completed, design permitting.

d) **Water-Curing the Concrete:**

d.1. All concrete surfaces, unless still sealed by unreleased Forms (which shall be kept from heating-up under ambient temperature) or submerged, shall be water-cured unless liquid membrane cured.

d.2. Water curing shall begin just after initial setting of concrete (which generally occurs by about 60 minutes of placement of un-admixtured concrete and by about 120 to 180 minutes of placement of admixtured concrete) and just after the surface water sheen has disappeared.

d.3. Surfaces water-cured shall be covered with wet sand, cotton mats, or double-thickness burlap (Jute/Hessian) sheets.

d.4. This Hessian material shall be placed tightly around and behind any projecting reinforcing steel in order to completely cover the fresh concrete surface.

d.5. The Hessian material shall be completely saturated with water and kept continuously saturated throughout the curing period.

d.6. After the initial saturation, unless water is kept running, all surfaces shall be covered with thick polythene sheeting or other approved impervious material in order to protect/prevent drying-up of concrete surface being cured continuously.

d.7. The sheeting shall be weighted down or secured well to prevent moisture-loss but the surfaces of the concrete shall be readily available for inspection of the Engineer (or his Representative).

d.8. The sheeting material shall be in good repair.

d.9. Sheeting that contains holes or is otherwise damaged shall be repaired or replaced immediately.

d.10. The Contractor shall be responsible for thoroughly inspecting and monitoring the concrete surfaces throughout the curing period to ensure continuous wet curing.

d.11. Additional water shall be poured on any areas where saturation is reduced.

d.12. Inspection of curing by the Contractor shall be conducted at least TEN times per day and night for the duration of the curing period – and even more often if ordered so by the Engineer.

d.13. The Engineer shall be advised of the curing inspection schedule and he (or his Representative) may accompany the workmen to verify the acceptability of curing.

e) **'COLD-WEATHER' CURING:**

e.1. When concrete is placed and the air temperature is expected to drop below 5°C during the curing period, the Contractor shall provide suitable measures such as straw, additional burlap or other suitable blanketing materials and/or housing and artificial hot-air-curing to maintain the concrete temperature between 10°C and 32°C as measured on the surface of the concrete.

e.2. The surface of the concrete shall be kept moist and warm by the use of an approved warm moisture barrier such as warm wet Burlap/Hessian.

e.3. The moisture barrier should be maintained in intimate surface contact with the concrete during the entire curing period.

e.4. After the completion of the curing during the entire required curing period, the Contractor shall stop the curing and remove the protection in such a manner that rapid cooling of the concrete will be prevented.

e.5. When concrete is placed in 'cofferdams' and subsequently flooded with ground water, the above curing conditions may be waived, provided the surface of the water is not permitted to freeze/dry.

viii. **"CONCRETING" IN "ADVERSE WEATHER" CONDITIONS:**

a) **'Concreting' in "Cold" Weather**

a.1. Concrete that freezes soon after placing, gains rather low strength and some permanent damage is certain to occur. Therefore, such concrete shall be removed and replaced immediately.

a.2. 'Planning for Protection of fresh concrete' during placement, and until it has attained the minimum properties required for the environment and the loading to which it will be exposed, shall be done well in advance of concreting and approved by the Engineer.

a.3. Appropriate equipment shall be made available in time for heating the concrete materials, for constructing enclosures and for maintaining favourable temperatures even after the concrete is placed.

a.4. Concrete shall never be placed on cold Forms and cold steel.

a.5. When the temperature of these items is below 5°C, the Contractor shall use means to raise their temperatures to above 10°C.

a.6. When faced with prolonged cold temperatures, all aggregates, or mixing water, or both, shall be heated to about 25°C to 32°C.

a.7. At temperature at least 10°C above freezing, it is seldom necessary to heat the Aggregates.

a.8. At temperatures below or at freezing, often only the Fine Aggregate is heated to produce concrete of the required temperature, provided the Coarse Aggregate is free of frozen lumps and the Temperature of Water for the Mix is at least 10°C.

a.9. If aggregate temperatures are above freezing, the desired concrete temperature usually can be obtained by heating only the mixing water.

a.10. Appreciable fluctuation in the mixing water temperature from batch to batch shall not be allowed.

b) **'Concreting' in "Hot" Weather:**

b.1. No concrete shall be placed when the ambient air temperature at job site in shade is expected to exceed about 35°C during placement operations.

b.2. When the temperature of the 'concrete mixture' is expected to exceed about 25°C, a retarding admixture shall be included in the approved mix design since setting time tends to reduce at higher temperatures.

b.3. The temperature of the concrete mixture immediately before placement shall not exceed 32°C.

b.4. When the ambient air temperature is above 32°C, all Forms, reinforcing steel, and other contact surfaces shall be cooled to below 32°C until concrete is placed.

b.5. When such high ambient temperature conditions exist, the most appropriate solution is to resort to evening-night-&-morning-time concreting.

b.6. However, if the above stated precautions are taken to help lower the temperature of contact surfaces and the concrete mix-ingredients are also cooled (explained ahead), concreting can be carried out even during day hours provided the ambient air temperature in shade does not exceed 40°C.

b.7. Mixers, chutes, belts, hoppers, pump lines, and other production and placement equipment can be shaded, painted white, covered with (wet) burlap, or otherwise cooled to reduce the effect of the sun's heat.

b.8. Forms and reinforcing steel can be sprinkled with cold water and covered with wet burlap until controlled concreting commences.

b.9. Sprinkling the area with water spray, gainfully cools the contact surfaces and surrounding air and desirably increases its relative humidity.

b.10. This not only reduces the 'temperature rise' of the concrete but also minimizes evaporation of water from the concrete during placement and after casting.

b.11. For slabs on ground, it is a good practice to dampen the sub-grade the evening before concreting.

b.12. There should be no standing water or puddles on the sub-grade or inside the Forms when the concrete is placed.

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STANDARD SUPERSTRUCTURE DRAWING FOR ROAD BRIDGES		
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Effective Simply Supported RIGHT Span (centre to centre of Bearings) : 4.0 m R.C. Slab-Deck, >22°-35° SKEW		LIVE LOAD: IRC 1 Lane of 70R or 1 or 2 Lanes of Class A, whichever governs, and Footpath Loading
Drg. No.: 217 of R.C.Slab-Deck cis 4.0 m-SS Span (>22°-35° SKEW)		
Drg. TITLE: REFERENCE NOTES (4 Sheets): Sheet 2/4		
Design: STDD.	Mentored by: Dr. V. K. Raina Bridge Techl Expert, DoR/ World Bank	Date: May 23, 2015
Drawn by: Bicky G. Shakha	Accepted by: Saroj K. Pradhan (DDG, DoR)	Revisions:
Checked by: Naresh P. Keshari Engineer, DoR	Approved by: Madhab K. Karki (DG, DoR)	

- b.13. The mix water may be cooled by using shaved or crushed ice but only as much ice should be used as will be melted entirely before this water is added to the mix.
- b.14. All water used for making ice and for cooling or sprinkling, and curing, must meet the same quality requirements as those for water used for Mixing of Concrete.
- b.15. Of particular concern are the polluting sulphates and chlorides (salts) in the mix, which can adversely affect the cement and corrode the reinforcing steel, respectively. These must be kept below their specified limits.
- b.16. Aggregates should be cooled by shading and sprinkling water (fog spray).
- b.17. Transporting and placing concrete shall be done as quickly as practical during hot weather.
- b.18. Delays contribute to loss of slump, a damaging increase in concrete temperature and loss of workability.
- b.19. Enough workmen and equipment shall always be available to handle and place concrete immediately upon delivery.
- b.20. Prolonged mixing, even at agitating speed of the Drum, shall be avoided since it might heat-up the mix and reduce workability.
- b.21. If delays occur, the heat generated by continued mixing/agitating can be minimized by stopping the mixer and then agitating intermittently, but the delays shall be kept short.
- b.22. Since concrete hardens more rapidly in hot weather, extra care in placing techniques is required to avoid Cold Joints.
- b.23. For placement of Concrete in Walls, Shafts, Columns, etc., shallower layers may be required to assure proper consolidation and monolithicity with each previous lift, effective dissipation of heat of hydration and to prevent segregation of the mix.
- b.24. Temporary sunshades and windbreakers help to minimize adverse effects of hot weather, winds, and surface evaporation.

ix. **CAUTION AGAINST "PLASTIC-SHRINKAGE" CRACKING of Concrete AND USING EXCESSIVE DOSAGES OF ADDITIVES like 'RETARDER' and 'SUPER-PLASTICISER'**

- a) Plastic Shrinkage cracks develop prior to initial setting of concrete and can appear more prominently in slabs. If the rate of surface evaporation from the freshly laid concrete is faster than the rate of upward bleeding through it, the concrete surface tends to dry up, hence shrink, causing cracks in plastic concrete due to tension from this shrinking under such condition. These cracks travel downwards from the surface and their propagation is locked only upon 'initial setting' of concrete.
- b) The longer the initial setting time, deeper will these cracks penetrate. Should they travel down to a significant depth of slab, then the slab can become a bunch of isolated concrete blocks separated by these cracks, and hence not be structurally monolithic with the rest of the Deck-section. Such deep-penetrating crack distress, in all probability, generally is not repairable by Epoxy filling of these cracks. The result may be a major Damage, requiring major rehabilitation.

- c) Hence minimum doses of Retarders and Super-Plasticizers shall be used so as to keep the initial setting time to just the required minimum to allow the required 'workability' of concrete.
- d) These cracks can be of random pattern (alligator-skin pattern) and/or may be somewhat parallel to each other and nearly perpendicular to the direction of wind that prevailed at the time of casting. Hence the field staff must look for these cracks before the concrete has initially set and, should these cracks occur, the plastic concrete should be quickly lightly 're-trowelled' on its surface (not re-vibrated) to close these cracks in time.
- e) Reducing the ambient Temperature and increasing the ambient Relative Humidity (by Fog-spraying), lowering the Temperature of Concrete to less than 32°C (by cooling the Aggregates and the mix-water), and reducing the Dosage of Retarder and Super-Plasticizer, will help in controlling the endemically dangerous Plastic Shrinkage Cracking.
- f) Concrete slabs which are correctly re-trowelled should not exhibit Plastic Shrinkage cracks because the action of floating and trowelling is a form of recompaction that tends to close them as fast as they form. (This trowelling can, however, aggravate sedimentation of solids in the mix and cause Plastic Settlement cracks – see ahead.)
- g) Although the Plastic Shrinkage cracks can be wide at their start (even up to 2 mm), the width rapidly diminishes with depth. Nevertheless, in severe cases they may pass through the full depth of a slab, in contrast with most types of Plastic Settlement cracks.

If not noticed in the soffit of not-easily-accessible-slab-soffits, thorough wetting at the top of the slab may show them in case of full depth penetration. Taking cores can reveal them precisely.

- h) Plastic Shrinkage cracks rarely reach the free ends of the slab (e.g. the edges of a slab) because these edges are free to move under plastic shrinkage. This is a very important way of differentiating them from long-term drying shrinkage cracks if the time of formation is unknown. However, Plastic Shrinkage cracks will form up to the ends of a slab which has been cast against a previous pour, especially if there is continuity of steel, because this acts as restraint.
- i) The factors that determine rate of surface evaporation are: the temperature of the concrete, the air temperature, relative humidity, and wind velocity of the air adjacent to the concrete. The evaporation increases as the humidity decreases, as the wind velocity increases, as the air temperature decreases, and as the concrete temperature increases. Of particular interest is the fact that rapid evaporation is at least as big a problem in cold weather as in hot weather! Even when the relative humidity be 100 per cent in cold weather, there will be a large amount of evaporation if the concrete is warm! Of all the factors listed above, only the concrete temperature is easily controllable. There is a definite advantage to cool the concrete! It shall be placed as cool as practical in warm weather and should not be overheated in cold weather. If the concrete temperature is reduced to about 27°C to 15°C, much of the evaporation can be eliminated!
- j) In hot weather, sometimes concreting during 4 p.m. on the previous day up to 12 noon on the next day may be resorted to for preventing formation of Plastic cracks and obtaining better quality concrete. But this will be effective only if it gives significantly lower concrete temperatures and lower wind velocity. The reduction of air temperature BUT not that of concrete (even with the increase in relative humidity) will not significantly reduce the Plastic Shrinkage cracking.

- k) If it is not possible to eliminate the risk of Plastic Shrinkage cracks even by improved timely curing, then changes to the concrete mix must be considered. First, check that the concrete does not contain an admixture with high retarding effects. If it does, try to reduce it or replace it with the one that does not retard so much (rather than counter it by adding a compensating accelerator!). Second, consider the use of air entrainment. Air-entrained concrete exhibits less Plastic Shrinkage cracks than plain concrete. At first sight this might seem illogical because as air entrainment reduces the rate of bleeding it should increase the risk of Plastic Shrinkage cracks occurring at a given rate of evaporation. However, most commercially available air-entraining agents are 'detergents' and therefore reduce the surface tension caused by drying, and consequently reduce the shrinkage cracking.
- l) The prevention and timely repair of Plastic Shrinkage cracks in slabs is particularly critical. This is because the cracks are wide at the top and can rapidly take in pollutants which may cause subsequent spalling and prevent the subsequent satisfactory application of sealing materials. Clearly wide cracks in slabs are not likely to be self-healing at the top and are likely to spall and allow ingress of pollutants.

x. **CAUTION AGAINST POSSIBLE DAMAGE DUE TO "PLASTIC SETTLEMENT" CRACKING OF CONCRETE**

- a) Plastic Settlement cracks occur in not-yet-initially-set concrete when there is a relatively high amount of bleeding through it and some form of obstruction to the downward sedimentation of its solids (e.g. the reinforcement bars). These obstructions 'break the back of the settling concrete' over them as its solids fall downwards around them, fomenting formation of hollows under their 'belly'. Thus Cracks show directly over formwork-tie-bolts and over reinforcement near the top of the plastic concrete, reflecting their pattern. Such Cracks can also appear in narrow columns and walls where the said sedimentation is prevented by the resulting arching of the concrete due to downward passage for sedimentation and there may be further aggravation by the presence of horizontal bars.
- b) Plastic Settlement Cracks can be prevented by reducing the bleeding and hence the sedimentation, and by reducing the obstructions to sedimentation.
- c) Admixtures such as plasticizers reduce water demand and thus are the most effective way of reducing bleeding and sedimentation and hence the plastic settlement cracks. These can also be eliminated by light re-vibration (not re-trowelling) of the not-yet-initially-set concrete if they have formed, thus also filling back the under-belly hollows.

- d) This light re-vibration shall not be applied too soon otherwise a second phase of bleeding can still cause Plastic Settlement cracks. The correct time can easily be determined by simple site trials: it will be the last time that a vibrating poker can be inserted into the concrete and removed without leaving a significant trace. Re-vibration is often the only way to eliminate plastic settlement cracks, particularly in deep sections. Trowelling the surface can actually aggravate these cracks as the pressure may only cause further settlement of solids!

xi. **BEWARE OF CRACKS DUE TO "PLASTIC-SHRINKAGE" and "PLASTIC SETTLEMENT" IN CONCRETE WHILE IT IS STILL PLASTIC AND HAS NOT YET ATTAINED "INITIAL SET"**

- a) Plastic cracks by their very nature pass through the cement matrix and around aggregate particles; therefore they are very rugged and capable of transferring shear, providing there is sufficient reinforcement to maintain aggregate interlock.

Consequently full structural repairs (using epoxy formulation) may not be necessary, though preferable....BUT only if the crack penetration is minor BECAUSE otherwise if deep penetration damage is done, EPOXYING WILL NOT restore full monolithicity (.....in which case the Deck-slab may have to be demolished, requiring major and very costly rehabilitational exercise). HENCE BEWARE OF PLASTIC CRACKING!!

- b) If cracks follow the pattern of the top reinforcement it may be difficult at first to determine whether they are due to Plastic Shrinkage or Plastic Settlement. If it can be shown that the cracks 'pass through the slab' and follow the pattern of the steel, then they are almost certainly Plastic Shrinkage cracks that have been orientated by the steel!
- c) Plastic cracks often form in the top face of sections e.g., Plastic Shrinkage cracks in slabs, and/or Plastic Settlement cracks on top of deep beams and walls. Thus they can be accessible, and this coupled with the fact that they form so early in the life of concrete, means that they may widen as thermal contraction and drying shrinkage take place. Consequently it may not be wise to fill plastic cracks with 'rigid' epoxy materials until it is certain that the long-term effects have subsided.
- d) Plastic Settlement cracks over steel must be immediately and efficiently 'sealed' if the concrete is in an exposed state (to eliminate the risk of corrosion of the steel). Reduced bond strengths due to under-belly voids thus formed under steel bars are dangerous.

xii. **ACCEPTABILITY CRITERIA OF CONCRETE CUBE CRUSHING TEST RESULTS FOR APPROVING THE CONCRETE THEY REPRESENT:**

- a) The acceptability criteria of Standard Cube crushing test results shall be that not more than 5% of works cubes fall below the specified minimum works strength. For this to be fulfilled, the Mean Strength of works cubes tested at 28 days age less 1.64 times the "Standard Deviation" should not be less than the required minimum 28 day works cube strength.

....cont'd

GOVERNMENT OF NEPAL MINISTRY OF PHYSICAL INFRASTRUCTURE AND TRANSPORT DEPARTMENT OF ROADS, BRIDGE BRANCH		
STANDARD SUPERSTRUCTURE DRAWING FOR ROAD BRIDGES		
Road Carriageway Width: 7.50m. plus 2 Footpaths		Overall Deck Width: 11.00 m
Effective Simply Supported RIGHT Span (centre to centre of Bearings) : 4.0 m R.C. Slab-Deck, >22°-35° SKEW		LIVE LOAD: IRC 1 Lane of 70R or 1 or 2 Lanes of Class A, whichever governs, and Footpath Loading
Drg. No.: 3/7 of R.C. Slab-Deck cis 4.0 m-SS Span (>22°-35° SKEW)		
Drg. TITLE: REFERENCE NOTES (4 Sheets): Sheet 3/4		
Design: STDD.	Mentored by: Dr. V. K. Raina Bridge Techl Expert, DoR/ World Bank	Date: May 23, 2015
Drawn by: Bicky G. Shakha	Accepted by: Saroj K. Pradhari (DDG, DoR)	Revisions:
Checked by: Naresh P. Keshari Engineer, DoR	Approved by: Madhab K. Karki (DG, DoR)	

b) ALTERNATIVELY (if the Standard Deviation for the concerned Concrete-Mix has not been established), the cube strength shall be accepted as complying with the strength requirement either "if none of the specimens tested falls below the minimum specified strength" or "if the average strength of the specimens is not less than the specified minimum, no individual test result falls below 85% of the minimum required works strength and the difference between the maximum and the minimum strengths of the test specimens is NOT GREATER THAN 20% of that average".

c) "In case of a dispute about the strength of concrete in a particular area of the cast concrete, three 50 mm dia. and 100 mm. long Standard concrete cores shall be drilled out from such an individual area and tested for their crushing compressive strength. These values shall then be rectified for concrete age and how the cores were cut, and the corresponding equivalent "cube" strengths worked out for each core. If their average exceeds 85% of required 28 days works cube strength and none falls below 75% of the required 28 days works cube strength, then concrete in such disputed area may be accepted – but of course subject to contractual conditions for poor work.

17. RELEASE OF THE STAGING SUPPORTING THE SLAB-DECK IN A SPAN:

After successfully curing the Concrete in the cast-in-situ Slab-Deck as specified above and the concrete in it attains a minimum works Cube Crushing Strength of 280 kg/cm² (age of Concrete: approximately 21 days after casting) the staging supporting the Slab-Deck may now be released.

18. BEARINGS

Tar Paper BEARINGS shall be used as indicated in the relevant Drg.

19. ARRANGEMENT AT EXPANSION-CONTRACTION GAPS

These shall be provided in the deck as indicated in attached relevant Drawing.

20. WEARING COARSE

50 mm thick Asphaltic concrete wearing course shall be provided over the Slab-Deck, as shown in the relevant Drawing.

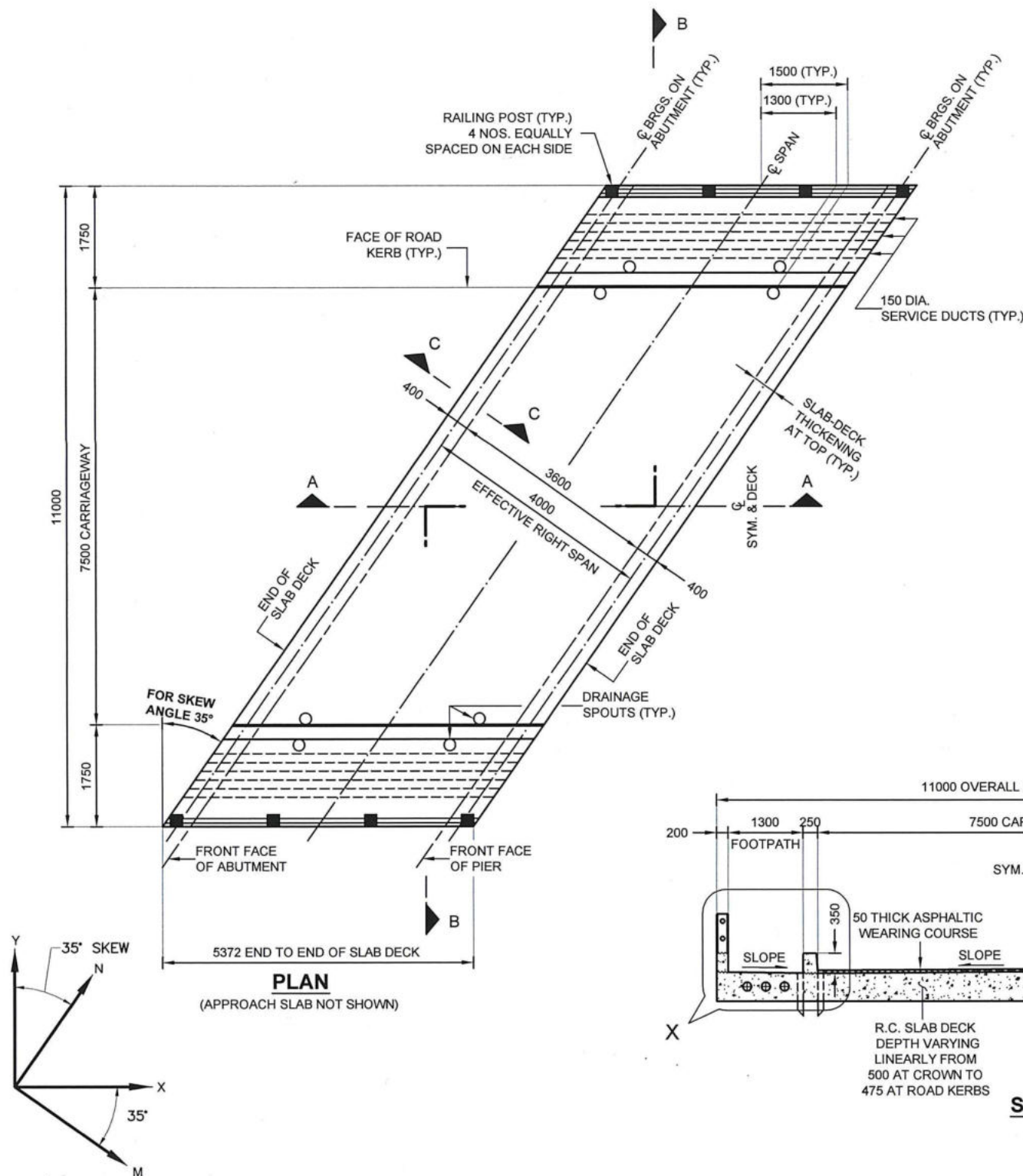
21. EARTHQUAKE EFFECTS:

The Horizontal Seismic coefficient assumed is 0.27 (i.e. 0.27G) accompanied by a Vertical coefficient of + or – 0.135G.

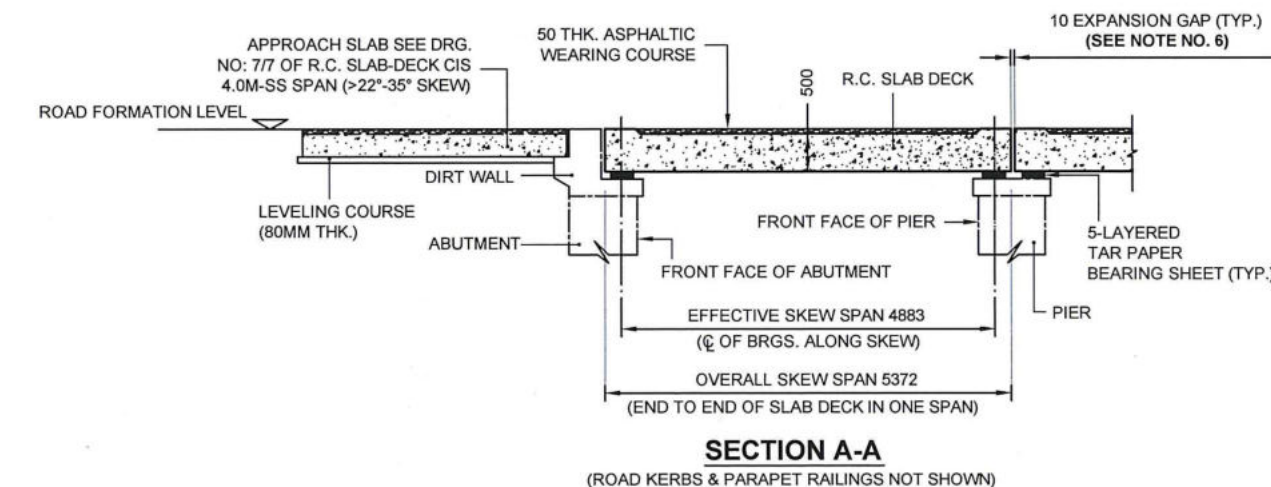
22. LIST Of the ATTACHED RELEVANT DRAWINGS PERTINENT TO THE ABOVE NOTES

<u>Drg. No:</u>	<u>'TITLE' of DRAWING</u>
1/7 of R.C. Slab-Deck cis 4.0 m-SS Span (>22°-35° SKEW)	REFERENCE NOTES (4 Sheets): Sheet 1/4
2/7 of R.C. Slab-Deck cis 4.0 m-SS Span (>22°-35° SKEW)	REFERENCE NOTES (4 Sheets): Sheet 2/4
3/7 of R.C. Slab-Deck cis 4.0 m-SS Span (>22°-35° SKEW)	REFERENCE NOTES (4 Sheets): Sheet 3/4
4/7 of R.C. Slab-Deck cis 4.0 m-SS Span (>22°-35° SKEW)	REFERENCE NOTES (4 Sheets): Sheet 4/4
5/7 of R.C. Slab-Deck cis 4.0 m-SS Span (>22°-35° SKEW)	GENERAL ARRANGEMENT DRAWING & DIMENSIONS
6/7 of R.C. Slab-Deck cis 4.0 m-SS Span (>22°-35° SKEW)	REINFORCEMENT DETAILS & BAR BENDING SCHEDULE
7/7 of R.C. Slab-Deck cis 4.0 m-SS Span (>22°-35° SKEW)	ADDITIONAL DETAILS

GOVERNMENT OF NEPAL MINISTRY OF PHYSICAL INFRASTRUCTURE AND TRANSPORT DEPARTMENT OF ROADS, BRIDGE BRANCH		
STANDARD SUPERSTRUCTURE DRAWING FOR ROAD BRIDGES		
Road Carriageway Width: 7.50m. plus 2 Footpaths		Overall Deck Width: 11.00 m
Effective Simply Supported RIGHT Span (centre to centre of Bearings) : 4.0 m R.C. Slab-Deck, >22°-35° SKEW		LIVE LOAD: IRC 1 Lane of 70R or 1 or 2 Lanes of Class A, whichever governs, and Footpath Loading
Drg. No.: 4/7 of R.C. Slab-Deck cis 4.0 m-SS Span (>22°-35° SKEW)		
Drg. TITLE: REFERENCE NOTES (4 Sheets): Sheet 4/4		
Design: STDD.	Mentored by: Dr. V. K. Raina Bridge TechI Expert, DoR/ World Bank	Date: May 23, 2015
Drawn by: Bicky G. Shakha	Accepted by: Saroj K. Pradhan (DDG, DoR)	Revisions:
Checked by: Naresh P. Keshari Engineer, DoR	Approved by: Madhab K. Karki (DG, DoR)	

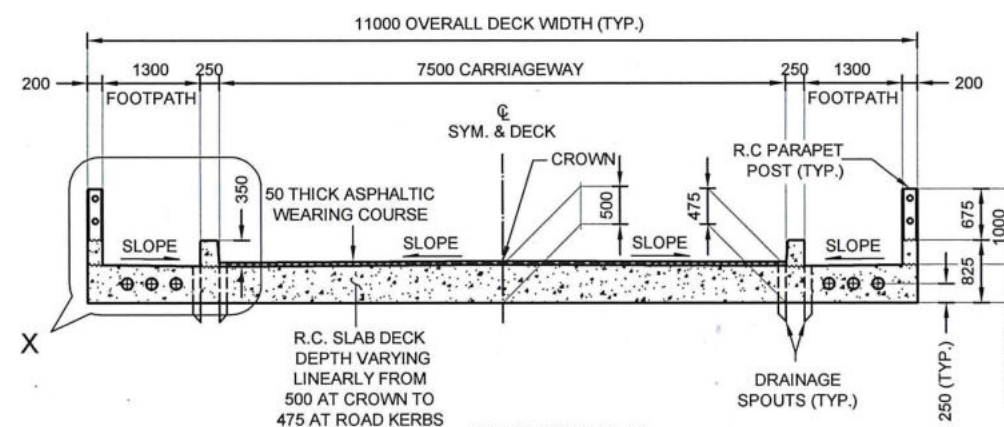


DIRECTIONS IN PLAN

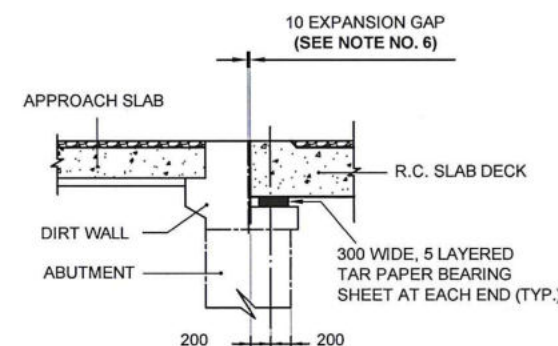


SECTION A-A

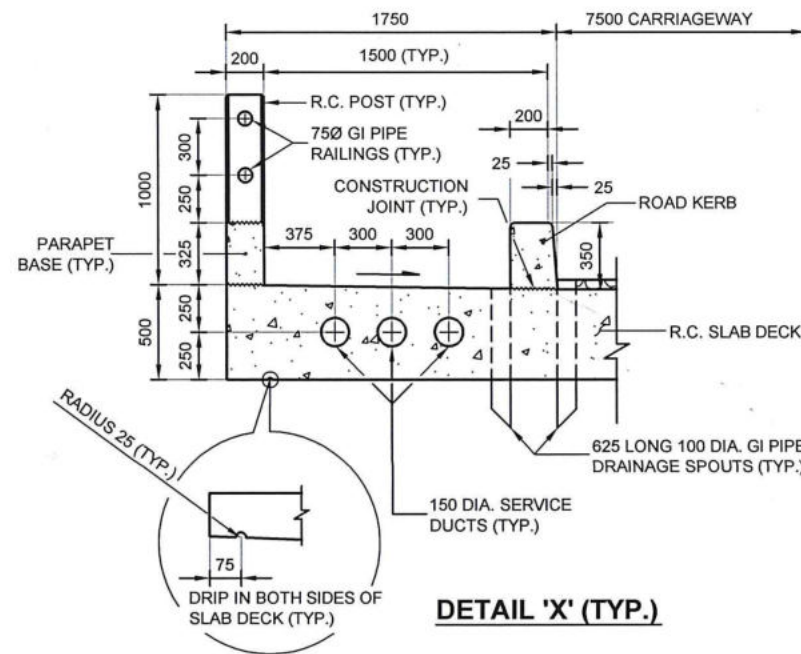
(ROAD KERBS & PARAPET RAILINGS NOT SHOWN)



SECTION B-B



SECTION C-C



DETAIL 'X' (TYP.)

NOTES:

1. All dimensions are in millimeters, unless stated otherwise.
2. No dimension shall be scaled from the Drawings; only written dimensions shall be followed.
3. This Drg. shall be read in conjunction with Drgs. No: 1/7 to 4/7 and 6/7 & 7/7 of R.C. Slab-Deck cis 4.0m-SS Span (>22°-35° SKEW).
4. Entire Slab-Deck (including portions under footpaths) shall be cast in one continuous operation, without any construction joints.
5. Dimensions & Quantities shown pertain to Superstructure of 35° SKEW in one span and these shall be suitably re-worked out for lesser SKEW angle.
6. AT EXPANSION GAP: Provide 10mm Nominal Expansion Gap as indicated, no Expansion Joint required, only strengthen the facing concrete edges of Slab-Deck and Dirt Wall or of the adjoining Slab-Decks, as the case may be, by ISA 100X100X8, each duly anchored back into concrete with 200mm long V-type 12mm dia. bars@500c/c approx., transversely. See Details in Drg. No: 7/7 of R.C. Slab-Deck cis 4.0m-SS Span (>22°-35° SKEW).

QUANTITIES IN ONE COMPLETE SUPERSTRUCTURE IN ONE SPAN

S.N.	Item	Quantity
1	Structural Concrete M35 in R.C. Slab Deck, Railing Posts, Parapet Bases and Road Kerbs.	31 cu.m
2	Reinforcement bars, HYSD, TMT, minimum 0.2% proof stress 500 MPa (Fe 500).	2.5 Tonnes
3	Asphaltic Wearing Course, Thickness 50mm.	40.5 sq.m
4	75mm dia. GI Pipes (Parapet Railings).	21.5 m
5	Drainage spouts each 625 mm long, 100mm dia. GI Pipe.	8 nos.
6	150 mm dia. Void-forming Plastic Tube Service Ducts.	32.5 m
7	300 wide, 5 Layered Tar Paper Sheet Bearings.	8.1 sq.m

- NOTES:** i) Exact Quantities shall, however, be calculated by the concerned Engineer for Costing Purposes.
ii) Total Weight of entire Superstructure in one Span = 87.5 Tonnes

**GOVERNMENT OF NEPAL
MINISTRY OF PHYSICAL INFRASTRUCTURE AND TRANSPORT
DEPARTMENT OF ROADS, BRIDGE BRANCH**



STANDARD SUPERSTRUCTURE DRAWING FOR ROAD BRIDGES

**Road Carriageway Width: 7.50m
plus 2 Footpaths**

Overall Deck Width 11.00 m

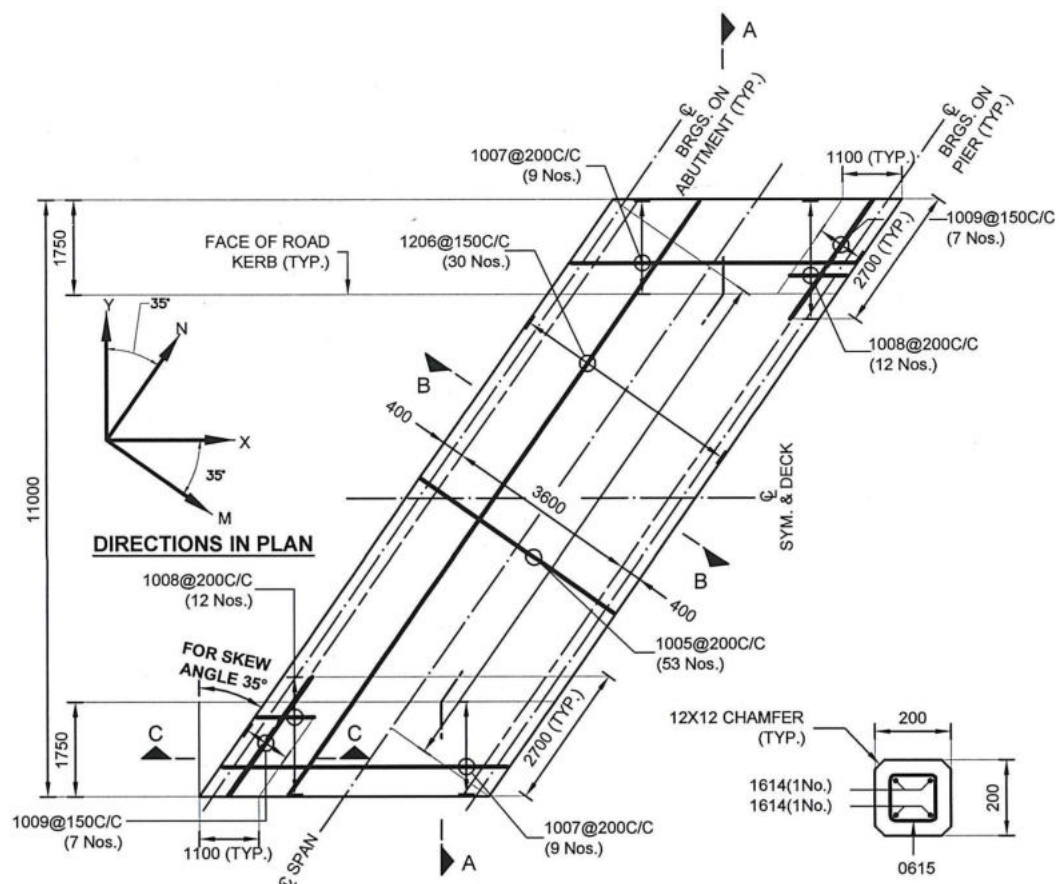
**Effective Simply Supported RIGHT Span
(center to center of Bearings): 4.0 m
R.C. Slab-Deck, SKEW >22°-35°**

**LIVE LOAD: IRC 1 Lane of 70R or 1 or
2 Lanes of Class A, whichever
governs and Footpath Loading**

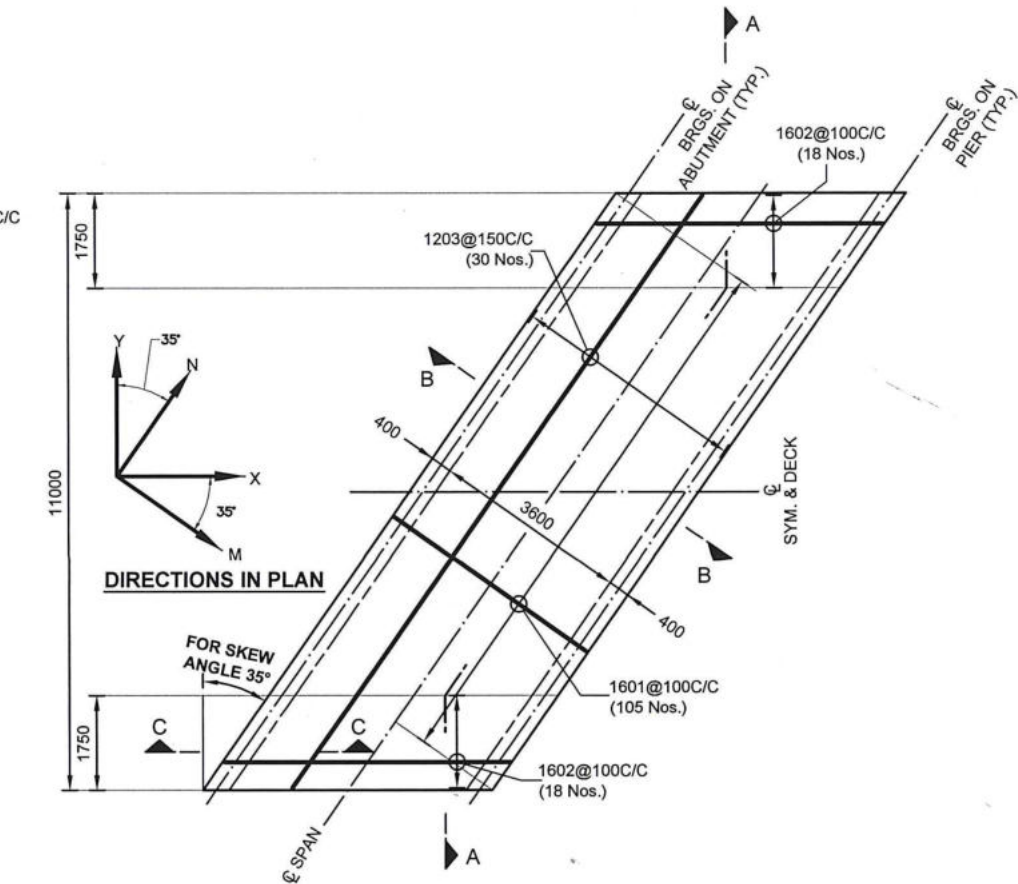
Drg. No : 5/7 of R.C. Slab-Deck cis 4.0m-SS Span (>22°-35° SKEW)

Drg. TITLE : GENERAL ARRANGEMENT DRAWING & DIMENSIONS

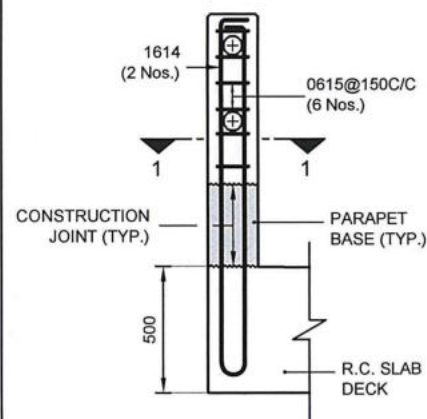
Design : STDD.	Mentored by : Dr. V.K. Raina Bridge Techl Expert, DOR/World Bank	Date : May 23, 2015
Drawn by : Bicky G. Shakha	Accepted by : Saroj K. Pradhan (DDG, DoR)	Revision :
Checked by : Naresh P. Keshari Engineer, DoR	Approved by : Madhab K. Karki (DG, DoR)	



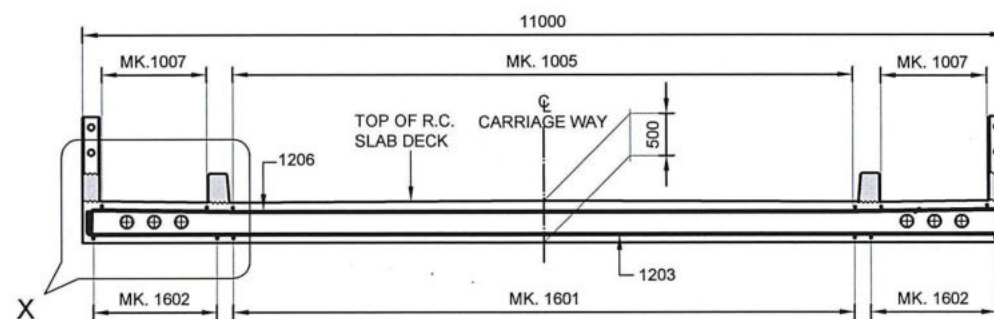
PLAN SHOWING ONLY TOP REINFORCEMENT DETAILS OF SLAB DECK
(SERVICE DUCTS, ROAD KERBS AND PARAPET BASES NOT SHOWN)



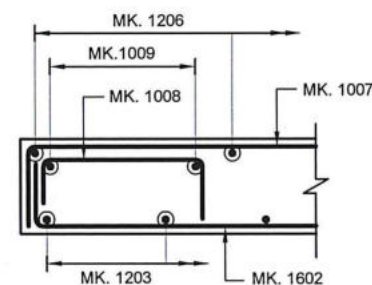
PLAN SHOWING ONLY BOTTOM REINFORCEMENT DETAILS OF SLAB DECK



PARAPET POST DETAIL



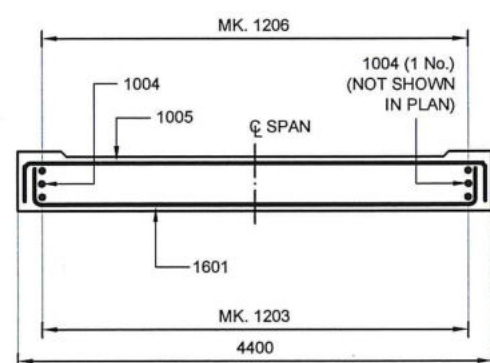
SECTION A-A
(BAR MARKS 1008, 1009, 1210, 1011, 1212, & 1013 NOT SHOWN;
BAR MARKS 1601 & 1005 IN FOOTPATH AREAS ALSO NOT SHOWN)



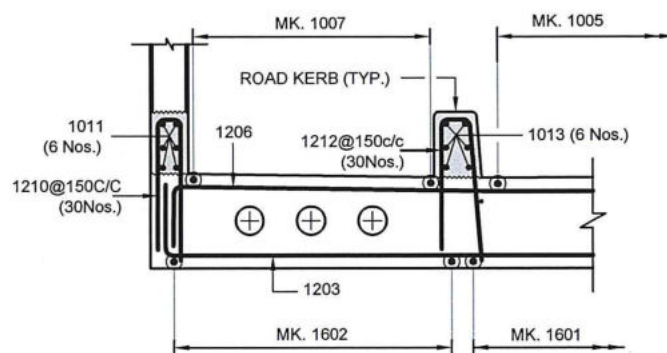
SECTION C-C
(ROAD KERBS NOT SHOWN)

NOTES :

- All dimensions are in millimeters, unless stated otherwise.
- No dimension shall be scaled from the Drawings; only written dimensions shall be followed.
- Dimensions, Reinforcement Bars and Quantities shown pertain to Superstructure of 35° SKEW in one span and these shall be suitably re-worked out for lesser SKEW angle.
- The reinforcement for Railing Posts, Parapet Bases & Road Kerbs shall be incorporated before casting Slab-Deck.
- Reinforcement of adjacent span superstructure and approach slab not shown.
- Where bar length available at site is less than that required in the structure, the same shall be made up by lapping of bars of same dia. (lap length generally 65Ø). Such lap lengths have not been accounted for in the reinforcement bending schedule here.
- The schedule of reinforcement shown here is indicative only, and is given purely for assisting the site Engineer and does not pretend to be complete in all respects. The site Engineer should check it and rectify it to suit.
- MK. = Bar Mark.
- This drawing shall be read in conjunction with Drgs. No: 1/7 to 5/7 of R.C. Slab-Deck cis 4.0m-SS Span (>22°-35° SKEW).



SECTION B-B



DETAIL 'X' (TYP.)
(BAR MARKS 1601 & 1005 IN FOOTPATH AREAS NOT SHOWN)

BAR BENDING SCHEDULE (PER SPAN)

S.No:	LOCATION	Bar Mark	Shape of Bar (Not to scale) Dimensions are in mm	Dia. of Bar (mm)	Length of each Bar (mm)	No. of Bars	Total Length of Bars (m)	Weight (kg)
1	SLAB-BOTTOM ALONG-M	1601		16	4700	105	493.5	779.9
2	SLAB-BOTTOM ALONG-X	1602		16	5670	36	204.1	322.6
3	SLAB-BOTTOM ALONG-N	1203		12	13730	30	411.9	366.1
4	SLAB-SIDES ALONG-N	1004		10	13340	2	26.7	16.5
5	SLAB-TOP ALONG-M	1005		10	4700	53	249.1	153.8
6	SLAB-TOP ALONG-N	1206		12	13730	30	411.9	366.1
7	SLAB-TOP ALONG-X	1007		10	5680	18	102.2	63.1
8	TOP-MESH ALONG-X AT ACUTE CORNER	1008		10	1500	24	36.0	22.2
9	TOP-MESH ALONG-N AT ACUTE CORNER	1009		10	3100	14	43.4	26.8
10	PARAPET BASE	1210		12	1450	60	87.0	77.3
11	PARAPET BASE ALONG-X	1011		10	5290	12	63.5	39.2
12	ROAD KERBS	1212		12	1500	60	90.0	80.0
13	ROAD KERB ALONG-X	1013		10	5290	12	63.5	39.2
14	PARAPET POST	1614		16	3080	16	49.3	77.9
15	PARAPET POST LINKS	0615		6	550	48	26.4	5.9

GOVERNMENT OF NEPAL MINISTRY OF PHYSICAL INFRASTRUCTURE AND TRANSPORT DEPARTMENT OF ROADS, BRIDGE BRANCH



STANDARD SUPERSTRUCTURE DRAWING FOR ROAD BRIDGES

Road Carriageway Width: 7.50m plus 2 Footpaths

Overall Deck Width 11.00 m

Effective Simply Supported **RIGHT** Span
(center to center of Bearings): **4.0 m**
R.C. Slab-Deck, SKEW >22°-35°

LIVE LOAD: IRC 1 Lane of 70R or 1 or 2 Lanes of Class A, whichever governs and Footpath Loading

Drg. No : **6/7** of R.C. Slab-Deck cis 4.0m-SS Span (>22°-35° SKEW)

Drg. TITLE : **REINFORCEMENT DETAILS & BAR BENDING SCHEDULE**

Design :
STDD.

Mentored by :
Dr. V.K. Raina
Bridge Techl Expert, DoR/World Bank

Date :
May 23, 2015

Drawn by :
Bicky G. Shakha

Accepted by :
Saroj K. Pradhan
(DDG, DoR)

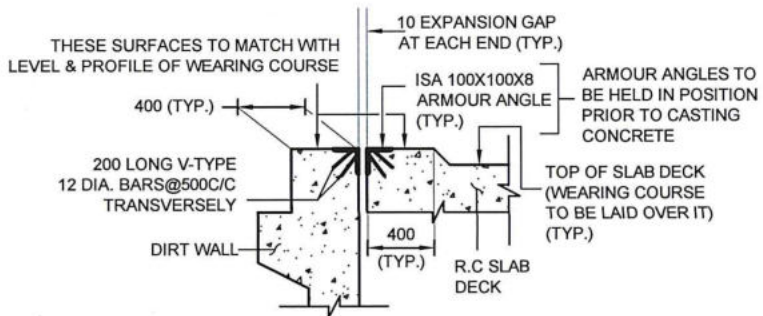
Revision :

Checked by :
Naresh P. Keshari
Engineer, DoR

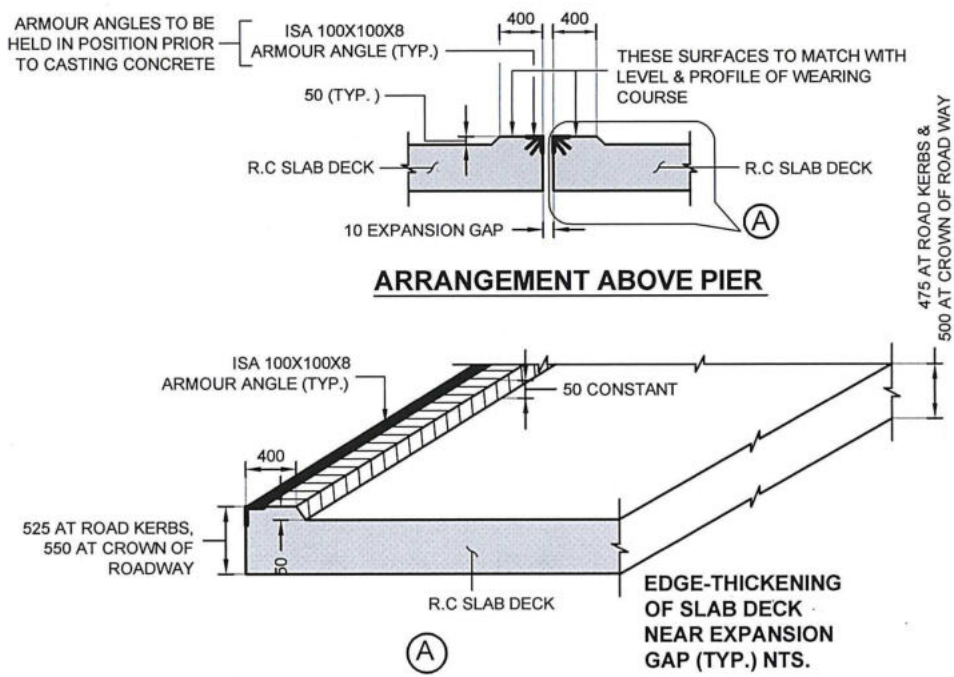
Approved by :
Madhab K. Karki
(DG, DoR)

ARRANGEMENTS AT EXPANSION GAPS

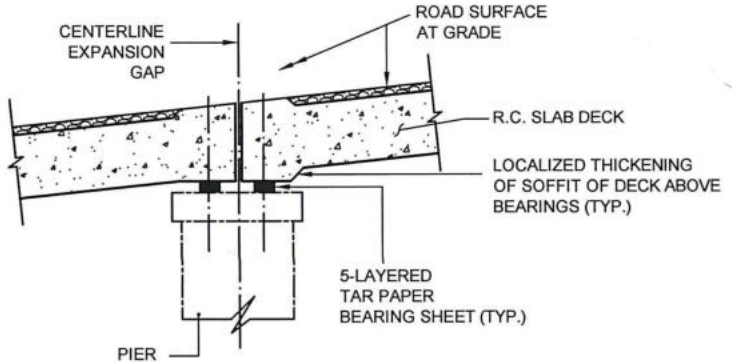
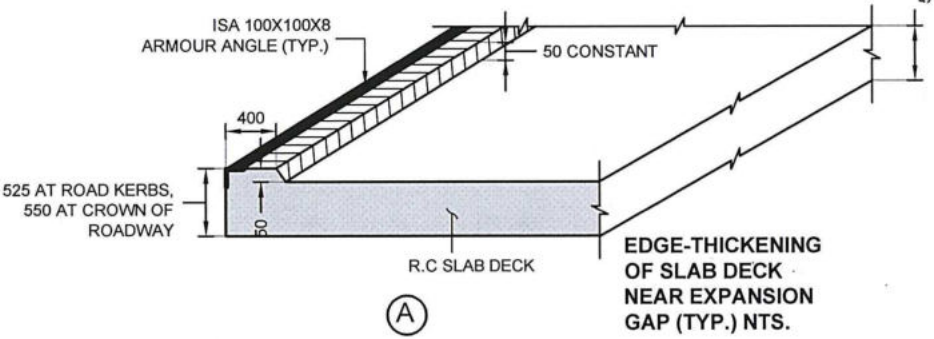
- 1. Expansion Gap shall be 10mm at Abutments and at Piers. Only strengthen the facing concrete edges of Slab Deck and Dirt Wall at Abutments and of the facing Slab Decks over Piers by Armour Angles ISA 100X100X8 each duly anchored back into concrete with 200mm long V-type 12mm dia. bars@500 c/c transversely.
- 2. Armour Angles shall run along the width of road carriageway along the SKEW between road-side faces of the Road Kerbs.



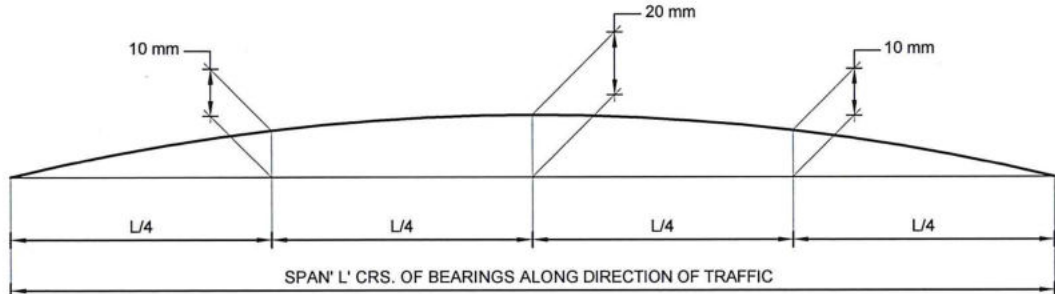
ARRANGEMENT ABOVE ABUTMENT



ARRANGEMENT ABOVE PIER



INSTALLATION OF BEARINGS WHEN SUPERSTRUCTURE IS AT GRADE (TYP.)



LONGITUDINAL CAMBER PROFILE TO BE GIVEN TO SOFFIT OF SLAB-DECK (TYP.)

APPROACH SLAB

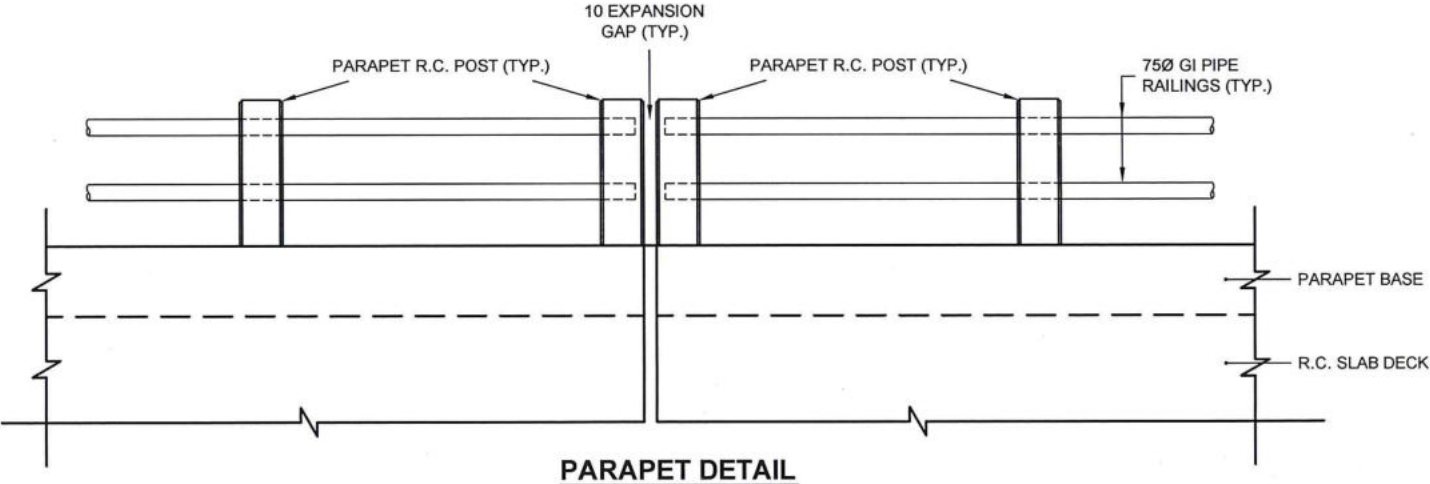
- 1. 3.5m long (along direction of Traffic), 7.5m wide (perpendicular to direction of Traffic) Approach Slab shall be provided behind each Abutment as generally shown in Drg. No: 5/7 of R.C. Slab-Deck cis 4.0 m-SS Span. (>22°-35° SKEW). These shall be cast on fully compacted backfill over suitable PCC leveling course.
- 2. Approach Slab shall be 300mm thick in M35 Grade concrete.
- 3. Reinforcement at its Top and at its Bottom, each, shall be 12mm dia. bars@150c/c both ways.
- 4. Suitable arrangement for Footpaths shall be provided on each side of Approach Slab taking due account of connections to Utilities.
- 5. Asphaltic Wearing Course shall be laid over the Approach Slabs matching the level & profile of wearing course on the adjacent Slab Deck.

ASPHALTIC WEARING COURSE

This shall be Provided between Road-Side faces of Road-Kerbs; its thickness: 50 mm constant.

NOTES:

- 1. All dimensions are in millimeters, unless stated otherwise.
- 2. No dimension shall be scaled from the Drawings; only written dimensions shall be followed.
- 3. This drawing shall be read in conjunction with Drgs. No: 1/7 to 6/7 of R.C. Slab-Deck cis 4.0 m-SS span (>22°-35° SKEW).



GOVERNMENT OF NEPAL MINISTRY OF PHYSICAL INFRASTRUCTURE AND TRANSPORT DEPARTMENT OF ROADS, <u>BRIDGE BRANCH</u>		
STANDARD SUPERSTRUCTURE DRAWING FOR ROAD BRIDGES		
Road Carriageway Width: 7.50m plus 2 Footpaths	Overall Deck Width 11.00 m	
Effective Simply Supported <u>RIGHT Span</u> (center to center of Bearings): 4.0 m R.C. Slab-Deck, SKEW >22°-35°	LIVE LOAD: IRC 1 Lane of 70R or 1 or 2 Lanes of Class A, whichever governs and Footpath Loading	
Drg. No : 7/7 of R.C. Slab-Deck cis 4.0m-SS Span (>22°-35° SKEW)		
Drg. TITLE : ADDITIONAL DETAILS		
<u>Design :</u> STDD.	<u>Mentored by :</u> Dr. V.K. Raina Bridge Techl Expert, DoR/World Bank	<u>Date :</u> May 23, 2015
<u>Drawn by :</u> Bicky G. Shakha	<u>Accepted by :</u> Saroj K. Pradhan (DDG, DoR)	<u>Revision :</u>
<u>Checked by :</u> Naresh P. Keshari Engineer, DoR	<u>Approved by :</u> Madhab K. Karki (DG, DoR)	