

3. SOIL NAIL

1. PROPOSED SOIL NAIL SHALL BE WITH FOLLOWING SPECIFICATION CONFORMING TO IS:1786, DAIMETER OF SOIL NAIL =25mm , DIAMETER OF DRILL HOLE =76mm (MIN.),GRADE OF SOIL NAIL =Fe500, TYPE = FULLY GROUTED, SIZE OF ANCHOR PLATE = 150x150x8mm,
2. PROPOSED SOIL NAIL SYSTEM IS BASED ON VARIOUS GEOLOGICAL INPUT PROVIDED BY GEOLOGIST. ACTUAL SUPPORT SYSTEM MAY BE REVISED BASED ON ACTUAL RESPONSE OF STRATA DURING EXCAVATION.
3. THE LENGTH AND DIRECTION OF SOIL NAILS MAY BE ALTERED IN CONSULTATION WITH SITE GEOLOGIST AND ENGINEER-IN-CHARGE.
4. PULL OUT TEST SHALL BE CARRIED OUT ON SOIL NAILS.
5. THE NUT OF THE GROUTED SOIL NAIL SHALL BE TIGHTENED 12 HOURS AFTER INSTALLATION TO ACHIEVE A FORCE AT THE ANCHOR PLATE OF APPROX. 20KN. THIS FORCE SHALL BE APPLIED BY CALIBRATED TORQUE WRENCH.
6. INCLINATION OF SOIL NAIL SHALL BE AT 10.0° DOWNWARD FROM HORIZONTAL, INCLINATION OF DRAINAGE HOLES SHALL BE AT 15.0° UPWARD FROM HORIZONTAL AND INCLINATION OF PIPE ROOFING SHALL BE AT 5.0° UPWARD FROM HORIZONTAL.

4. STEEL RIB FABRICATION

1. ALL STEEL SECTION AND PLATES USED FOR RIBS AND ACCESSORIES SHALL CONFORM TO IS: 2062 AND WILL BE OF GRADE E250.
2. ALL BOLTS AND WASHERS SHALL CONFORM TO IS: 1367 AND OF GRADE 4.6.
3. DESIGN, FABRICATION & ERECTION OF STEEL STRUCTURE SHALL CONFORM TO IS:800. THE TOLERANCES FOR FABRICATION OF STEEL STRUCTURE SHALL BE AS PER IS:7215, UNLESS NOTED OTHERWISE..
4. ALL WELDING (SHOP OR FIELD) SHALL CONFORM TO IS:816, IS:9595, IS:1024 AND SHOULD BE CARRIED OUT BY USING SHIELDED ARC METHOD AS DESCRIBED IN THE SP-12, ISI HAND BOOK FOR GAS WELDERS AND ISI HANDBOOK OF MANUAL METAL ARC WELDING FOR WELDERS.
5. LAGGING SHALL CONFORM TO IS:2062 AND OF GRADE E250.
6. TIE ROD SHALL CONFORM TO IS:432 (PART-1) OF GRADE E250.
7. ALL STEEL MEMBERS SHALL HAVE STRAIGHT EDGES, BLUNT SURFACES, IF NECESSARY SHALL BE SHEARED, CROPPED, SAWN OR FLAME CUT AND GROUND ACCURATELY TO THE REQUIRED DIMENSION AND SHAPE.
8. ALL STEEL SHALL BE CLEAN AND FREE FROM CORROSION.
9. ALL SECTION JOINTS ARE OF BOLTED CONNECTIONS. ALL BOLTS SHALL BE HEXAGON FIT BOLTS MEETING THE REQUIREMENTS OF IS:3640 & SHALL CONFORM TO PROPERTY CLASS 5.6 OF IS:1367 (PART 3).
10. ALL WELDING SHALL BE DONE AT SHOP UNLESS SPECIFIED OTHERWISE ON THESE DRAWINGS.
11. BEFORE TAKING THE ACTUAL FABRICATION, ALL THE DIMENSIONS OF THE MEMBERS SHALL BE VERIFIED BY SHOP LAYOUT.
12. SIZES OF FILLET WELD SHALL BE AS MARKED ON THE DRAWINGS. MIN. SIZE OF FILLET WELD TO BE USED SHALL BE 6mm. MAXIMUM SIZE OF FILLET WELD SHALL BE EQUAL TO THE THICKNESS OF THE LEAST THICK CONNECTED MEMBER.
13. WELDING ELECTRODES SHALL CONFORM TO IS:814.
14. PERCENTAGE OF FIELD WELDS TO BE TESTED SHALL BE 100%.

5. PIPE ROOFING & GROUTING

1. PIPE ROOFING SHALL BE OF Ø89mm (OUTER DIAMETER) 6.30mm WALL THICKNESS, 6.0m LONG, YIELD STRENGTH 310 Mpa FULLY GROUTED @ 400mm c/c CIRCUMFERENTIAL SPACING.
2. AFTER DRIVING THE FIRST SET OF FOREPOLING PIPES, GROUTING (@ 1.5kg/cm2 MAXIMUM) SHALL BE DONE THROUGH THESE PERFORATED PIPES , SO THAT THE OVERBURDEN MATERIAL GETS SUFFICIENT SELF STANDING STRENGTH.
3. AFTER GROUTING, THE PIPES SHALL BE FILLED WITH GROUT PASTE / M15 CONCRETE.
4. INCLINATION OF PIPE ROOFING SHALL BE AT 5.0° UPWARD FROM HORIZONTAL.
5. THE OVERLAPPING BETWEEN THE PIPE ROOF UMBRELLA SHALL BE MINIMUM 2.0m BETWEEN THE EACH SUBSEQUENT STAGE.
6. THE SLUMP VALUE OF THE GROUT MIX SHALL BE 120mm TO 150mm.
7. GROUT MIX SHOULD CONSIST OF LOW SLUMP CEMENT WITH A MIN. PROPORTION OF 1:3 (CEMENT:SAND).
8. THE WATER CEMENT RATIO SHALL BE 0.5.
9. ADMIXTURES LIKE BENTONITE AND GLENIUM CAN BE USED AS PLASTICIZER TO INCREASE THE WORKABILITY OF GROUT MIX.
10. IN CASE OF GROUT MIX NOT PASSING THROUGH THE FINE STRATA, THE ULTRA FINE CEMENT SHALL BE USED.
11. THE WORKING PARAMETERS LIKE GROUT VOLUME, PRESSURE, DEPTH, SURFACE HEAVE SHALL BE RECORDED AT EACH STAGE OF COMPACTION GROUTING PROCESS.

6. STEEL FIBRE REINFORCED SHOTCRETE(SFRS)

A. GENERAL

- i) SFRS MATERIALS, ADMIXTURES, PRODUCTION,METHOD OF APPLICATION,TEMPERATURE CONTROL AND TESTING IN GENERAL, SHALL CONFORM TO RELEVANT TECHNICAL SPECIFICATIONS AND APPLICABLE TO INDIAN STANDARDS IS:269, IS:383, IS:456, IS:516, IS:2645, IS:8112, IS:9012, IS:9103, IS:12269, IS:15388 OR, WHERE NOT COVERED BY THESE STANDARDS TO THE EQUIVALENT INTERNATIONAL STANDARDS.
- ii) SFRS FOR THE PURPOSE OF THIS WORK IS DEFINED AS WET MIX OF CEMENT, AGGREGATES, WATER, STEEL FIBRES, SILICA FUMES AND ADMIXTURES IN CORRECT PROPORTIONS WITH MAXIMUM SIZE OF AGGREGATE LESS THAN 10 MM PROJECTED AT HIGH VELOCITY FROM A SPRAY NOZZLE ON TO A SURFACE TO FORM A LAYER OF PNEUMATICALLY APPLIED CONCRETE ON THAT SURFACE.
- iii) IN WET MIX OF SFRS, ALL MATERIALS INCLUDING CEMENT, AGGREGATES ETC. SHALL BE WEIGH BATCHED AND MIXED TOGETHER WITH WATER AND ADMIXTURES, BUT WITHOUT ACCELERATORS, TO PRODUCE MORTAR OR CONCRETE.THE MIXTURE SHALL THEN BE CONVEYED BY POSITIVE DISPLACEMENT (OR COMPRESSED AIR) TO A NOZZLE WHERE AIR AND ACCELERATOR AND/OR ADMIXTURES SHALL BE INJECTED TO INCREASE VELOCITY AND FINAL MIX SHALL BE PROJECTED WITHOUT INTERRUPTION INTO THE DESIRED PLACE.
- iv) SFRS SHALL HAVE MINIMUM COMPRESSIVE STRENGTH OF 10 MPa AT 3 DAYS, 15MPa AT 7 DAYS AND 25 MPa AT 28 DAYS. THE STRENGTH AND WORKABILITY REQUIREMENTS SHALL BE ESTABLISHED BY APPROPRIATE MIX DESIGN AND SUBSEQUENT LAB./ INSITU TESTS ON THE TEST PANELS AT THE ACTUAL SITE(S) OF APPLICATION (FOR ALL ROCK-TYPES ENCOUNTERED DURING EXCAVATION). INTENDED ADMIXTURES, OTHER INGREDIENTS SHALL ALSO BE USED IN SPECIFIED QUANTITY IN THESE TRIAL MIXES TO ARRIVE AT OPTIMUM QUANTITIES OF ALL INGREDIENTS.
- v) ALL BIS STANDARDS REFERRED TO SHALL BE OF LATEST EDITIONS.
- B. MATERIALS AND MIX DESIGN
- i) FOR THE PURPOSE OF SPRAYING SFRS, ONLY WET MIX METHOD SHALL BE USED.
- ii) ALL INGREDIENTS SHALL BE WEIGH BATCHED.
- iii) THE WATER CEMENT RATIO SHALL BE 0.45 (MAXIMUM) BY WEIGHT OF CEMENTITIOUS MATERIAL (CEMENT + MICROSILICA).
- iv) THE WORKABILITY SHALL BE MEASURED BY SLUMP TEST. SLUMP SHALL BE BETWEEN 100 AND 140 MM.
- v) A TYPICAL MIX SHALL HAVE THE FOLLOWING MAIN COMPONENTS IN SUITABLE PROPORTIONS IN ORDER TO MEET STRENGTH REQUIREMENTS AND TO ENSURE PROPER WORKABILITY:

ORDINARY PORTLAND CEMENT, AGGREGATES (FINE & COARSE) , STEEL FIBRES, ADMIXTURES (ACCELERATOR AND SUPER PLASTICIZERS), MICROSILICA (SILICA FUMES)

- vi) ORDINARY PORTLAND CEMENT SHALL CONFORM TO THE REQUIREMENTS OF INDIAN STANDARD CODE IS:269 OR IS: 8112 OR IS:12269. HOWEVER, CEMENT WITH HIGHER FINENESS SHALL BE PREFERRED.
- vii) AGGREGATE(S) SHALL CONFORM TO THE REQUIREMENT OF INDIAN STANDARD CODE IS:383. THE AGGREGATE SIZE SHALL NOT EXCEED 12 MM. THE GRAIN SIZE DISTRIBUTION OF AGGREGATE SHALL BE IN ACCORDANCE WITH THE FOLLOWING TABLE:-

SIEVE SIZE PERCENTAGE PASSING THROUGH THE SIEVE

MM	MINIMUM	MAXIMUM
0.075	0	2
0.150	4	12
0.300	11	26
0.600	22	50
1.180	37	72
2.360	55	90
4.750	73	100
9.500	90	100
10.00	100	100

THE AGGREGATE SHALL BE WELL GRADED AND NO FRACTION SHALL CONSTITUTE MORE THAN 30% OF THE TOTAL.THE CONTENTS OF CRUSHED AND NON CUBICAL MATERIAL SHOULD NOT EXCEED 10%. IN CASE CRUSHED MATERIALS ARE USED AS PART OF AGGREGATES, TESTS FOR COMPRESSION SHALL BE DONE TO ESTABLISH WHETHER THE ADDITION OF THE CRUSHED MATERIAL GIVES AN IMPROVED RESULT.

viii) WATER SHALL BE CLEAN AND FREE FROM INJURIOUS AMOUNTS OF OILS, ACIDS, ALKALIES, SALTS, SUGAR, ORGANIC MATERIALS OR OTHER SUBSTANCES THAT MAY BE DELETERIOUS TO SFRS, WIREMESH OR FIBERS AND OTHER INGREDIENTS AND CONFORM TO IS : 456. 2000 SPECIFICATIONS.

- ix) AIR AND SUPPLY LINES USED FOR SPRAYING SFRS SHALL BE CLEAN AND FREE FROM ANY GREASY MATERIAL SUCH AS OIL ETC.

- x) IT SHALL BE ENSURED THAT ALL MATERIALS, AS SPECIFIED, ARE USED ON THE WORK WITHIN THEIR RESPECTIVE EFFECTIVE LIFE SPAN W.R.T MANUFACTURING DATE.
- xi) BATCHING PLANT SHALL BE CAPABLE OF MAINTAINING DESIRED ACCURACY. THE MIXING PLANT SHALL BE CAPABLE OF THOROUGHLY MIXING THE SPECIFIED MATERIALS IN SUFFICIENT QUANTITY TO MAINTAIN CONTINUOUS PLACING. THE WET MIX DELIVERY EQUIPMENT SHALL BE OF A DESIGN AND SIZE WHICH CAN DELIVER THE PREMIXED MATERIAL ACCURATELY, UNIFORMLY AND CONTINUOUSLY.THE EQUIPMENT SELECTED FOR EACH OPERATION SHALL BE SUCH THAT IT CAN SUFFICIENTLY HANDLE THE LIMITS(UPPER AND LOWER) OF QUANTITIES TO BE HANDLED FOR EACH OPERATION. SUCH LIMITS SHALL BE WORKED OUT BY THE CONTRACTOR AND APPROVED BY THE ENGINEER-IN-CHARGE. RECOMMENDATIONS OF THE EQUIPMENT MANUFACTURER WITH REGARD TO THE TYPE AND SIZE OF NOZZLE TO BE USED, THE DIRECTIONS FOR USE OF SUCH EQUIPMENT AND ITS SUBSEQUENT MAINTENANCE SHALL BE STRICTLY FOLLOWED TO ENSURE QUALITY WORK.
- xii) AIR COMPRESSOR SHALL BE CAPABLE OF KEEPING UP A SUPPLY OF CLEAN AIR ADEQUATE FOR SIMULTANEOUS OPERATION OF A BLOW PIPE FOR CLEANING AWAY REBOUND ALSO.
- xiii) THE STEEL FIBRE USED IN SFRS SHALL BE PRODUCED FROM HIGH TENSILE STEEL, EITHER COLD ROLLED OR COLD DRAWN WIRES. FIBRES SHALL BE DRY AND FREE FROM OIL, GREASE AND CHLORIDES. THE FIBRES SHALL SATISFY THE FOLLOWING SUGGESTED PARAMETERS. HOWEVER THE FINAL VALUE SHALL BE ADOPTED AS PER TRIAL DESIGN MIX/ TEST PANEL RESULTS.

LENGTH OF STEEL FIBRES 30 MM - 35 MM

GEOMETRIC SHAPE STEEL FIBRES SHALL HAVE SUITABLY DEFORMED PROFILE TO ENSURE PROPER MATRIX OF SFRS MIX AND TO DEVELOP BETTER BOND ANCHORAGE WITH NO FIBRE BALLING.

ASPECT RATIO (LENGTH/DIAMETER)	40	45	50	55	60	65
QUANTITY OF STEEL FIBRES(Kg/M³)	50 Kg/M³					

FIBRE TENSILE STRENGTH > 1000 MPA

MIXING PROCEDURE ADOPTED SHOULD BE SUCH THAT THERE IS NO FIBRE BALLING I.E. FIBERS DO NOT TANGLE TOGETHER TO FORM CLUMPS OR FIBRE BALLS.


- xiv) A PROVEN SYSTEM TO CONTROL THE CONSISTENCY SHALL BE USED TO ENSURE GOOD WORKABILITY. LOW PUMPING PRESSURE, ADEQUATE SLUMP RETENTION AND LOW REBOUND. ONLY PROVEN ADMIXTURES WHICH MEET THE REQUIREMENTS OF THE SPECIFICATIONS BASED ON FIELD TRIALS AND LONG TERM SATISFACTORY PERFORMANCE AND COMPATIBILITY BETWEEN SUPER PLASTICIZERS AND ACCELERATORS SHALL BE USED TO ENSURE A HOMOGENEOUS MIX AND BETTER DISPERSION OF THE VARIOUS CONSTITUENTS OF THE SFRS MIX.
- xv) SUPER PLASTICIZER/WATER REDUCING AGENTS SHALL BE ADDED AT THE BATCHING PLANT TO KEEP THE SFRS MIX WORKABLE DURING TRANSPORTATION AND TO ENSURE GOOD PUMPABILITY AT AN ACCEPTABLE LOW WATER CEMENT RATIO.THE SUPER PLASTICIZERS SHALL BE FREE OF CHLORIDES.THE QUANTITY OF SUPER PLASTICIZERS MAY BE ADJUSTED TO COMPENSATE THE SLUMP LOSS BECAUSE OF STEEL FIBRES.
- xvi) A PROVEN ACCELERATOR SHALL BE ADDED FOR PROVIDING A QUICK SETTING TIME. THESE SHALL HAVE SILICATE BASE & SHALL BE ENVIRONMENT FRIENDLY. ONLY LIQUID ACCELERATORS SHALL BE USED TO ACHIEVE LOW REBOUND AND ESPECIALLY LOW FIBRE REBOUND. THE ACCELERATOR SHALL HAVE A PH VALUE LESS THAN 12.THE ACCELERATOR SHALL BE ADDED AT THE NOZZLE AND DOSES SHALL BE MINIMUM AND SHALL NOT EXCEED 5% OF THE WEIGHT OF CEMENT AND MICROSILICA. THE ACCELERATORS SHALL HAVE THE PROPERTY TO PROVOKE A SHARP SLUMP LOSS OF THE SFRS MIX WITHIN SPLIT SECONDS AND ENABLE IT TO ASSUME THIXOTROPIC CHARACTERISTICS,WHEN IT HITS SUBSTRATE, THUS ENSURING ADHERENCE IN THICK LAYERS WITHOUT TRICKLING AND SUBSEQUENTLY ENSURING REDUCTION IN THE FIBRE REBOUND.
- xvii) MICROSILICA SHALL BE ADDED IN THE MIX AT THE BATCHING PLANT FOR FACILITATING THE MIXING AND DISTRIBUTION OF FIBRES TO REDUCE FIBRE REBOUND AND IMPROVE BOND BETWEEN CEMENT MATRIX AND FIBRES AS ALSO TO IMPROVE ADHERENCE WHEN THE ROCK MASS SURFACE IS WET. THE DOSE OF SILICA FUMES SHALL BE 5% TO 7% OF CEMENT BY WEIGHT SUBJECT TO SITE TRIALS. SILICA FUMES SHALL HAVE A BULK DENSITY BETWEEN 500-700 KG/CUM. CHEMICAL & PHYSICAL REQUIREMENTS OF THE MICRO SILICA SHALL BE AS UNDER:

CHEMICAL REQUIREMENTS

S. NO.	CHARACTERISTIC	REQUIREMENT	MINIMUM FREQUENCY OF TESTING OR AS DESIRED BY ENGINEER-IN-CHARGE
1.	SIO2* , MIN.	85.0	SINGLE LOT UPTO 400 T
2.	MOISTURE CONTENT *, MAX	3.0	SINGLE LOT UPTO 100 T
3.	LOSS ON IGNITION *, MAX	4.0	SINGLE LOT UPTO 100 T
4.	ALKALIES AS NA2O, PERCENT, MAX.	1.5	SINGLE LOT UPTO 400 T
* PERCENT BY MASS			
PHYSICAL REQUIREMENTS			
S. NO.	CHARACTERISTIC	REQUIREMENT	MINIMUM FREQUENCY OF TESTING OR AS DESIRED BY ENGINEER-IN-CHARGE
1.	SPECIFIC SURFACE M²/G,MIN	15	SINGLE LOT UPTO 400 T
2.	OVERSIZE PERCENT RETAINED ON 45 MICRON IS SIEVE,MAX	10	SINGLE LOT UPTO 100 T
3.	OVERSIZE PERCENT RETAINED ON 45 MICRON IS SIEVE, VARIATION FROM AVERAGE PERCENT,MAX	5	SINGLE LOT UPTO 100 T
4.	COMPRESSIVE STRENGTH 7 DAYS AS PERCENT OF CONTROL SAMPLE, MIN.	85.0	SINGLE LOT UPTO 400 T

- xviii) THE MIX DESIGN SHALL PROVIDE THE FOLLOWING DETAILS FOR ONE CUBIC METER OF SFRS MIX.

ORDINARY PORTLAND CEMENT	....KG
AGGREGATE	
NATURAL FINE AGGREGATE	....SIZE
NATURAL COARSE AGGREGATE	....SIZE
CRUSHED FINE AGGREGATE	....SIZE
CRUSHED COARSE AGGREGATE	....SIZE
STEEL FIBRES -----LENGTH -----DIA (MM) (MM)	....KG
SUPER PLASTICIZERS	....KG
ACCELERATOR	....KG
MICROSILICA	....KG
WATER CEMENT RATIO	....
SLUMP	....CM
DENSITY (WET)	....KG/M³

					Project Title	This drawing is the property of AGNITIO INFRASTRUCTURE PROJECTS PVT LTD and must not be passed on to any person or body not authorised by us to receive it nor be copied or otherwise made use of either in full or in part by such person or body without our prior permission in writing.	Client	 BUILDING INFRASTRUCTURE - BUILDING THE NATION	Drawing Title: GENERAL NOTES	CONSULTANT	
					Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing pre-construction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02) ,NH-150 (New NH-02), NH-61 (New NH-29) and NH-39 (New NH-02) on Engineering, Procurement and Construction (EPC) mode in the state of Nagaland	Original Size: A2		Drawing No.: HEC—AIPPL/NHIDCL/KB/TUN/16	Sheet : OF 45	HIGHWAY ENGINEERING CONSULTANT IN ASSOCIATION WITH AGNITIO INFRASTRUCTURE PROJECTS PVT LTD	
						Path -		Scale :— NTS			
Revision	Details	Chk By	Date	Suffix		Plotting Scale: N.T.S	National Highways & Infrastructure Development Corporation Ltd	Drn S.TYAGI	Dgn. P.MISHRA	Appd A.C. GARG	Date OCT—2018