Appendix-E

Standard Specifications and Code of Practice for Road Bridges Section II Loads and Stresses The Indian Roads Congress 1990

STANDARD SPECIFICATIONS
AND
CODE OF PRACTICE
FOR
ROAD BRIDGES

SECTION II
LOADS AND STRESSES

THE INDIAN ROADS CONGRESS
1990

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Section II

LOADS AND STRESSES

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LOADS AND STRESSES

SCOPE : The object of the Standard Specifications and Code of Practice is to establish a common procedure for the design and construction of road bridges in India. This publication is meant to serve as a guide to both the design engineer and the construction engineer but compliance with the rules therein does not relieve them in any way of their responsibility for the stability and soundness of the structure designed and erected by them. The design and construction of road bridges require an extensive and thorough knowledge of the science and technique involved and should be entrusted only to specially qualified engineers with adequate practical experience in bridge engineering and capable of ensuring careful execution of work.

201. CLASSIFICATION

201.1. Road bridges and culverts shall be divided into classes according to the loadings they are designed to carry.

I.R.C. Class AA Loading:—This loading is to be adopted within certain municipal limits, in certain existing or contemplated industrial areas, in other specified areas, and along certain specified highways. Bridges designed for Class AA Loading should be checked for Class A Loading also, as under certain conditions, heavier stresses may be obtained under Class A Loading.

Note: "Where Class 70-R is specified, it shall be used in place of IRC Class AA loading".

I.R.C. Class A Loading :—This loading is to be normally adopted on all roads on which permanent bridges and culverts are constructed.

I.R.C. Class B Loading :—This loading is to be normally adopted for temporary structures and for bridges in specified areas. Structures with timber spans are to be regarded as temporary structures for the purpose of this Clause.

For particulars of the above three types of loading, see Clause 207.

201.2. Existing bridges which were not originally constructed or later strengthened to take one of the above specified I.R.C. Loadings will be classified by giving each a number equal to that of the highest standard load class whose effects it can safely withstand.

Appendix I gives the essential data regarding the limiting loads in each bridge class, and forms the basis for the classification of bridges.

201.3. Individual bridges and culverts designed to take electric tramways or other special loadings and not constructed to take any of the loadings described in Clause 201.1 shall be classified in the appropriate load class indicated in Clause 201.2.

202. LOADS, FORCES AND STRESSES

202.1. The loads, forces and stresses to be considered in designing road bridges and culverts are :

1. Dead load,
2. Live load,
3. Impact or dynamic effect of the live load,
4. Wind load,
5. Horizontal forces due to water currents,
6. Longitudinal forces caused by the tractive effort of vehicles or braking of vehicles and/or those caused by restraint to movement of free bearings,
7. Centrifugal forces,
8. Buoyancy.
9. Earth pressure,
10. Temperature stresses,
11. Deformation stresses,
12. Secondary stresses,
13. Erection stresses,
14. Seismic forces.

202.2. All members shall be designed to sustain safely the various loads, forces and stresses that can co-exist, and all calculations shall tabulate distinctly the various combinations of the above loads and stresses covered by the design.

12.	Temperature effects (see note ii)	F_{te}
13.	Deformation effects	F_d
14.	Secondary effects	F_s
15.	Erection effects	F_{er}
16.	Seismic force	F_{eq}
17.	Wave pressure (see note iii)	F_{wp}
18.	Grade Effect (see note iv)	G_o

Notes : (i) The snow loads may be based on actual observation or past records in the particular area or local practices, if existing.

(ii) Temperature effects (F_{te}) in this context is not the frictional force due to the movement of bearing but that which is caused by rib shortening, etc.

(iii) The wave forces shall be determined by suitable analysis considering drawing and inertia forces etc. on single structural members based on rational methods or model studies. In case of group of piles, piers etc., proximity effects shall also be considered.

(iv) For bridges built in grade or cross-fall, the bearings shall normally be set level by varying the thickness of the plate situated between the upper face of the bearing and lower face of the beam or by any other suitable arrangement. However, where the bearings are required to be set parallel to the inclined grade or cross-fall of the superstructure, an allowance shall be made for the longitudinal and transverse components of the vertical loads on the bearings.

202.2. All members shall be designed to sustain safely most critical combination of various loads, forces and stresses that can co-exist, and all calculations shall tabulate distinctly the various combinations of the above loads and stresses covered by the design.

202.3. Combination of Loads and Forces

The following combinations shall be adopted for working out stresses in members :

Combination (I) $G+Q$ or $G_s+Q_{lm}+F_{wo}+F_f+G_b+F_{ef}+F_{sp}+G_s$

(II) (I)$+F_s+F_d+F_t$

(III) $(II)+W+F_{wp}$

(IV) $(II)+F_{eq}+F_{wp}$

(V) $(II)+F_{im}+W$

(VI) $G+F_{wc}+G_b+F_{cp}+F_{cr}+F_f+W+G_e$

(VII) $(VI)+F_{eq}-W$

Note : These combination of forces are not applicable for working out base pressure on foundation for which provision made in relevant I.R.C. Bridge Code shall be adopted.

203. PERMISSIBLE INCREASE IN STRESSES

The permissible increase of stresses in the various members due to the combinations stated in para 202.3. above shall be as follows :

Combination	I	...	Nil
,,	II	...	15%
,,	III	...	33⅓%
,,	IV	...	50%
,,	V	...	33⅓%
,,	VI	...	33⅓%
,,	VII	...	50%

*204. DELETED

205. DEAD LOAD

The dead load carried by a girder or member shall consist of the portion of the weight of the superstructure (and the fixed loads carried thereon) which is supported wholly or in part by the girder or member including its own weight. The following unit weights of materials shall be used in determining loads, unless the unit weights have been determined by actual weighing of representative samples

*Deleted, as relevant provisions are covered in IRC : 5-1970, Standard Specifications and Code of Practice for Road Bridges-Section I.

of the materials in question, in which case the actual weights as thus determined shall be used:

	Materials		Weight t/m^3
1.	Ashlar (granite)	...	2.7
2.	Ashlar (sandstone)	...	2.4
3.	Stone setts :		
	(a) Granite	...	2.6
	(b) Basalt	...	2.7
4.	Ballast (stone screened, broken, 2.5 cm to 7.5 cm gauge, loose) :		
	(a) Granite	...	1.4
	(b) Basalt	...	1.6
5.	Brickwork (pressed) in cement mortar	...	2.2
6.	Brickwork (common) in cement mortar	...	1.9
7.	Brickwork (common) in time mortar	...	1.8
8.	Concrete (asphalt)	...	2.2
9.	Concrete (breeze)	...	1.4
10.	Concrete (cement—plain)	...	2.2
11.	Concrete (cement plain with plums)	...	2.3
12.	Concrete (cement—reinforced)	...	2.4
13.	Concrete (cement—prestressed)	...	2.5
14.	Concrete (lime—brick aggregate)	...	1.9
15.	Concrete (lime—stone aggregate)	...	2.1
16.	Earth (compacted)	...	1.8
17.	Gravel	...	1.8
18.	Macadam (binder premix)	...	2.2
19.	Macadam (rolled)	...	2.6
20.	Sand (loose)	...	1.4
21.	Sand (wet compressed)	...	1.9
22.	Coursed rubble stone masonry (cement mortar)	...	2.6

Materials		Weight t/m^3
23. Stone masonry (lime mortar)	...	2.4
24. Water	...	1.0
25. Wood	...	0.8
26. Cast iron	...	7.2
27. Wrought iron	...	7.7
28. Steel (rolled or cast)	...	7.8

206. TRAFFIC LANES

The number of traffic lanes on a bridge shall be determined by the maximum integral number of trains of standard Class A vehicles described in Clause 207, which can be accommodated on the clear carriageway width of the bridge, with the vehicles travelling parallel to the length of the bridge and leaving the minimum clearances specified in Clause 207.

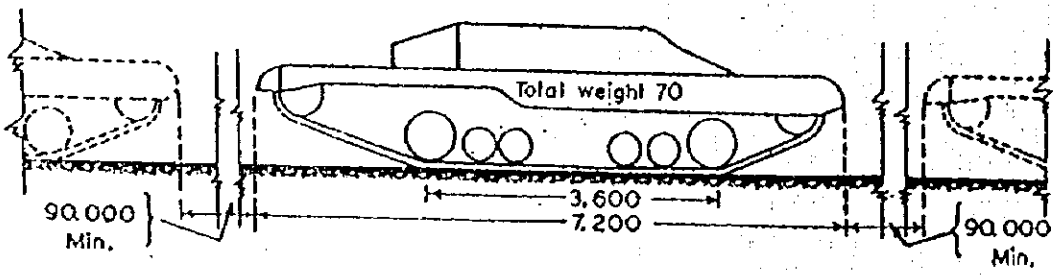
All new bridges shall be of either one-lane, two-lane, or four-lane width. Three-lane bridges shall not be constructed. In the case of four-lane or multiples of two-lane bridges, at least 1.2 m wide central verge shall be provided.

207. LIVE LOADS

207.1. Details of I.R.C. Loadings

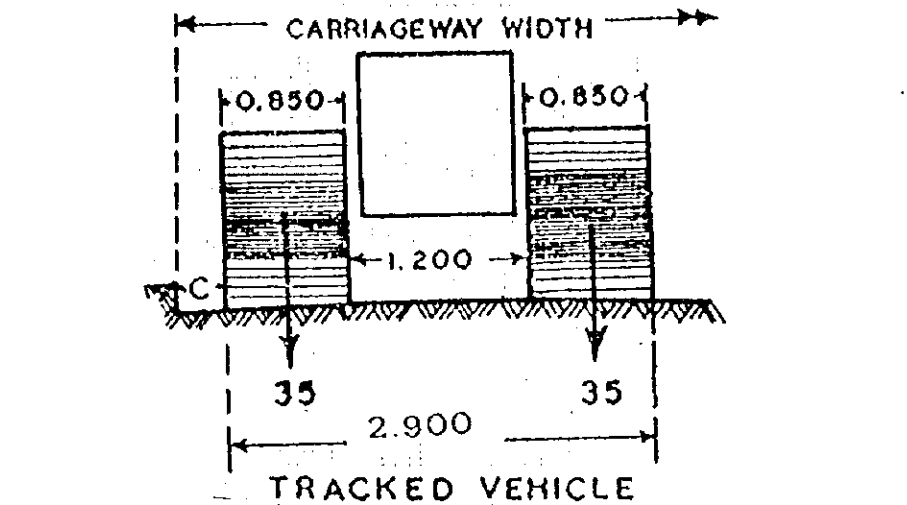
207.1.1. For bridges classified under Clause 201.1, the designed live load shall consist of standard wheeled or tracked vehicles or trains of vehicles as illustrated in Figs. 1 to 3 and Appendix 1. The trailers attached to the driving unit are not to be considered as detachable.

207.1.2. Within the kerb to kerb width of the roadway the standard vehicle or train shall be assumed to travel parallel to the

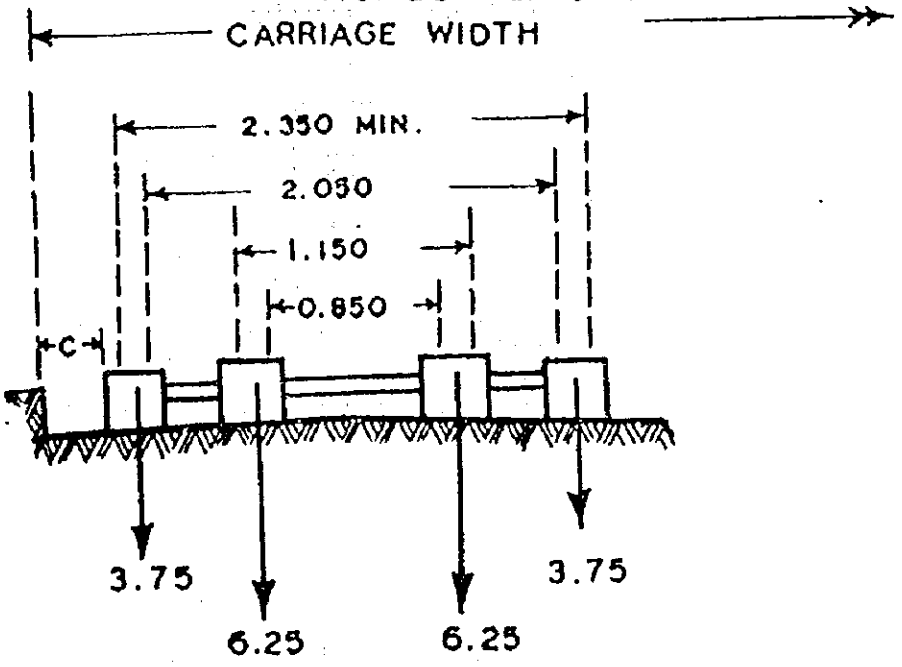


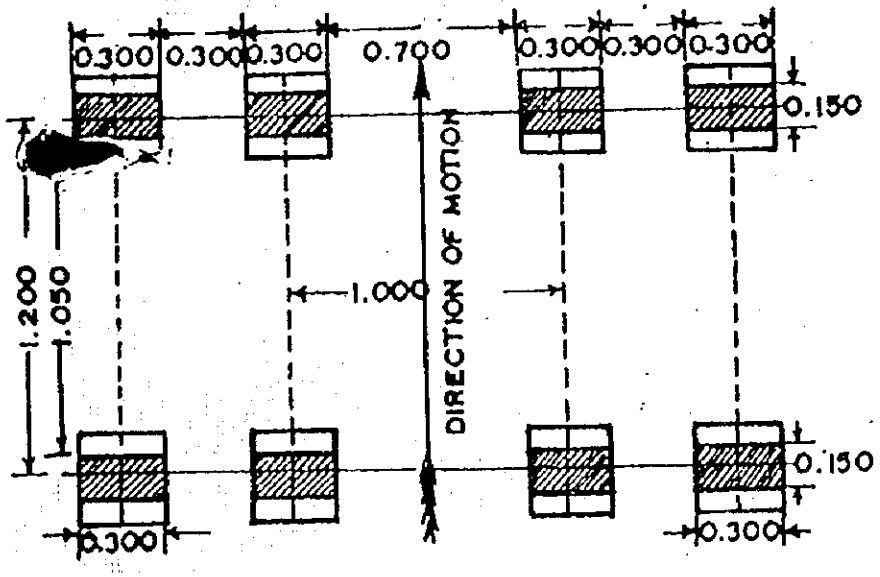
TRACKED VEHICLE

Fig. 1. Class AA tracked and wheeled vehicles (Clause 207.1)



TRACKED VEHICLE





PLAN

WHEELED VEHICLE

Fig. 1 Class AA tracked and wheeled vehicles (Clause 207.1)

Notes:

1. The nose to tail spacing between two successive vehicles shall not be less than 90 m.

2. For multi-lane bridges and culverts, one train of Class AA tracked or wheeled vehicles whichever creates severer conditions shall be considered for every two traffic lane width.

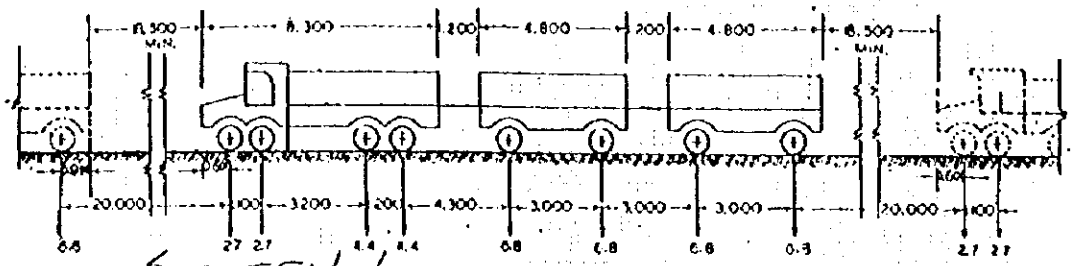
No other live load shall be considered on any part of the said 2-lane wide carriageway of the bridge when above mentioned train of vehicles is crossing the bridge.

3. The maximum loads for the wheeled vehicle shall be 20 tonnes for a single axle or 40 tonnes for a bogie of two axles spaced not more than 1.2 m centres.

4. The minimum clearance between the road face of the kerb and the outer edge of the wheel or track, C, shall be as under:

Carriageway width	Minimum value of C
Single-Lane Bridges	
3.8 m and above	0.3 m
Multi-Lane Bridges	
Less than 5.5 m	0.6 m
5.5 m or above	1.2 m

5. Axle loads in tonne linear dimensions in metre.



Σ = 55.4t

Class A train of vehicles

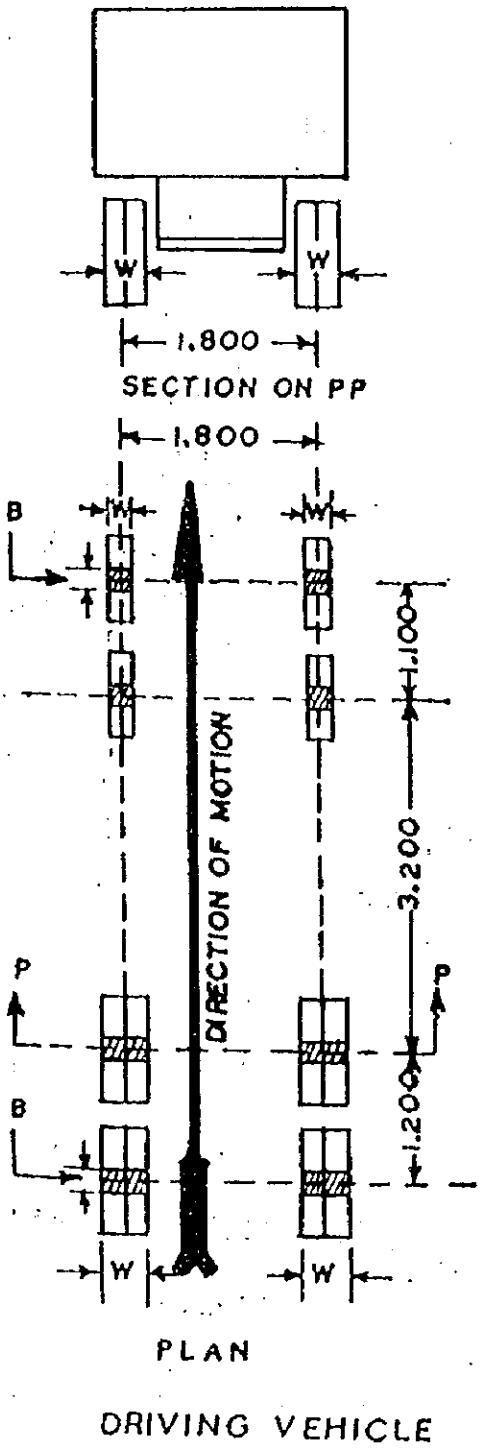


Fig. 2
Class 'A' train of vehicles

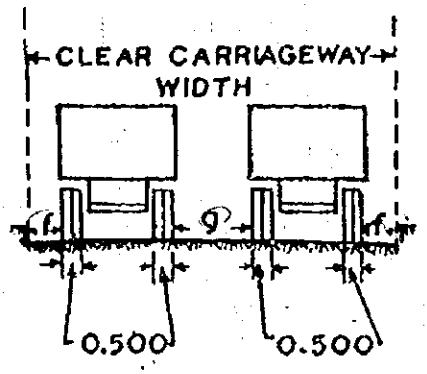
Notes :

1. The nose to tail distance between successive trains shall not be less than 18.4 m.

2. No other live load shall cover any part of the carriageway when a train of vehicles (or trains of vehicles in multi-lane bridge) is crossing the bridge.

3. The ground contact area of the wheels shall be as under:

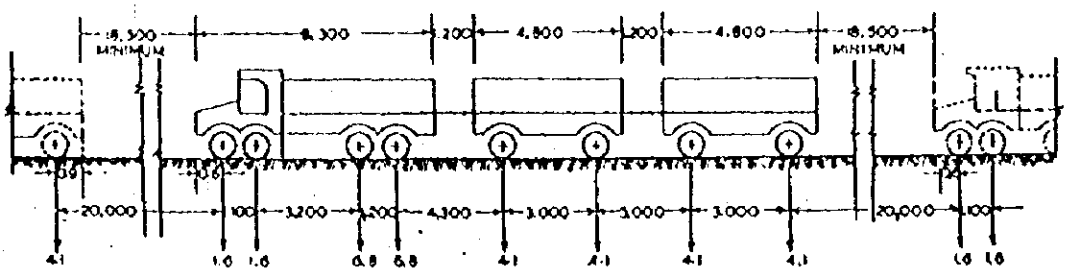
Axle load tonne	Ground contact area	
	B mm	W mm
11.4	250	500
6.8	200	380
2.7	150	200



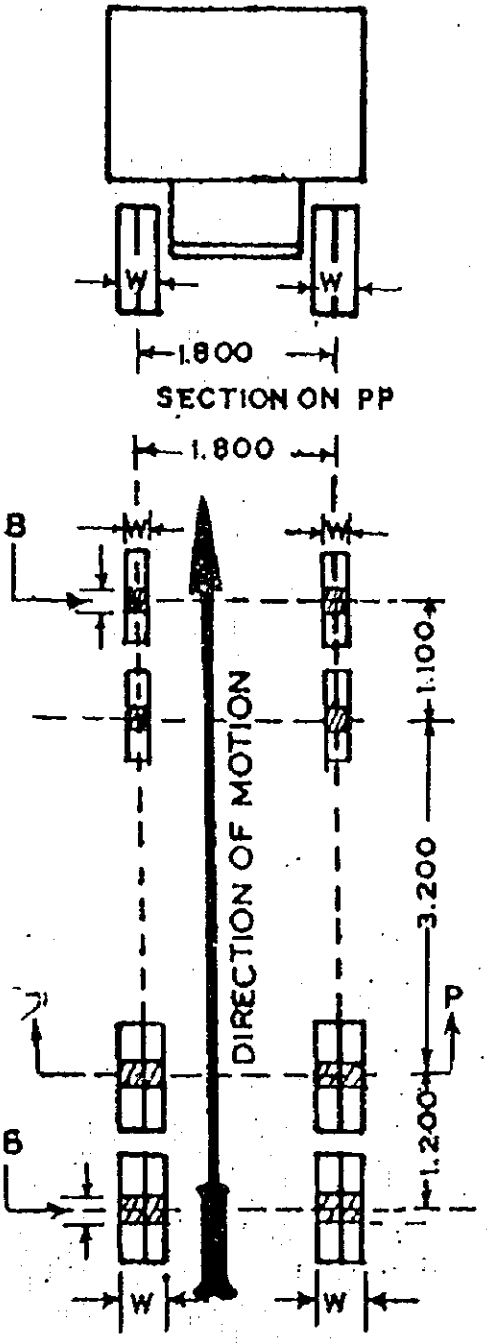
4. The minimum clearance, *f*, between outer edge of the wheel and the roadway face of the kerb, and the minimum clearance, *g*, between the outer edges of passing or crossing vehicles on multi-lane bridges shall be given below:

Clear carriageway width	*g*	*f*
5.5 m to 7.5 m	Uniformly increasing from 0.4 m to 1.2 m	150 mm for all carriageway widths
Above 7.5 m	1.2 m	

5. Axle loads in tonne linear



Class B train of vehicles



Plan
Driving vehicle
Fig. 3
Class B train of vehicles
(Clause 207.1)

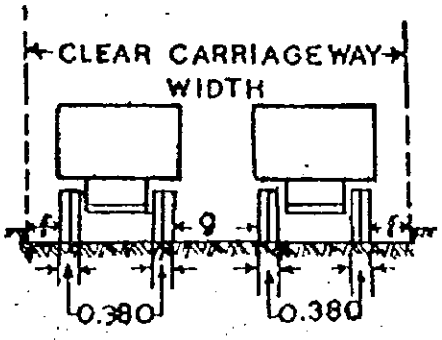
Notes:

1. The nose to tail distance between successive trains shall not be less than 18.4 m.

2. No other live load shall cover any part of the carriageway when a train of vehicles (or trains of vehicles in multi-lane bridge) is crossing the bridge.

3. The ground contact area of the wheels shall be as under:

Axle load tonne	Ground contact area	
	B mm	W mm
6.8	200	380
4.1	150	300
1.6	125	175



4. The minimum clearance, *f*, between outer edge of the wheel and the roadway face of the kerb, and the minimum clearance, *g*, between the outer edges of passing or crossing vehicles on multi-lane bridges shall be as given below:

Clear carriageway width	*g*	*f*
5.5 m to 7.5 m	Uniformly increasing from 0.4 to 1.2 m	150 mm for all carriageway widths
Above 7.5 m	1.2 m	

5. Axle loads in tonne linear dimensions in metre

length of the bridge, and to occupy any position which will produce maximum stresses provided that the minimum clearances between a vehicle and the roadway face of kerb and between two passing or crossing vehicles, shown in Figs. 1 to 3, are not encroached upon.

207.1.3. For each standard vehicle or train, all the axles of a unit of vehicles shall be considered as acting simultaneously in a position causing maximum stresses.

207.1.4. Vehicles in adjacent lanes shall be taken as headed in the direction producing maximum stresses.

207.1.5. The spaces on the carriageway left uncovered by the standard train of vehicles shall not be assumed as subject to any additional live load.

*207.2. DELETED

207.3. **Dispersion of Load through Fills on Arch Bridges**

The dispersion of loads through the fills above the arch shall be assumed at 45 degrees both along and perpendicular to the span in the case of arch bridges.

208. REDUCTION IN THE INTENSITY OF LIVE LOAD STRESSES ON BRIDGES ACCOMMODATING MORE THAN TWO TRAFFIC LANES

208.1. The position and number of loaded lanes used shall be such as to produce maximum stresses in all cases.

208.2. Where maximum stresses are produced in any member by simultaneously loading more than two traffic lanes, the intensities of the resultant live load stresses shall be reduced by 10 per cent for each additional loaded traffic lane in excess of the two-lanes subject to a maximum reduction of 20 per cent, and subject also to the condition that the stresses as thus reduced are not lower than the stresses resulting from a simultaneous loading on two traffic lanes.

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*Deleted as relevant provisions are covered in IRC: 21—1972 Standard Specifications and Code of Practice for Road Bridges—Section III.

209. FOOTWAY, KERB, RAILINGS AND PARAPET LOADING

(the provisions under this Clause do not apply to Foot-Bridges)

209.1. For all parts of bridge floors accessible only to pedestrians and animals and for all footways the loading shall be 400 kg/m². Where crowd loads are likely to occur, such as on bridges located near towns, which are either centres of pilgrimage or where large congregational fairs are held seasonally, the intensity of footway loading shall be increased from 400 kg/m² to 500 kg/m².

209.2. Kerbs, 0.6 m or more in width, shall be designed for the above loads and for a local lateral force of 750 kg per metre, applied horizontally at the top of the kerb. If the kerb width is less than 0.6 m, no live load shall be applied in addition to the lateral load specified above.

Note : The horizontal force need not be considered in the design of the main structural members of the bridge.

209.3. In calculating stresses in members of structures with cantilevered footways, the footways shall be considered as located on one side or on both sides, or unloaded, whichever condition gives the maximum stresses.

209.4. In bridges designed for any of the loadings described in Clause 207.1, the main girders, trusses, arches, or other members supporting the footways shall be designed for the following live loads per square metre of footway area, the loaded length of footway taken in each case being such as to produce the worst effects on the member under consideration:

(a) For effective span of 7.5 m or less, 400 kg/m² or 500 kg/m² as the case may be, based on sub-clause 209.1

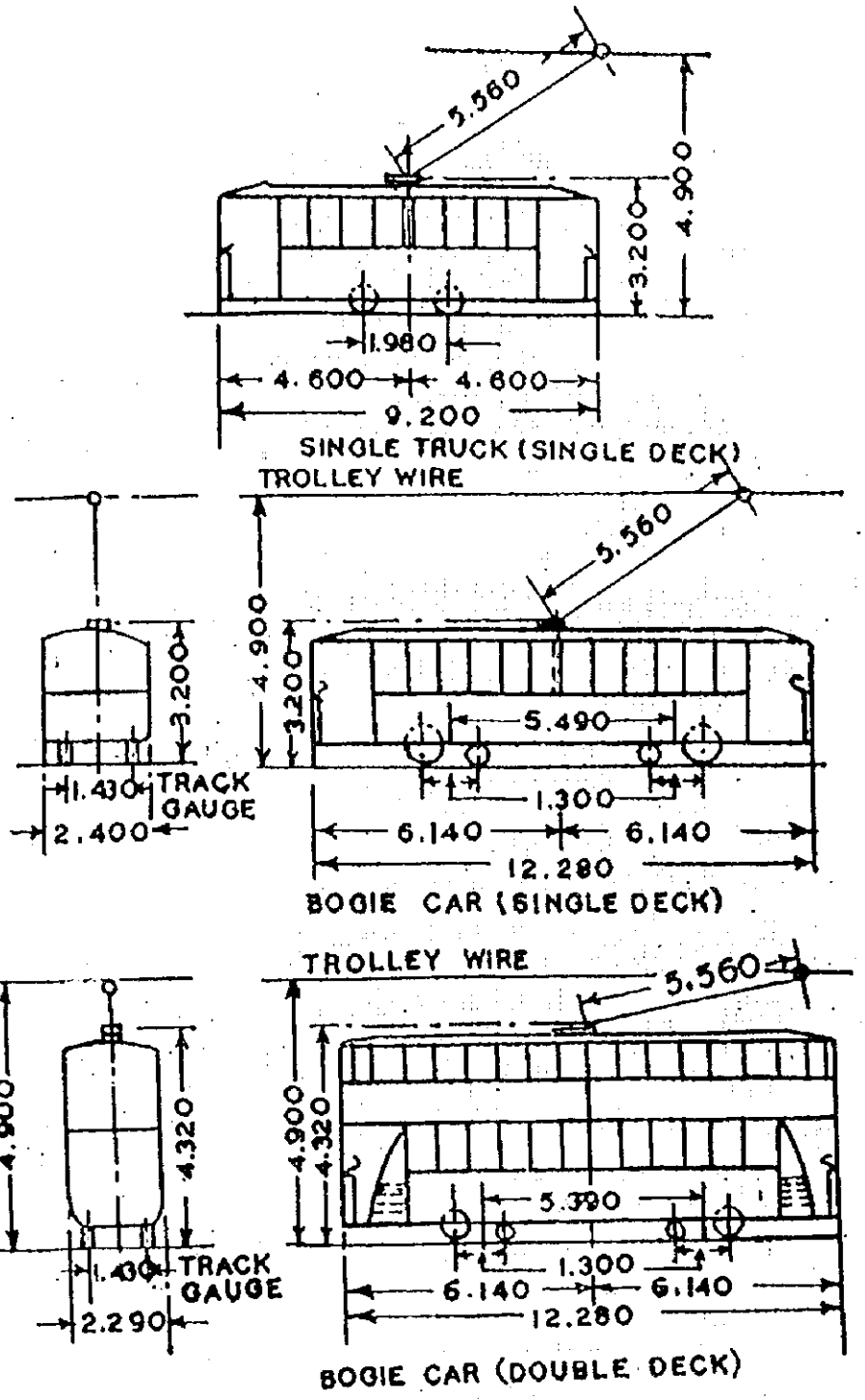
(b) For effective spans of over 7.5 m but not exceeding 30 m, the intensity of load shall be determined according to the equation :

$$P = P' - \left(\frac{40L - 300}{9} \right).$$

(c) For effective spans of over 30 m, the intensity of load shall be determined according to the equation:

$$P = \left(P' - 260 + \frac{4800}{L} \right) \left(\frac{16.5 - W}{15} \right)$$

where $P' = 400$ kg/m² or 500 kg/m² as the case may be, based on sub-clause 209.1,



Notes:

1. Clearance between passing single deck bogie cars on straight tracks laid at standard 2.75 m track centres shall be 300 mm.
2. Clearance between passing double bogie cars on straight tracks laid at standard 2.75 m track centres shall be 450 mm.
3. Linear dimensions in metre.

ROLLING STOCK WEIGHT

Description	Loaded weight tonne	Unloaded weight tonne
Single truck (single deck)	9.6	7.9
Bogie car (single deck)	15.3	12.2
Bogie car (Double deck)	21.5	16.0

Fig. 4. Average dimensions of tramway rolling stock (Clause 210.1)

P = the live load in kg/m²,

L = the effective span of the main girder, truss or arch in m, and

W = width of the footway in m.

209.5. Each part of the footway shall be capable of carrying a wheel load of 4 tonne, which shall be deemed to include impact, distributed over a contact area 300 mm in diameter; the permissible working stresses shall be increased by 25 per cent to meet this provision. This provision need not be made where vehicles cannot mount the footway as in the case of a footway separated from the roadway by means of an insurmountable obstacle, such as truss or a main girder.

Note : A footway kerb shall be considered mountable by vehicles.

209.6. The railings and parapets shall be designed to resist a lateral horizontal force and a vertical force each of 150 kg/m applied simultaneously at the top of the railing or parapet. These forces need not be considered in the design of the main structural members if footpaths are provided. In cases where footpaths are provided, the effect of these forces shall be considered in the design of the structural system supporting the railings and the footpath up to the face of the footpath kerb only.

210. TRAMWAY LOADING

210.1. When a road bridge carries tram lines, the live load due to the type of tram cars sketched in Fig. 4 shall be computed and shall be considered to occupy a 3 m width of roadway.

210.2. A nose to tail sequence of the tram cars or any other sequence which produces the heaviest stresses shall be considered in the design.

210.3. Stresses shall be calculated for the following two conditions and the maximum thereof considered in the design :

(a) Tram loading, followed and preceded by the appropriate standard loading specified in Clause 207.1 together with that standard loading on the traffic lanes not occupied by the tram car lines.

(b) The appropriate standard loading specified in Clause 207.1 without any tram cars.

211. IMPACT

211.1. Provision for impact or dynamic action shall be made by an increment of the live load by an impact allowance expressed as a fraction or a percentage of the applied live load.

211.2. **For Class A or Class B Loading:**—In the members of any bridge designed either for Class A or Class B loading (vide Clause 207.1), this impact percentage shall be determined from the curves indicated in Fig. 5. The impact fraction shall be determined from the following equations which are applicable for spans between 3 m and 45 m.

(i) Impact factor fraction for reinforced concrete bridges $= \frac{4.5}{6+L}$

(ii) Impact factor fraction for steel bridges $= \frac{9}{13.5+L}$

where L is the length in metres of the span as specified in Clause 211.5.

211.3. **For Class AA Loading and Class 70 R Loading :**—The value of the impact percentage shall be taken as follows:

(a) For spans less than 9 m :

(i) For tracked vehicles : 25 per cent for spans upto 5 m linearly reducing to 10 per cent for spans of 9 m

(ii) For wheeled vehicles : 25 per cent

(b) For spans of 9 m or more:

(i) Reinforced concrete bridges

Tracked vehicles : 10 per cent upto a span of 40 m and in accordance with the curve in Fig. 5 for spans in excess of 40 m

Wheeled vehicles : 25 per cent for spans upto 12 m and in accordance with the curve in Fig. 5 for spans in excess of 12 m

(ii) Steel bridges

Tracked vehicles : 10 per cent for all spans

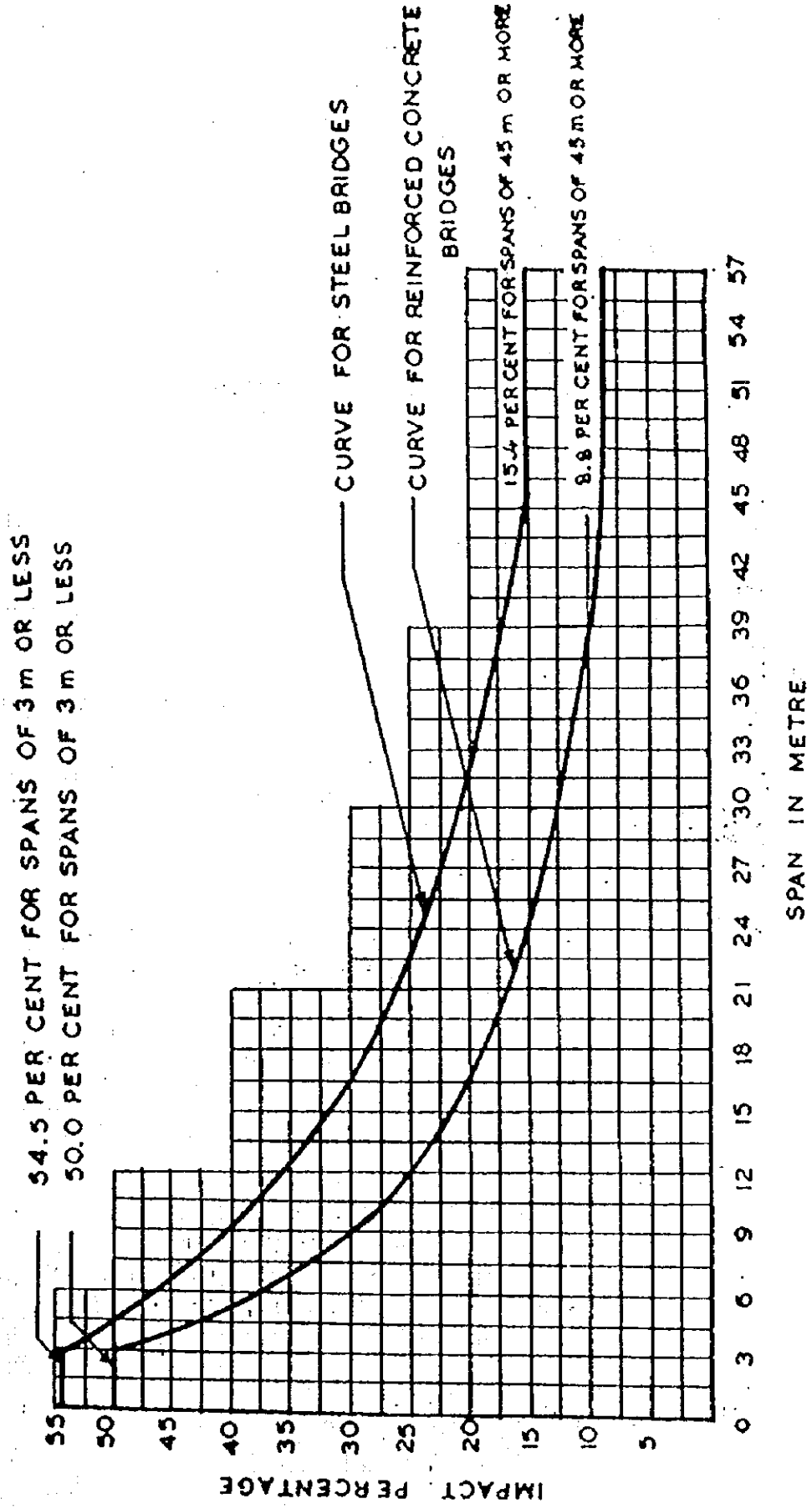


Fig. 5. Impact percentage curves for highway bridges for Class A and Class B loading (Clause 211.2)

Wheeled vehicles	:	25 per cent for spans upto 23 m and in accordance with the curve indicated in Fig. 5 for spans in excess of 23 m.

211.4. No impact allowance shall be added to the footway loading specified in Clause 209.

211.5. The span length to be considered for arriving at the impact percentages specified in Clauses 211.2 and 211.3 shall be as follows :

(a) For spans simply supported or continuous or for arches .....the effective span on which the load is placed.

(b) For bridges having cantilever arms without suspended spans.....the effective overhang of the cantilever arms reduced by 25 per cent for loads on the cantilever arm and the effective span between supports for loads on the main span.

(c) For bridges having cantilever arms with suspended Span .....the effective overhang of the cantilever arm plus half the length of the suspended span for loads on the cantilever arm, the effective length of the suspended span for loads on the suspended span and the effective span between supports for loads on the main span.

Note : "For individual members of a bridge such as a cross girder or deck slab etc. the value of L mentioned in 211.2 or the spans mentioned in 211.3 shall be the effective span of the member under consideration".

211.6. In any bridge structure where there is a filling of not less than 0.6 m including the road crust, the impact percentage to be allowed in the design shall be assumed to be one-half of what is specified in Clauses 211.2 and 211.3.

211.7. For calculating the pressure on the bearings and on the top surface of the bed blocks, full value of the appropriate impact percentage shall be allowed. But, for the design of piers, abutments and structures, generally below the level of the top of the bed block, the appropriate impact percentage shall be multiplied by the factor given below :

(a) For calculating the pressure at the bottom surface of the bed block	0.5

(b) For calculating the pressure on the top 3 m of the structure below the bed block	... 0.5 decreasing uniformly to zero
(c) For calculating the pressure on the portion of the structure more than 3 m below the bed block	zero

211.8. In the design of members subject, among other stresses, to direct tension, such as hangers in a bowstring girder bridge, and in the design of members subject to direct compression, such as spandrel columns or walls in an open spandrel arch, the impact percentage shall be taken the same as that applicable to the design of the corresponding member or members of the floor system which transfer loads to the tensile or compressive members in question.

211.9. These Clauses on Impact do not apply to the design of suspension bridges.

212. WIND LOAD

212.1. All structures shall be designed for the following lateral wind forces. These forces shall be considered to act horizontally and in such a direction that the resultant stresses in the member under consideration are the maximum.

212.2. The wind force on a structure shall be assumed as a horizontal force of the intensity specified in Clause 212.3 and acting on an area calculated as follows :

(a) For a deck structure :
The area of the structure as seen in elevation including the floor system and railing, less area of perforations in the hand railing or parapet walls.

(b) For a through or half-through structure :
The area of the elevation of the windward truss as specified at (a) above plus half the area of elevation above the deck level of all other trusses or girders.

212.3. The intensity of the wind force shall be based on the table of wind pressures and wind velocities given on page 21 and shall be allowed for in the design. The pressures given therein shall however, be doubled for bridges situated in areas such as the Kathiawar Peninsula and the Bengal and Orissa coasts shown hatched in Fig. 6.

HYPOTHETICAL VEHICLES FOR CLASSIFICATION OF VEHICLES AND BRIDGES (REVISED)

Appendix 1

NOTES FOR LOAD CLASSIFICATION CHART

1. The possible variations in the wheel spacings and tyre sizes, for the heaviest single axles—cols. (f) and (h), the heaviest bogie axles—col. (j) and also for the heaviest axles of the train vehicle of cols. (e) and (g) are given in cols. (k),(l),(m) and (n). The same pattern of wheel arrangement may be assumed for all axles of the wheel train shown in cols. (e) and (g) as for the heaviest axles. The overall width of tyre in mm may be taken as equal to [150 ÷ (p − 1) 57], where "p" repressents the load on tyre in tonnes, wherever the tyre sizes are not specified on the chart.

2. Contact areas of tyres on the deck may be obtained from the corresponding tyre loads, max, tyre pressures col. (p) and width of tyre treads.

3. The first dimension of tyre size refers to the overall width of tyre and second dimension to the rim diameter of the tyre. Tyre tread width may be taken as overall tyre width minus 25 mm for tyres upto 225 mm width, and minus 50 mm for tyres over 225 mm width.

4. The spacing between successive vehicles will be 30 m. This spacing will be measured from the rear-most point of ground contact of the leading vehicles to the forward-most point of ground contact of the following vehicle in case of tracked vehicles; for wheeled vehicles, it measured from the centre of the rear-most axle of the leading vehicle to the centre of the first axle of the following vehicle.

5. The classification of the bridge shall be determined by the safe load carrying capacity of the weakest of all the structural members including the main girders, stringers (or road bearers), the decking, cross bearers (or transome) bearings, piers and abutments, investigated under the track, wheel axle and bogie loads shown for the various classes. Any bridge upto and including class 40 will be marked with a single class number—the highest tracked or wheel standard load class which the bridge can safely withstand. Any bridge over class 40 will be marked with a single class number if the wheeled and tracked classes are the same, and with dual classification sign showing both T and W load classes if the T and W classes are different.

6. The calculations determining the safe load carrying capacity shall also allow for the effects due to impact, wind pressure, longitudinal forces, etc., as described in the relevant Clauses of this Code.

7. The distribution of load between the main girders of a bridge is not necessarily equal, and shall be assessed from considerations of the spacing of the main girders, their torsional stiffness, flexibility of the cross bearers, the width of roadway and the width of the vehicles, etc., by any rational method of calculations.

8. The maximum single axle loads shown in columns (f) and (h) and the bogie axle loads shown in column (j) correspond to the heaviest axles of the trains, shown in columns (e) and (g) in load-classes upto and including class 30-R. In the case of higher load classes, the single axle loads and bogie axle loads shall be assumed to belong to some other hypothetical vehicles and their effects worked out separately on the components of bridge deck.

9. The minimum clearance between the road face of the kerb and the outer edge of wheel or track for any of the hypothetical vehicles shall be the same as for Class AA vehicles, when there is only one-lane of traffic moving on a bridge. If a bridge is to be designed for two lanes of traffic for any type of vehicles given in the Chart, the clearance may be decided in each case depending upon the circumstances.

(ALL LINEAR DIMENSIONS IN MILLIMETRE) (1) S.A. means single axle, (2) B.A. means bogie axle, (3) R means Revised

Class	TRACKED VEHICLES	width of track	width over track	WHEELED VEHICLES											
				Four wheelers	Max. single axle load	Six wheelers	Max. single axle load	Max. bogie load	Minimum wheel spacing and tyre sizes of critical (Heaviest) axles.				Max. tyre load on min. tyre size	Max. tyre pressure	Remarks
(a)	b	c	d	e	f	g	h	j	k	l	m	n	o	p	q
3				1.8 t 0.7 1.1 610 1980 910	1.1 t	2.42 t 0.6 0.98 0.84 610 1980 2590 910	1.0 t		370 SA. 150 x 410				0.55 t On col (k) 150 x 410	2.46 kg/cm²	
5R	5.5 t 1980 Nose to tail Length. 3660	230	1980	5.5 t 2.1 3.4 610 3050 910	3.4 t	5.4 t 1.0 2.2 2.2 610 3200 1220 910	2.2 t	4.5 t	SA. for (f) 220 x 510 1780 SA. 190 x 410 BA. 190 x 410	350/360 1780 SA. 150 x 410 (f)&(r) BA. 150 x 410			1.7 t on col (k) 220 x 410	4.218 kg/cm²	
9R	9.5 t 2740 Nose to tail Length. 4270	300	2130	9.2 t 3.4 5.8 610 3960 910	5.8 t	10 t 3.0 3.5 3.5 610 3200 1220 910	3.5 t	7.0 t	SA. for (f) 300 x 510 1910 SA. 230 x 510 BA. 230 x 510	480/360 1910 SA. 220 x 510 for (f) SA. 150 x 510 BA. 150 x 510			2.9 t on col (k) 250 x 510	5.273 kg/cm²	
12R	12.5 t 2740 Nose to tail Length. 4880	300	2290	12 t 4.5 7.5 610 3960 910	7.5 t	12 t 2.4 4.8 4.8 610 3200 1220 910	4.8 t	9.6 t	SA for (f) 360 x 510 2060 SA. 250 x 510 SA. 250 x 510	510/430 2060 SA. 230 x 510 for (f) SA. 190 x 510 BA. 190 x 510			3.75 t on col (k) 360 x 610	5.273 kg/cm²	
18R	19 t 3050 Nose to tail Length. 5490	360	2360	15.5 t 3.5 10.0 610 4270 910	10.0 t	18.7 t 3.5 7.6 7.6 610 3660 1220 910	7.6 t	15.2 t	SA for (f) 410 x 610 2130 SA. 360 x 510 BA. 360 x 510	510/480 2130 SA. 230 x 510 for (f) SA. 220 x 510 BA. 220 x 510			5.00 t on col (k) 410 x 610	5.273 kg/cm²	
24R	25 t 3650 Nose to tail Length. 5490	360	2440	20 t 4.0 12.0 610 4270 910	12.0 t	23.2 t 4.2 8.5 8.5 610 3960 1220 910	8.5 t	17.0 t	SA for (f) 410 x 610 2210 SA. 410 x 610 BA. 410 x 610	660/510 2210 SA. 300 x 510 for (f) SA. 230 x 510 BA. 230 x 510	220 250 SA. 300 x 510 for (f) SA. 230 x 510 BA. 230 x 510		6.00 t on col (k) 410 x 610	5.273 kg/cm²	
30R	30 t 3660 Nose to tail Length. 6400	410	2590	38 t 4.0 10.0 10.0 14.0 60 3660 1220 4880 910			14.0 t	20 t Axle spacing 1220	2440 SA. 530 x 610 BA. 460 x 610	760/510 2440 SA. 360 x 510 BA. 230 x 510	300 2440 SA. 360 x 510 BA. 230 x 510	2440 200 SA. 190 x 510 BA. 190 x 510	7.00 t on col (k) 530 x 610	5.273 kg/cm²	
40R	40 t 3660 Nose to tail Length. 7320	560	2740	55 t 5.0 7.0 7.0 12.0 12.0 12.0 610 3660 1220 3050 4270 1070 910			16.0 t	26 t Axle spacing 1070	2510 SA. 530 x 610 BA. 460 x 610	760/660 2510 SA. 360 x 610 BA. 300 x 510	330 2510 SA. 360 x 610 BA. 300 x 510	2510 200 SA. 190 x 510 BA. 190 x 510	8.00 t on 530 x 610 single axle could for wind effect The length of vehicle may be assumed 2440	5.273 kg/cm²	
50R	50 t 4270 Nose to tail Length. 7540	610	2790	65.5 t 5.0 7.0 7.0 15.5 15.5 15.5 610 3660 1220 3050 4270 1070 910			17.5 t	32 t Axle spacing 1070		860/760 2590 SA. 410 x 610 BA. 360 x 610	360 2590 SA. 410 x 610 BA. 360 x 610	2590 200 SA. 190 x 510 BA. 190 x 510	DITTO	5.273 kg/cm²	Actual max. tyre load 4.38 t on 410 x 610
60R	60 t 4570 Nose to tail Length. 7920	760	2840	74 t 5.0 7.5 7.5 18.0 18.0 18.0 610 3660 1220 3050 4270 1070 910			19.0 t	36 t Axle spacing 1070		860 2670 SA. 410 x 610 BA. 410 x 610	380 2670 SA. 410 x 610 BA. 410 x 610	2670 230 SA. 220 x 510 BA. 220 x 510	DITTO	5.273 kg/cm²	Actual max. tyre load 4.75 t on 410 x 610
70R	70 t 4570 Nose to tail Length. 7920	840	2900	100 t 8.0 12.0 12.0 17.0 17.0 17.0 17.0 910 3960 1220 2130 1370 3050 1370 910			20 t	40 t 20.0 20.0 1220 830 830 1220		2790 860 SA. 410 x 610 BA. 410 x 610	2790 380 SA. 410 x 610 BA. 410 x 610	2790 510 250 SA. 230 x 510 BA. 230 x 510	DITTO	5.273 kg/cm²	Actual max. tyre load 5.00 t on 410 x 610

Appendix-F

Geological Survey Results

F-1 Boring Log Chart

Kurizampa

Depth From (m	To (m)	Run (m)	Recovery length	Recover %	RQD %	Pieces length710cm	Description of the core
0.00	0.36	0.36	0.36	100	-	-	Greyish brown, fine grained sand with moderately weathered, sharp & irregular shaped quartzite. (top soil).
0.36	0.52	0.16	0.16	100	-	-	- do - but the clastic sizes are bigger than above which is boulders to gravels.
0.52	0.67	0.15	0.15	100	-	-	- do - with few tabular clastic of hard & compact quartzite.
0.67	1.17	0.50	0.20		-	-	Same matrix but more clastic. The clastic are more than martrix.
1.17	1.69	0.52	0.52	100	-	-	- do - (top soil).
1.69	2.22	0.53	0.53	100	-	-	Greyish white to white coloured, moderately weathered tabular & irregular in shape having sharp edges (not insitu).
2.22	2.42	0.20	0.20	100	-	-	Greyish brown fine sand with boulders to gravel size white colour quartzite having sharp edges (top soil).
2.42	2.79	0.35	0.35	100	-	-	Greyish white & pink colour having irregular, sharp edges of boulders and gravels.
2.79	2.85	0.06	0.06	100	-	-	Sandy matrix with quartzite clastic.
2.85	3.30	0.45	0.45	100	-	-	- do - with clastic of quartzite having pebbles & granules sizes.
3.30	3.76	0.46	0.46	100	-		Greyish white, hard and compact fractured quartzite having tabular, sharp edges. (Insitu rock?).

3.76	5.07	1.31	0.07	21	-		-d o -
			0.20			1 no (20c	Light greenish colour phyllite with vertical foliation calcareous? & insitu.
5.07	5.18	0.11	0.11	100	-	-	Greyish white to greenish coloured quartzitic phyllite having vertical foliation insitu.
5.18	5.27	0.09	0.09	100	-	-	Greyish red colour, hard and compact quartzite insitu.
5.27	5.46	0.19	0.13	68	68	-	- do -
5.46	5.90	0.84	0.13	39	^-	-	- do -
			0.30		-	-	Variegated coloured of quartzite, phyllitic quartzite having sharp edges (transported materials which may be placed in the core).
5.90	6.23	0.33	0.20	61	-	-	- do -
6.23	6.57	0.34	0.20	69			Greyish white & light blue colour quartzite fractured between the two core. (insitu rock).
6.57	6.83	0.26	0.20	77	50	-	Greyish white to light blue colour, hard & compract quartzite
6.83	6.90	0.70	0.70	100	-	-	Greyish white to light blueish colour hard and compact quartzite.
6.90	7.11	0.21	0.13	62	48	-	- do -
7.11	7.30	0.19	0.19	100			- do - fractured and fragmented core.
7.30	7.56	0.26	0.26	100	58	-	- do - with fractured core at the top.
7.56	7.70	0.14	0.14	100	-	-	- do - highly fractured core.
7.70	7.93	0.23	0.23	100	49	-	- do - solid core at the bottom.
7.93	8.35	0.42	0.30	71	26		- do - fractured core

							at the bottom.
8.35	8.78	0.43	0.37	86	42	18 (pices	- do -
8.78	8.99	0.21	0.21	100	52	-	Greyish white, hard & compact quartzite fractured in between.
8.99	9.04	0.05	0.05	100	-	-	- do - (solid core).
9.04	9.36	0.32	0.32	100	-		- do - fractured core
9.36	10.35	0.99	0.88	89	26		- do -

BORING LOG CHART

DATE COMPLETED : 12/2/98
SURVEYED BY :

Chamkar

GROUND ELEVATION
GROUND WATER LEVEL

Elevation (m)	Depth (m)	Date of drilling	Depth No sample (m	Speed of bit (min)	SPT "N" value	RQD (%)	Core reco-very (%)	Symbolic representation	Vasual description of soil/rock
					Field test results				
	0.00	21/1/98	0.30	500RPM			-		Micaceous soil with few pieces of Biotite schiest
	0.30		0.72				-		"
	0.72		0.82		14 blows against 0.30cm		-		Soil (micaceous)
	0.82		1.19				-		
	1.19		1.39				-		Soil with sandy materials (silty sand)
	1.39		1.74				-		Sandy matrix with a piece of with sharp edge shape pegmatite inbetween the run & micaceous soil towards the bottom.
	1.74		2.13				89%		Fractured core of pegmatite & quartzite at the bottom.
	2.13		2.27				-		Sand with pieces of biotite schiest, pegmatite.
	2.27		2.47				75%		Piece of dull white to light yellow colour massive, fine grained quartzite.
	2.47		2.66						A piece of (10cm) solid core of pegmated with rare broken pieces.

	2.66	2.79			92.3	Fractured core of pegmatite.
	2.79	3.05			46%	Broken core of pegmatite.
	3.05	3.28			34.7%	Pebbles size core of mainly river boulders includes, basic rock & quartzite. Small pieces to
	3.28	3.77			40.8%)	Semi round shape of basic rock, quartzite and one large size pegmatite.
	3.77	3.89			83.3%	Pieces of basic rock, semi round shape pebbles and fractured core of pegmatite.
	3.89	5.07			-	Sludge constitute sandy materials.
	5.07	5.39			-	- do -
	5.39	5.57			55.5%	Small pieces to semi round shape, basic rock, pegmatite & quartzite.
	5.57	6.93			25.7%)	Small pieces to small round shape, sharp edge shape core of quartzite, dominently pegmatite .
	6.93	7.03			90%	Small pieces irregular to semi round shape of pagmatite quartzite.
	7.03	7.60			61.4%	Small pieces to semi round shape core of quartzite biotite schist, pagmatite, quartzite.
	7.60	7.85			60%	Pebbles of semi round shape to pieces of pegmatite, quartzite and rare pieces of basic rock.

	7.85		8.41			62.5%	Pebbles to cobble size of irregular to semi round shape core of quartzite, pegmatite & quartz mica schiest.
	8.41		8.72			48.3%	Small pieces of irregular sahpe core of pegmatite, quartz mica schist, quartzite and granite.
	8.72		9.14			42.8%	Cobble to core size of pegmatite & quartzite.
	9.14		9.69			54.5%	Small pieces to core size of (0.10m) pegmatite micaceous quartzite and rare pieces of basic rock.
	9.69		9.82			76.1%	Pebble to cobble size of quartzite, quartz mica schist and light green colour basic rock.
	9.82		10.04			90.9%	Fragmented core of weathered pegmatite and highly pulverised pagmatite at the bottom.
	10.04		10.60			-	Sludge, may be representing the pagmatite
	10.60		11.47				Sludge of pegmatite
	11.47		11.63			100%	Broken core of pegmatite with a piece of quartzite.
	11.63		12.23			41.6%	Small pieces to broken core of pegmatite with a piece of gneiss & basic rock.

	12.23		12.67			68%	Pebble to cobble size, irregular to semi round shape of pagmatite, granite & quartzite.
	12.67		13.13			54.3%	Irregular to semi round shape cobbles to 12 cm core of pegmatite.
	13.13		13.83			21.4%	Semi rounded to irregular shape cobbles of pegmatie, quartzite, basic rock.
	13.83		14.45			48.3%	Irregular to semi round shape cobbles of granite, pegmatite basic rock.
	14.45		14.62			94%	Pebbles to flat pieces of basic rock with corre of (10cm) pegmatite at the bottom.
	14.62		15.42			15%	Pieces of basic rock & pagmatite/granite
	15.42		16.17			26.6%	Piece of granite with 0.14 of quartzite
	16.17		16.82			23%	Pieces of basic rock with pagmatite/granite towards the bottom
	16.82		17.52			0.11%	Solid core of pegmatite.
	17.52		18.17			23%	Solid to fractured core of quartz biotite schiest with limonitic coating along the fracture plane.

	18.17		18.84				0.11%		Semi round shape cobble of pegmatit
	18.84		19.55				28.1%		Small pieces sub angular to semi round shape cobbles of basic rock/granite
	19.55		20.33				19.2%		Piece of basic rock, granite,
	20.33		20.83				20%		- do - pegmatite/granite
	20.83		21.33				4%		At the starting (0.00-0.05) pieces of pegmatite, quartz mica schist. 0.05-0.20 quartz mica schist with garnet grains.
	21.33		22.58				36%		Broken core of quartz biotite schiest with minor, garnet grains.

Bjee

Depth From (m)	Depth To (m)	Run (m)	Litholog (m)	Rec. (%)	SPT	RQD (%)	Pieces Length > 18cm	Lithological/Soil Description.
0.00	1.00	1.00						Core missing, during Logging at Head quarter
1.00	2.00	1.00			20cm = 8			
2.00	2.45	0.45			10cm = 16			
2.45	3.20	0.75	0.38	50.6				Highly broken core of garnetiferous mica schist.
3.20	4.20	1.00	1.00	100		76	2	Slightly fractured core of garnetiferrous mica schist.
4.20	5.20	1.00	0.35	35		13		Broken core of garnetiferous mica schists.
5.20	6.20	1.00	0.11	36		11		Broken core of garnetiferous mica schists.
			0.25					Solid to broken core of garnetiferous mica schists.
6.20	6.85	0.65	0.22					Fractured core of biotite gneiss with one piece of fine grained quartzite at bottom.
6.85	7.85	1.00	0.13	72		55	1	Broken core of gneiss with few pieces of white colour fine grained quartzite.
			0.04					Broken core of gneiss
			0.55					Solid core of gneiss with few grains of garnet at places.
7.85	8.85	1.00	0.20	25				Broken core of pegmatite.
			0.05					Garnetiferous mica schists.
8.85	9.85	1.00	0.17	54		12		Garnetiferous mica schists.
			0.18					Gneiss with few specks of garnet.
			0.07					Garnetiferous mica schists
			0.10					Solid core of gneiss
9.85	10.85	1.00	0.10	80		28		Garnetiferous mica schists.
			0.37					Banded gneiss with few specks of garnet.

Source : Geology and Mines

			0.33					Biotite gneiss.
10.85	11.85	1.00	0.34	34		13	1	Fractured to solid core of banded biotite gneiss.
11.85	12.85	1.00	0.30	30				Broken core of quartzite, biotite gneiss with 8cm solid core of gneiss at the end.
12.85	13.85	1.00	0.25	25				At the starting few broken cores of quartzite with gneiss & solid core of gneiss towards the end.
13.85	14.85	1.00	0.58	58		38	1	Partly broken core of biotite gneiss.
14.85	15.85	1.00	0.25	42				Irregular to semirounded shaped pebbles of quartzite, biotite gneiss and basic rocks.
			0.17					Broken core of gneiss.
15.85	16.85	1.00	0.18	82		55	2	Irregular to semirounded shaped pebbles of quartzite, biotite gneiss and basic rocks.
			0.64					Solid core of gneiss.
16.85	17.65	0.80	0.50	73		41		Partly broken core of coarse grained biotite gneiss.
17.65	18.20	0.55	0.50	90		25		Partly broken core of coarse grained biotite gneiss.

Borehole closed at the depth of 18.20 mts. on ---------- 1998.

Source : Geology and Mines

Wachy Zam

Depth From (m)	Depth To (m)	Run (m)	Litholog (m)	Reco (%)	SPT	RQD (%)	Pieces Length > 18cm	Lithological/Soil Description.
0.00	1.00	1.00						Empty
1.00	1.60	0.60	0.21	35				Hard, compacked, moderately weathered schist intruded by quartz veins which is in turn folded.
1.60	2.60	1.00	0.25	50		25		Greyish white hard & compact granite compact gneissschists fractured core at the bottom.
2.60	3.30	0.70	0.15	46		21		Augen gneiss highly weathered and fractured.
			0.17					Hard and compact, moderately weathered tourmaline granite.
3.30	3.45	0.15	0.15	100				Cobbles & pebbles of melanocratic of quartzite and schists with sharp edges.
3.45	4.45	1.00	0.05	25		11		Cobbles & pebbles of melanocratic of quartzite and schists with sharp edges with addition of granite.
			0.16					Moderately weathered, hard augen gneiss.
			0.04					Quartzitic schists having schistose structure and moderately to highly weathered.
4.45	5.45	1.00	0.11			11		- do -
			0.10					Green coloured biotite quartzite which is hard and compact broken core at the bottom.
			0.06					Fractured sharp edges micaceous/sericitic quartzite/gneoss.

Source : Geology and Mines

			0.12					Banded/Laminated quartzite.
5.45	5.60	0.15	0.32					Variegated colour of green and black quartzite, pegmatite, carbonaceous quartzite with irregular sharp edges and tabular shape. (Core found excess in this run)
5.60	5.75	0.15	0.10					- do -
			0.10					Coarse grained highly weathered gneiss.
5.75	5.85	0.10	0.10	100				Coarse grained highly weathered gneiss, highly fractured core.
5.85	6.65	0.80	0.51	64		36	1	Coarse grained moderately to highly weathered gneiss, less fractured.
6.65	6.85	0.20	0.08	40				Coarse grained gneiss but fractured at the top.
6.85	7.45	0.60	0.04	58		20		- do -
			0.35					Light greenish colour banded quartzite
7.45	7.65	0.20	0.19	95		19		Massive, fine grained light greenish colour quartzite. Some reddish spots/stains are also noticed. May be the presence of garnet in it.
7.65	7.75	0.10	0.06	60				- do -
7.75	8.55	0.80	0.30	34				Highly broke n core of gneiss with 1cm to 2 cm thick pegmatite patches at the begining & end.
8.55	9.55	1.00	0.09	75		27		Broken core of gneiss.
			0.21					Broken and deviated core of quartzite with pegmatite pieces.
			0.45					Biotite gneiss with minor quartz-vein.
9.55	10.25	0.70	0.21	30				Weathered quartzitic schists with 7cm thick pegmatite core at the end. The quartzitic schist is broken along the foliation plane longitudinally with respect to the borehole.

Source : Geology and Mines

10.25	11.25	0.11	0.20	20			Broke core of biotite gneiss with reddish stains at places on the broken surface along the foliation plane.
11.25	12.25	1.00	0.04	33		29	Broken core of pegmatite.
			0.29				Solid core of pegmatite with specks of tourmaline and pin head red garnet at places.
12.25	12.60	0.35	0.08	65			Broken core of pegmatite.
			0.06				Biotite gneiss
			0.09				Quartzite containing some mica.
12.60	13.60	1.00	0.05	43		15	Quartzite (deviated core one piece)
			0.38				Broken core of biotite gneiss with one pegmatite vein. Last 15cm solid core.
13.60	14.10	0.50	0.13	26			Highly broken core of quartzite.
14.10	15.10	1.00	1.00	100		69	Biotite gneiss, fractured at few places.
15.10	15.35	0.25	0.20	80			Broken core biotite gneiss, last 5cm core is quartzite.
15.35	16.25	0.90	0.24	27		10	Micaceous quartzite, first 10cm solid and rest broken core.
16.25	17.25	1.00	0.25	34		25	Quartzite.
			0.09				Pegmatite, mineralogically consists of moscovite, tourmaline & reddish pin head garnet.
17.25	18.25	1.00	0.43	43		35	- do -

Borehole closed at the depth of 18.25m on ---------- 98.

Source : Geology and Mines

Mangdichu (Left Bank Side))

Depth From (m	To (m)	Run (m)	Recovery %	RQD %	Pieces le 718cm	Lithologg (m)	Lithological description
0.00	0.30	0.30	-		-	-	Pebbles of quartzite with sharp edge with scandy matrix
0.30	0.50	0.20	100	85?		0.20	Greyish brown colour moderately weathered quartzite. Colour Bedding is clearly seen & redrilled core.
0.50	0.85	0.20	80			0.16	Cobbles of quartzite quartzte phyllite having sub-rounded to angular in shape.
1.05	1.10	0.05	100			0.05	Greyish white quartzite
1.10	1.45	0.35	100			0.35	Pebbles and cobbles sizes of quartzite & quartzitic phyllite oblique fractured core of greyish white colour at the bottom.
1.45	2.05	0.60	100			0.60	Micaceous quartzite which is fractured (it may be due to mis handling) with few pebbles of quartzite at the bottom.
2.05	2.55	0.50	100			0.50	Pebbles of quartzite having sharp edges with quartzite & quartzitic phyllite /micaceous quartzite.
2.55	2.60	0.05	100			0.05	Laminated micacires quartzite, fractured core.
2.60	2.85	0.25	100			0.25	- do - fractured core (overburden continuing).

2.85	3.05	0.20	50			0.10	- do - of pebbles to cobble size.
3.05	3.15	0.10	100			0.10	Hard & compact quartzite, fractured perpendicular to the bedding.
3.15	3.75	0.60	45			0.27	Fractured & fragmented core of micaceous quartzite with pebbles to cobbles of quartzite having sharp edges.
3.75	4.50	0.75	79			0.59	Greyish yellow to greyish white quartzite, 48cm of solid core of quartzite.
4.50	5.20	0.70	100			0.70	Pebbles to cobbles of quartzite & micaceous quartzite with few fractured core.
5.20	5.45	0.20	100			0.20	Pebbles to cobbles of quartzite having sub-rounded, elongated & tabular in shape.
5.45	6.50	1.05	83			0.87	Moderately weathered gneiss, granite gneiss, quartzite & laminated micaceous quartzite. The core length ranges from 0.04m to 0.25m (Overburden continuing).
6.50	6.90	0.40	60			0.24	Pebbles to cobbles of micaceous quartzite & quartzite which are having sharp edges with few fractured core.
6.90	7.90	1.00	55			0.55 0.17	Pebbles to cobbles of quartzite & micaceous quartzite having irregular & angular in shape.
						0.38	Hard & compact

							moderately weathered quartzite having oblique & perpendicular fracture
7.90	8.55	0.65	82			0.53 0.35	Cobbles & pebbles of quartzite & micaceous quartzite.
						0.18	Quartzite with oblique fracture.
8.55	8.85	0.30	57			0.17	Cobbles of quartzite, fractured
8.85	9.70	0.85	20			0.17	Fractured core of quartzite & micaceous. quartzite
9.70	10.00	0.30	33			0.10	Greyish white quartzite (Overburden continuing).
10.00	10.25	0.25	60			0.15	Micaceous quartzite fractured.
10.25	10.55	0.30	80			0.24	- do -
10.55	10.80	0.25	48			0.12	- do -
10.80	11.00	0.20	35			0.17	Pebbles of quartzite.
11.00	11.30	0.30	30			0.15	Greyish white solid core of quartzite.
11.30	11.50	0.20	50			0.10	Greyish white solid core of quartzite.
11.50	11.65	0.15	67			0.10	Fractured core of quartzite & micaceous quartzite.
11.65	11.95	0.30	43			0.13	Solid core of micaceous quartzite.
11.95	12.25	0.30	30			0.09	Pebbles of quartzite & micaceous quartzite.
12.25	12.75	0.50	0.30			0.15 0.08	Greyish white quartzite which is being redrilled.
						0.07	Pebbles micaceous quartzite & quartzite having sharp edges.

12.75	13.25	0.50	16			0.08	- do -
13.25	13.75	0.50	26			0.13	Cobbles and pebbles quartzite (Overburden of still continuing).
13.75	14.25	0.50	16			0.80	- do -
14.25	14.75	0.50	40			0.20	Solid core of micaceous quartzite.
14.75	15.20	0.45	22			0.10	Fractured core of micaceous quartzite & quartzite.
15.20	16.20	1.00	32			0.32	Solid corer of micaceous quartzite.
16.20	16.70	0.50	12			0.06	Fractured core of micaceous quartzite.
16.70	17.00	0.30	6			0.02	- do -
17.00	18.00	1.00	12			0.12	Pebbles of predominently of quartzite with few granite gneiss & green basic pebbles coloured
18.00	18.30	0.30	27			0.08	Pebbles of micaceous quartzite.
18.30	18.80	0.50	70			0.35	White colour quartzite. 30cm quartzite core.
18.80	19.10	0.30	17			0.05	Pebbles to granules of quartzite having sharp edges.

Note : The entire borehole has been drilled in the overburden and the matrix has been washed a by the water which is being used during the drilling.

Mangdichu (Right Bank Side)

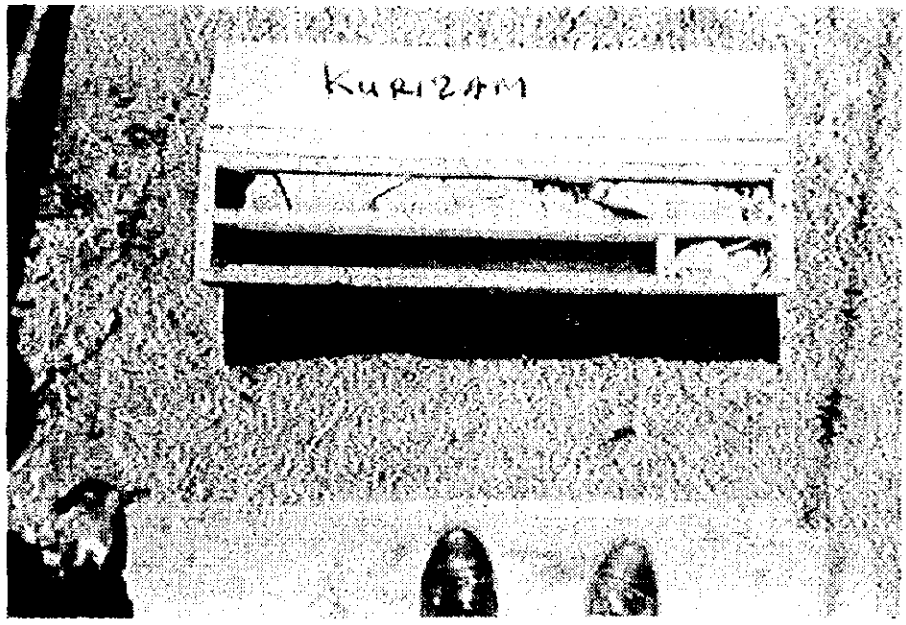
Depth From (m	To (m)	Run (m)	Revovery %	RQD %	Pieces le 718cm	Litholog (m)	Lithological description
0.00	0.80	0.80	30	12.5		0.24	Moderately weathered quartzite having sharp edges with pebbles granules of quartzite with sandy matrix. (The cores are found to be redrilled) overburden.
0.80	1.40	0.60	15	20		0.13	Greyish brown, hard & compact quartzite which is fresh to moderately weathered. It is found to have redrilled and (overburden).
1.40	1.80	0.40	10	-		0.7	Greysih white to dirty white, fresh to moderately weathered. quartzite Redrilled core and appears apprears to be (overburden)
1.80	2.00	0.20	50	50	-	0.10	Greyish white hard & compact conglomerate having an old fracture which is observed at the surface. The conglomerate consists of quartzite cobbles & quartz clastic.
2.00	2.55	0.55	45			0.25	- do - fractured core
2.55	2.90	0.35	80			0.30	- do - slightly less fractured
2.90	3.40	0.50	70	24		0.35	
						0.12	Highly weathered conglomerate
						0.23	Conglomerate highly fractured & fragments
3.40	3.50	0.10	100			0.10	- do - with sharp edges core.
3.50	3.75	0.25	100			0.25	- do - with sharp some cores have becomes to pebbles size.

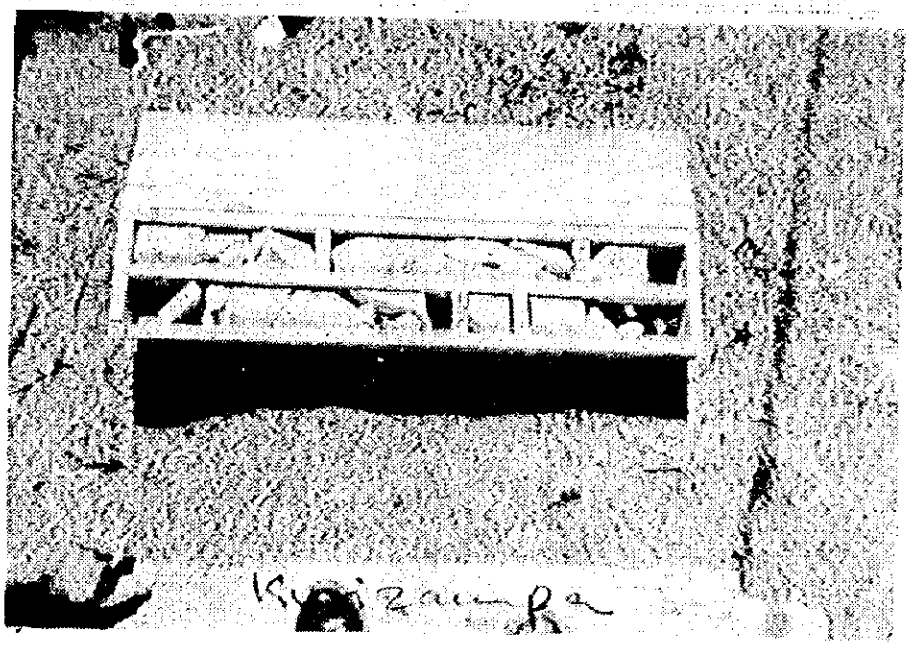
3.75	3.90	0.15	67			0.10	Conglomerate which is moderately weathered and fractured.
3.90	4.40	0.50	100	24		0.50	
						0.22	Fracture conglomerate with iron staining at the fractured surfaces.
						0.28	Conglomerate & solid core but fractured at the bottom.
4.40	4.90	0.50	100			0.50	Fractured conglomerate with iron staining at the fracture surfaces.
4.90	5.40	0.50	100			0.50	Conglomerate moderately weathered but there is a vertical fracture to the core and the size of clasts change to pebbles.
5.40	5.75	0.35	100			0.35	- do -
5.75	6.10	0.35	100			0.35	- do - solid core at the bottom with two fracture planes.
6.10	6.50	0.40	100			0.40	Fractured core of highly weathered conglomerate. The fractures are mostly found along the bedding planes in filled with coarse sand
6.50	7.50	1.00	68			0.68	- do - less fractured at the bottom.
7.50	7.70	0.20	100			0.20	- do -
7.70	8.05	0.35	66			0.23	- do - more fractured at the bottom & also mica is found along the bedding plane.
8.05	8.55	0.40	100			0.40	Moderately weathered conglomerate but highly fractured.
8.55	8.90	0.35	100			0.35	- do -
8.90	9.40	0.50	88	24		0.44	Moderately weathered

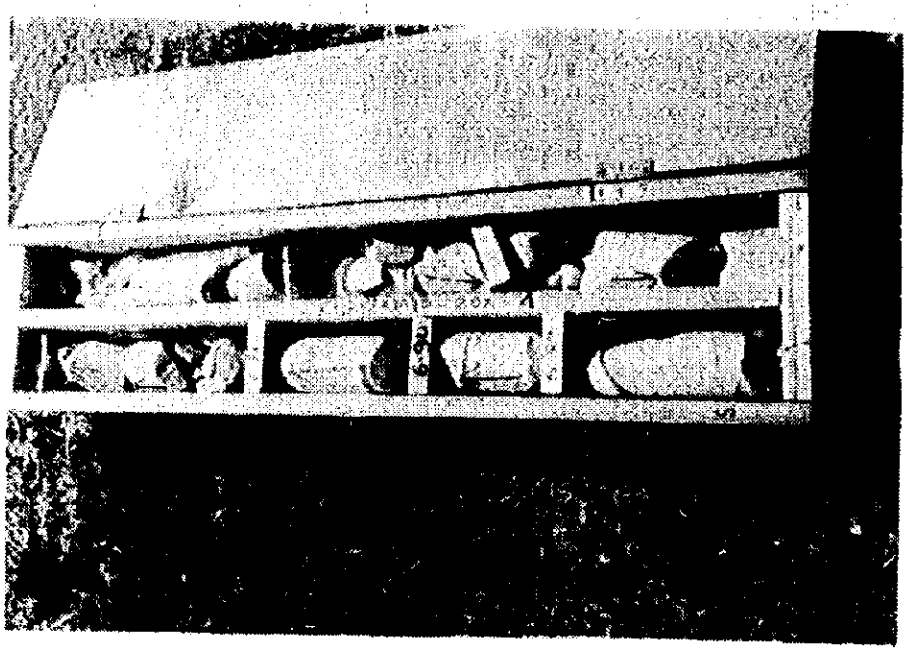
							conglomerate but less fracture with fracture axis 40 degree and vertical axis to the core. Staining of iron oxide with coarse grained sand infill.
9.40	9.90	0.50	100	40		50	- do - solid core but the vertical fracture is penetrative at places it changes to oblique with same staining & infill.
9.90	10.80	0.90	100	21		0.90	Moderately weathered conglomerate with bigger size clasts & the bedding fracture is dominent.
10.80	11.15	0.35	100	31		0.35	- do -
11.15	11.55	0.40	94			0.33	- do - fractured at the top & solid core at the bottom. An oblique fracture along the bedding.
11.55	12.15	0.60	97	90		0.58	Moderately weathered solid core & elongation of pebbles oblique to the core.

F-2 Boring Core Photograph

Kurizampa







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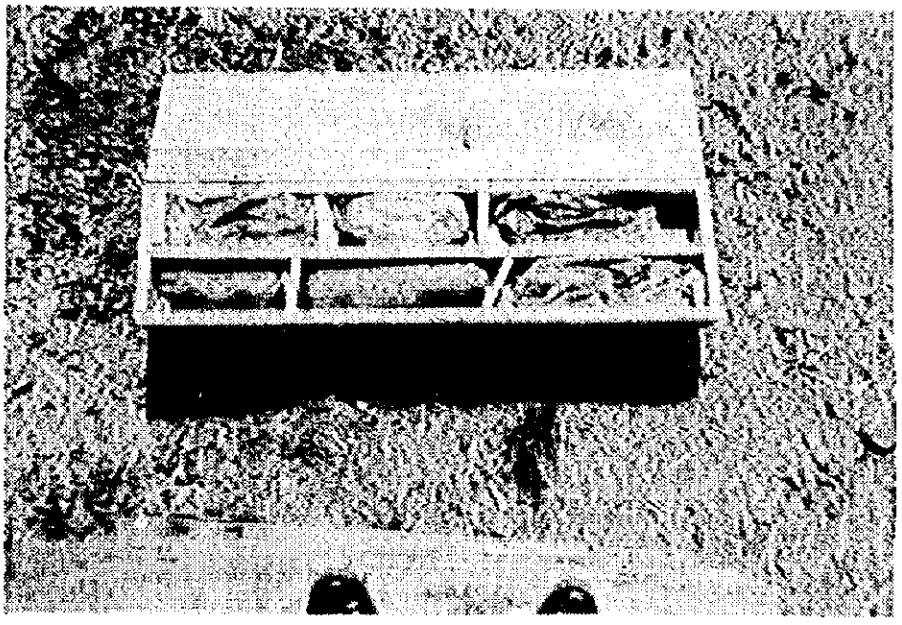

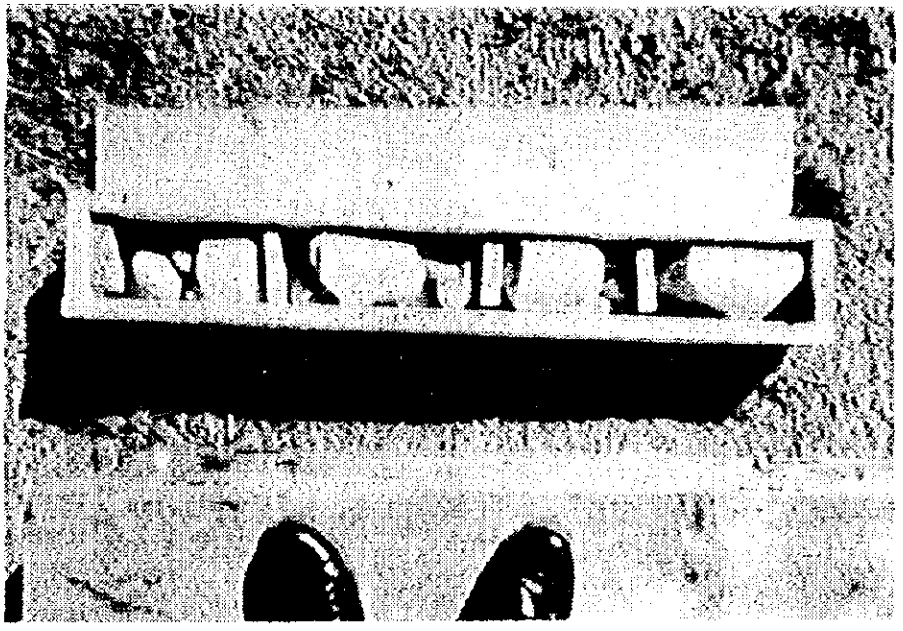

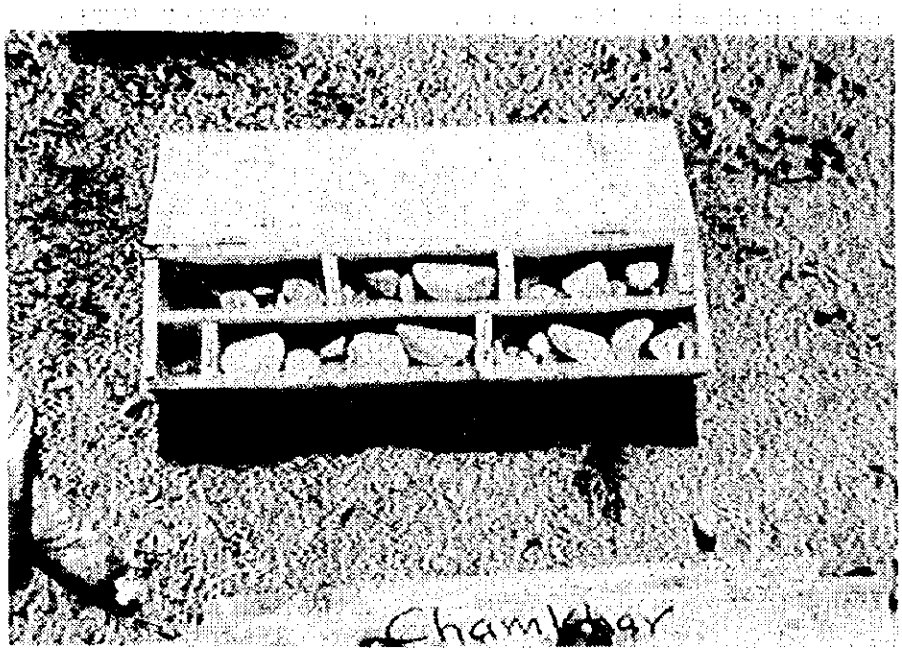
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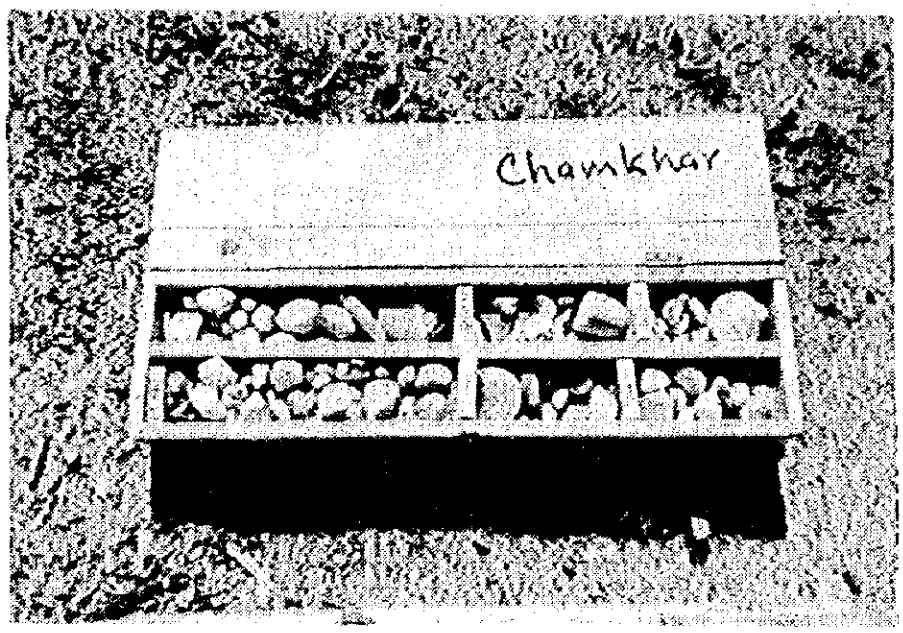
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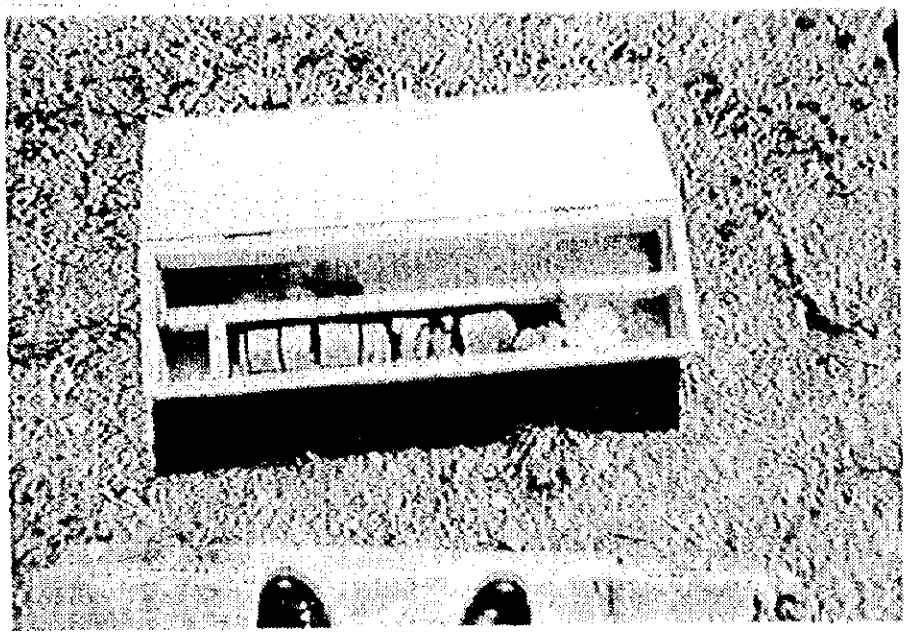
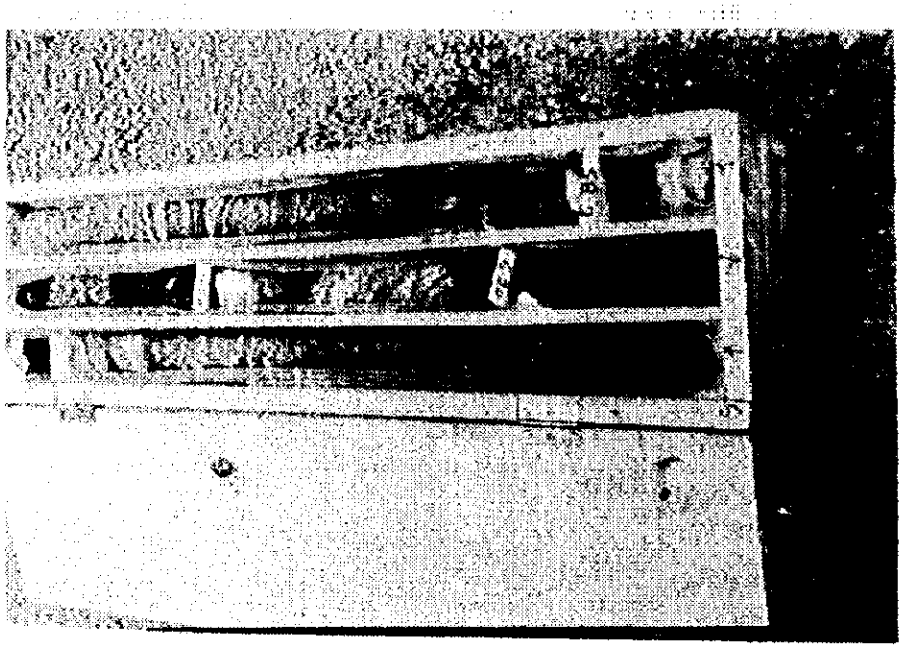
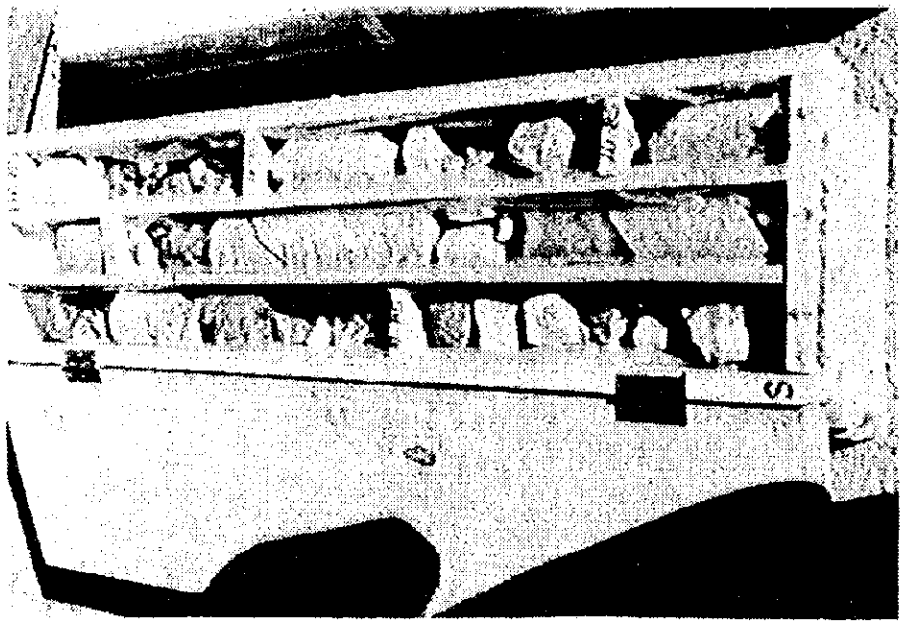
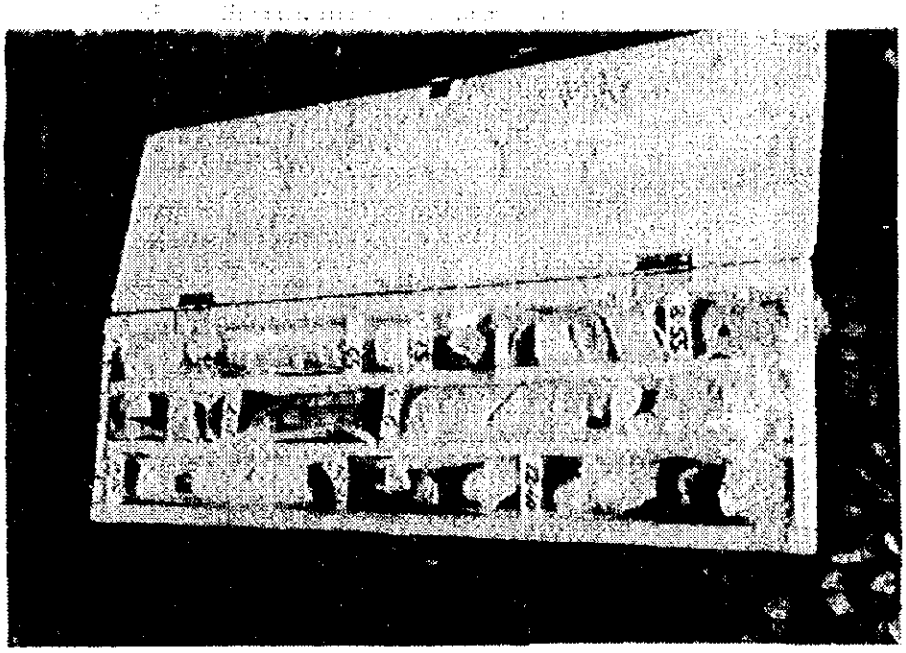
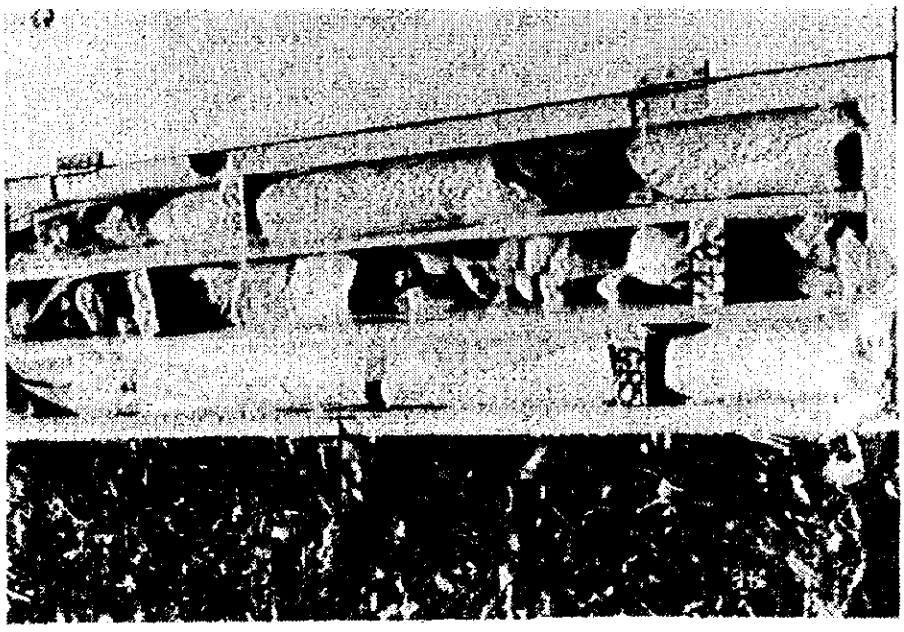




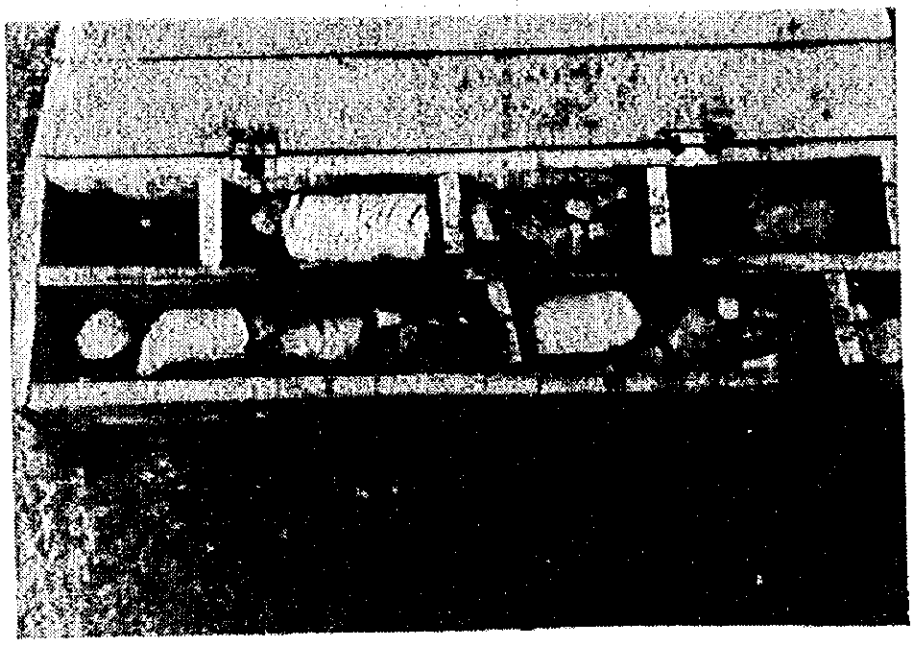


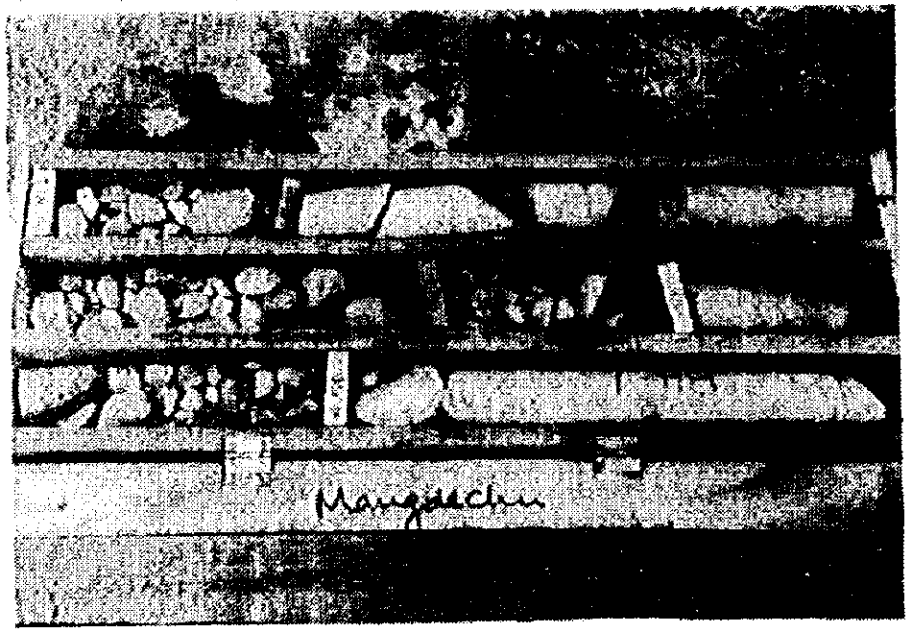
Wachy Zam

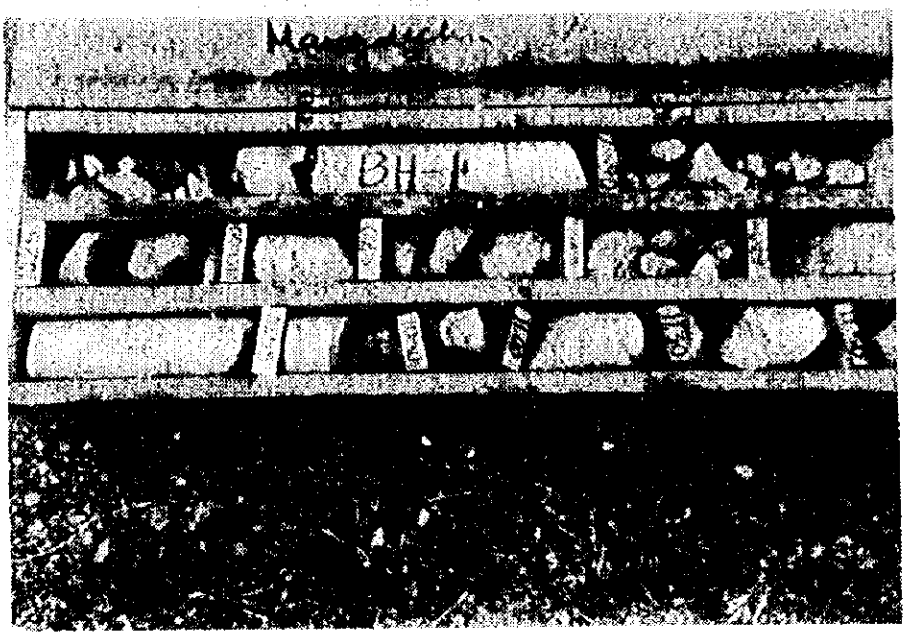




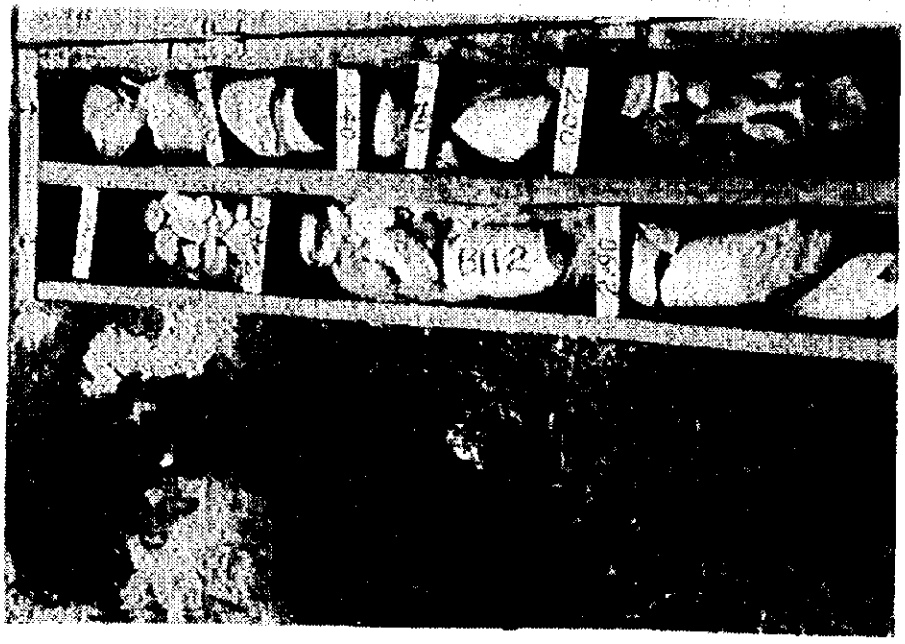
Mangdichu (Left Bank Side)



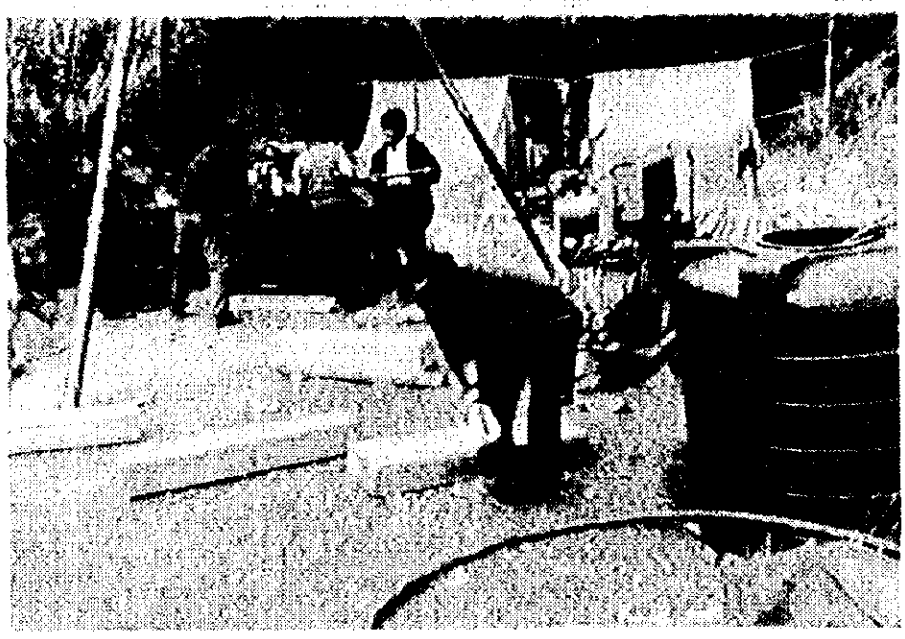



BH

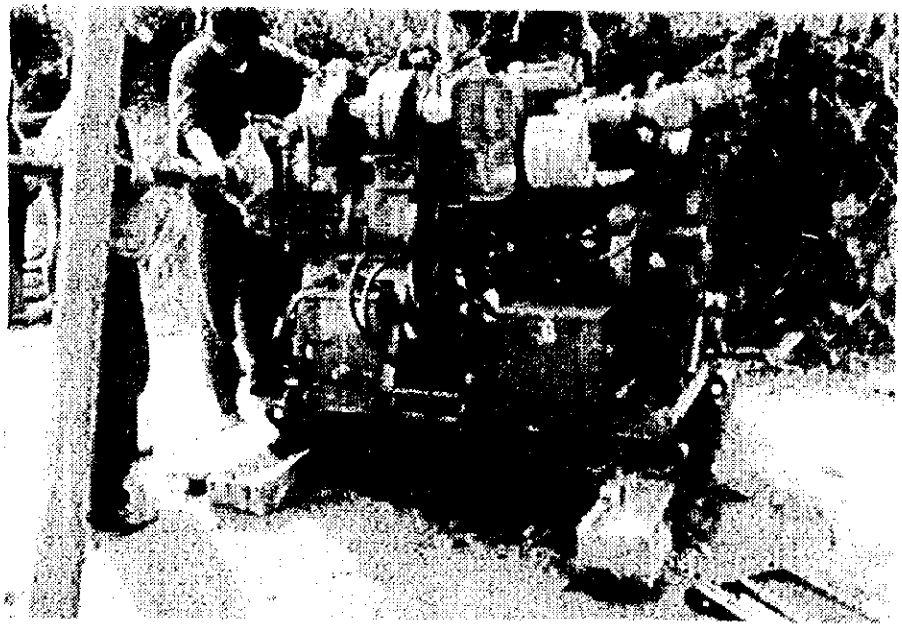
Mangdichu (Right Bank Side)



F -3 Site Photograph

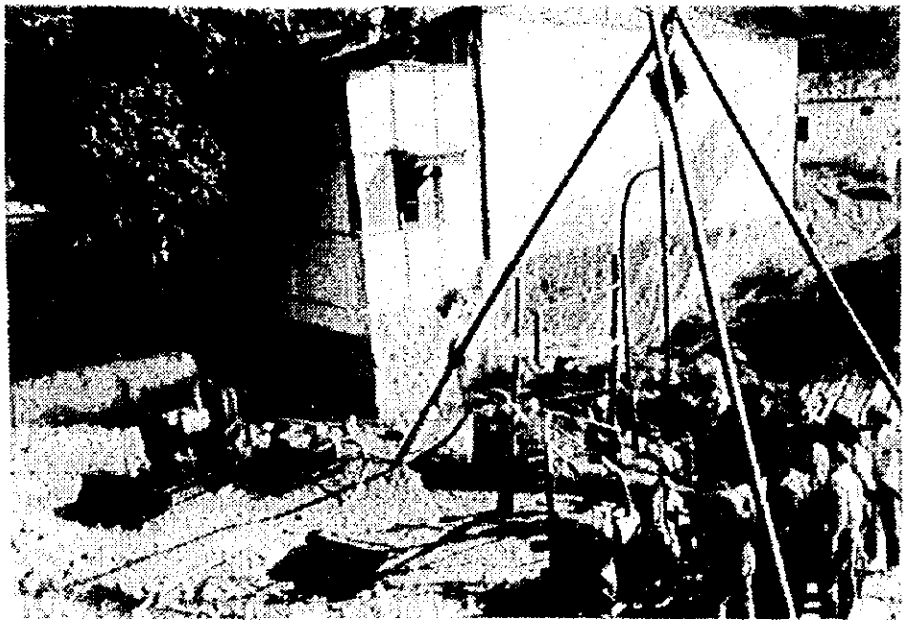


Drilling site at Wachy Zam

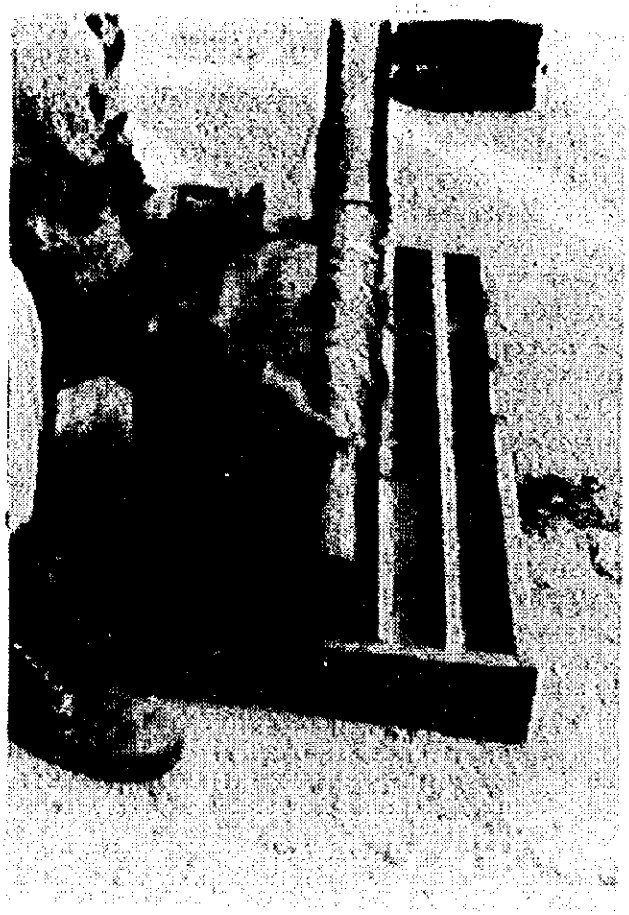


Setting up the drilling machine for drilling at Wachy Zam

Drilling in progress at Mangdichu, bore hole No. 2

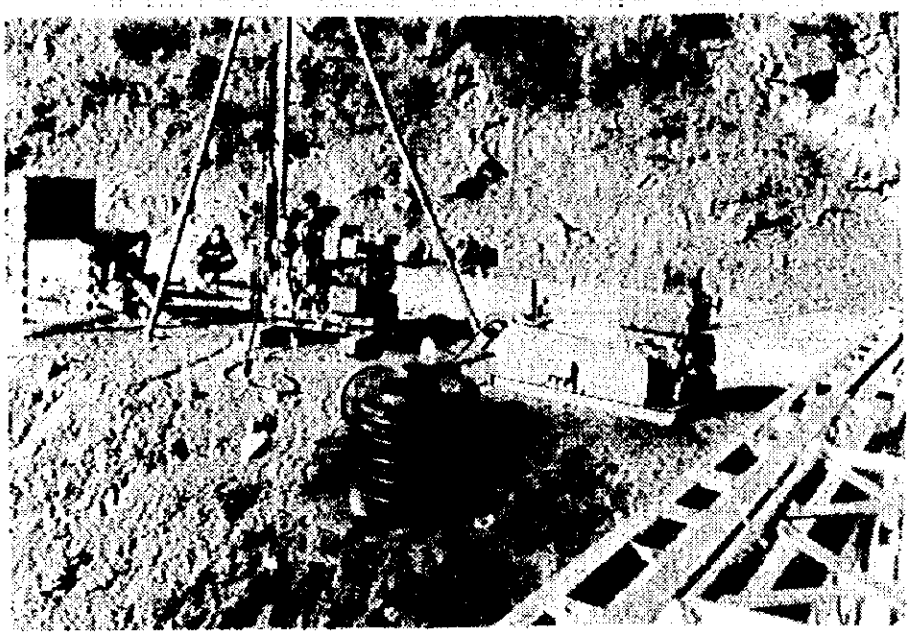


Drilling in progress at Mangdichu, bore hole No. 1



Removing core from core barrel (Bjee Zam)

Drilling in progress at Bjee Zam



Drill hole site at Bjee Zam