

(現地概要)

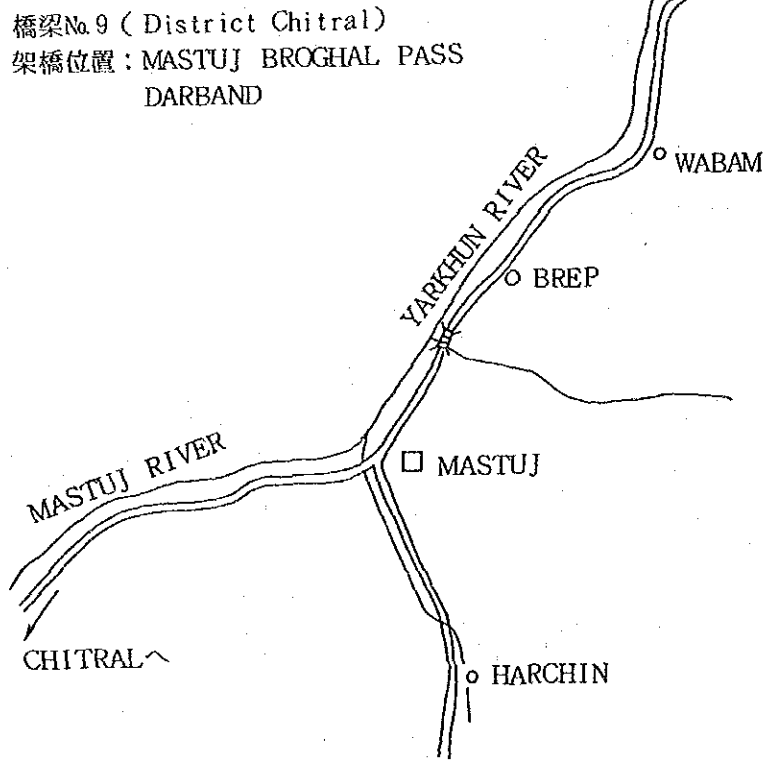
橋梁番号	No. 9		橋梁名(仮)	
橋梁位置	地区 (DISTRICT)	Chitral	道路名 位置	Mastuj Broghal Pass, Darband
既存橋	なし		橋耐久 性	
種益人口	現況	2.0万	将来	2.5万
交通量 (ADT, PCU)	現況		将来	
土質、水位	地形	Hilly Terrain		
		地図		
	土質	Rocky		
		土質図		
河川	形状	幅員70~80m		
	水位	HWL: 5.0m LWL: -		
想定橋梁 吊り橋	活荷重	A class		
	橋長	70m	幅員	5.0m
	上部工			
	下部工	Abuttment R. C. C.		
現場条件	資材搬入	可 (Mastujより約30km)		
	作業スペース			
	設備			
隣接橋への 距離	上流側			
	下流側			
接続道路状況	舗装		幅員	
備考				

(橋梁を必要とする理由)

(冬期のため現地調査ができなかった)

1. 位置: Chitral郡の奥地でMastujより約20km北上した地点。
2. 目的: 架橋地点より奥のクローズされた地区へのアクセスが目的、Broghal Passまで奥地に42の集落あり。
3. 人口: クローズド・エリアの人口約2万人。
4. 産物: 木材、鉱物(アンチモニー)、農産物は、小麦ととうもろこしを少量。

位置図



- (注) ・ 架橋地点までのアクセスは郡都Chitralよりきわめて遠く、険しい山岳地帯なので、冬期の車によるアクセスは不可能。(約7ヶ月間)
- ・ また、崖崩れヶ所が多い。
 - ・ 架橋にあたっては、工期、工程管理に注意が必要。

(現地概要)

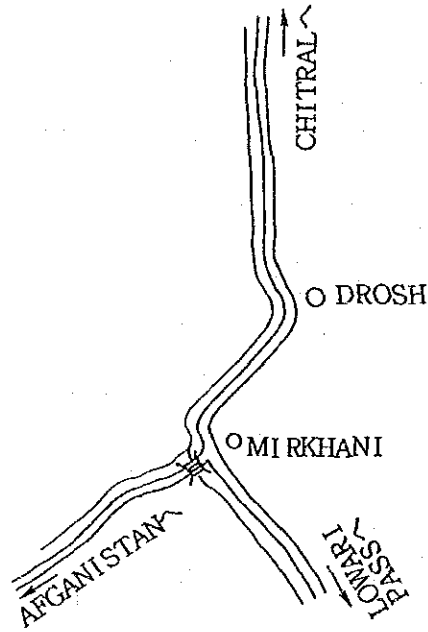
橋梁番号	No 10		橋梁名(仮)	
橋梁位置	地区 (DISTRICT)	Chitral	道路名 位置	NCC Naggar West Road, KM-1
既存橋	あり		構耐久 造性	
裨益人口	現況	1万	将来	1.5万(人口増加率23.4%/年)
交通量 (ADT, PCU)	現況		将来	
土質、水位	地形	Hilly		
		地図		
	土質	Rocky		
		土質図		
河川	形状	幅員70m		
	水位	河床から8.5m	HWL: 3.0m LWL: 1.5m	
想定橋梁 吊り橋	活荷重	A class (35tons)		
	橋長	70	幅員	5m
	上部工			
	下部工	R. C. Abutt, 基礎: Pile		
現場条件	資材搬入	可(Chitral又はDroshより)又は(Dirより)		
	作業スペース	有		
	設備			
隣接橋への 距離	上流側	車道橋 なし		
	下流側	車道橋 なし		
接続道路状況	舗装	NCC Roadあり	幅員	
備考				

(橋梁を必要とする理由)

- 位置: ディール郡の郡都Dir市より北上し、Gujar Levyを経由して、Lowari峠(高度約3,300m)を越え、Naggarにて、Naggar West Roadに入り1kmの地点。
Naggar West Roadは隣国アフガニスタンにつながっている。
- 目的: 一種のNCC Roadのバイパス。
(冬期Lowari Passがクローズされた後でも、この道は交通可である。但し、NWFPと結ぶためには、1度アフガニスタンに入り、Asadabad, Jalalabad経由で、Khayber峠越えでPeshawarに至る。)
- 人口: 架橋地点のMirkhaniより奥、アフガン国境までの集落は、Shret, Guranga, Dommel Nisar, 部落 Lambarbat, Aranov等があり人口約1万人。
- 産物: タバコ、大理石、果物(リンゴ、オレンジ)、木材。

位 置 図

橋梁No.10
District: Chitral
架橋位置: NCC NAGGAR WEST ROAD



- (注) ・ アクセスが悪いのと、冬期の交通閉鎖があるので工期には充分注意が必要。
・ この橋以外に上流、下流とも橋梁なし。
・ NCC Road (Nowshera, Chakdarra, Chitralを結んでいる幹線道路)

(現地概要)

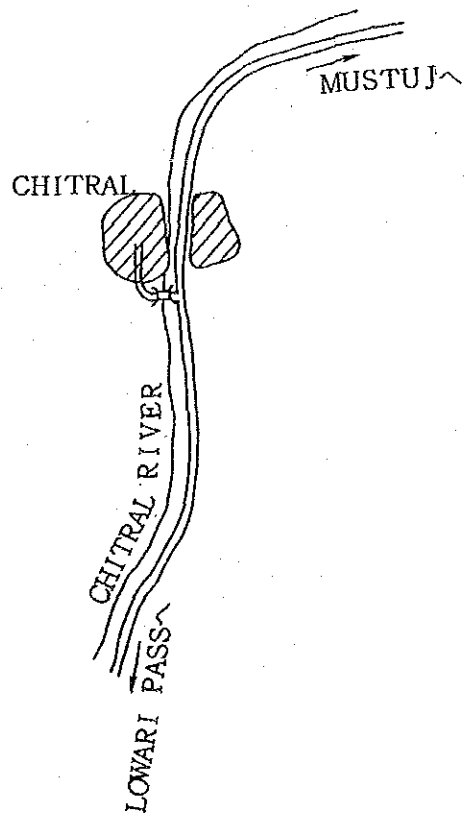
橋梁番号	No 11		橋梁名(仮)	
橋梁位置	地区 (DISTRICT)	Chitral	道路名 位置	NCC Chitral Town Road
既存橋	あり		構耐久 造性	
裨益人口	現況	2.5万人	将来	人口増加率 3.4%/年
交通量 (ADT, PCU)	現況		将来	
土質、水位	地形	平坦		
		地図		
	土質	Rocky		
		土質図		
河川	形状	幅員 100m		
	水位	河床より 8 m	HWL: 2.5m LWL: 1.5m	
想定橋梁 R.C.C又は 吊り橋	活荷重	35tons		
	橋長	100 m	幅員	5 m
	上部工			
	下部工			
現場条件	資材搬入	可 (Chitralより、市街地より 1 km)		
	作業スペース			
	設備			
隣接橋への 距離	上流側			
	下流側			
接続道路状況	舗装		幅員	
備考				

(橋梁を必要とする理由)

- 位置: Chitral市の南部で、NCC Roadと対岸の村落を結ぶため、Chitral川をわたる地点。
現在、上流、下流とも近くに橋梁がないため、Chitral市内の混雑した街路を通過しなければならない。
- 目的: 架橋地点の対岸より奥地は、Chitral郡の小麦、野菜、果物の産地と木材を産するため、(産物) これらの搬出と、日用必要品の輸送のため。
- 人口: 将来3.5万人と推定。

位 置 図

- 橋梁No. 11
- District: Chitral
- 架橋位置: NCC CHITRAL TOWN ROAD



(注) ・ Chitralからのアクセスはきわめて良いが、Chitral郡自体が冬期アクセス困難になるため、工期に注意を要する。

(現地概要)

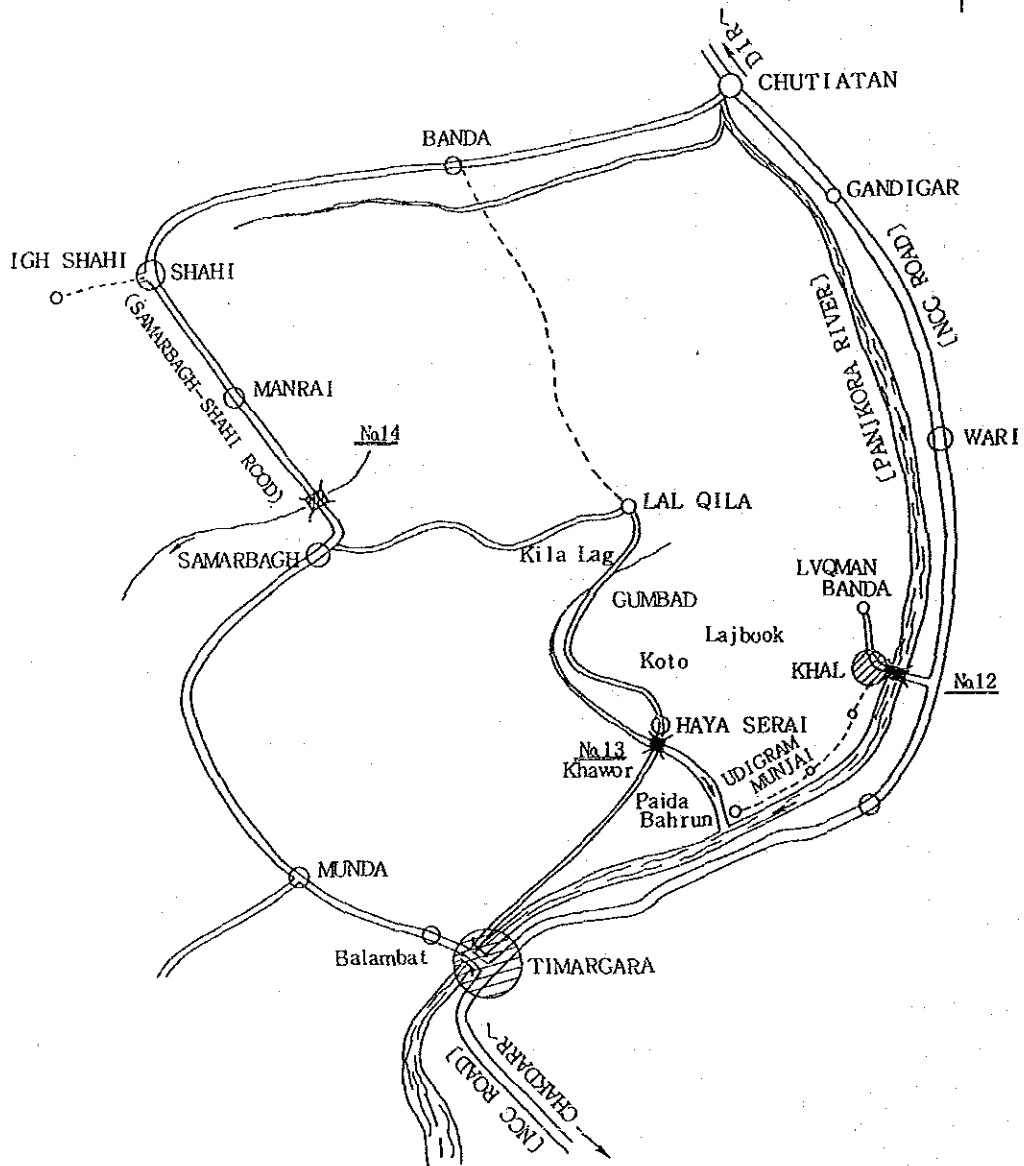
橋梁番号	No 12		橋梁名(仮)	
橋梁位置	地区 (DISTRICT)	Dir	道路名 位置	NCC Road KM-135, Khal on Panjkora River
既存橋	あり、架橋予定地の 上流約600m		橋耐久 造性	吊り橋 老朽化はげしい
裨益人口	現況	15万人	将来	
交通量 (ADT, PCU)	現況		将来	
土質、水位	地形	地図		
	土質	Gravel/Roulders		
		土質図		
	河川	形状	幅員 100~110m	
	水位	河床より 5 m		
想定橋梁	活荷重	18ton		
吊り橋 又は コンクリート橋	橋長	100~120m	幅員	5 m
	上部工			
	下部工	基礎: Pile		
現場条件	資材搬入	可 (TimargaraよりNCC道路にて)		
	作業スペース	右左岸とも有		
	設備			
隣接橋への 距離	上流側	既存道 60kmにて	車道橋 あり (於 Dir)	
	下流側	既存道 38kmにて	車道橋 あり (於 Timargara)	
接続道路状況	舗装	NCC道路あり	幅員	6~7 m
備考				

(橋梁を必要とする理由)

- 位置: TimargaraよりDir方向にNCC道路をPanjkora川沿いに北上し、約25km地点 (NCC KM-135) で対岸にKhalの町を望む地点。
- 目的: 現在、NCC道路よりKhalの町には老朽化した吊り橋が存在するが、車輛の通行はできない。
Khalの町よりPanjkora川沿いに、Lu Man Banda, Udigram Munjai等多くの集落があり、川の上、下流に車輛通行可能な橋梁なし。
- 産物: 小麦、米、砂糖きび等の農産物を多く産し、又玉ねぎ、エンドウ豆等の野菜の他に、果物 (オレンジ、リンゴ等) を産する。

位 置 図

- | | | |
|--------------------------|---------------------|-------------------------|
| - 橋梁No 1 2 | No13 | No14 |
| - District:DIR | DIR | DIR |
| - 架橋位置: NCC ROAD, Km-135 | BRIDGE ON HAYASERAI | SAMAR BAGH SHAHI ROAD N |
| KHAL ON PANJKORA RIVER | KHAWAR | Km-2~3, Bukai Khawar |



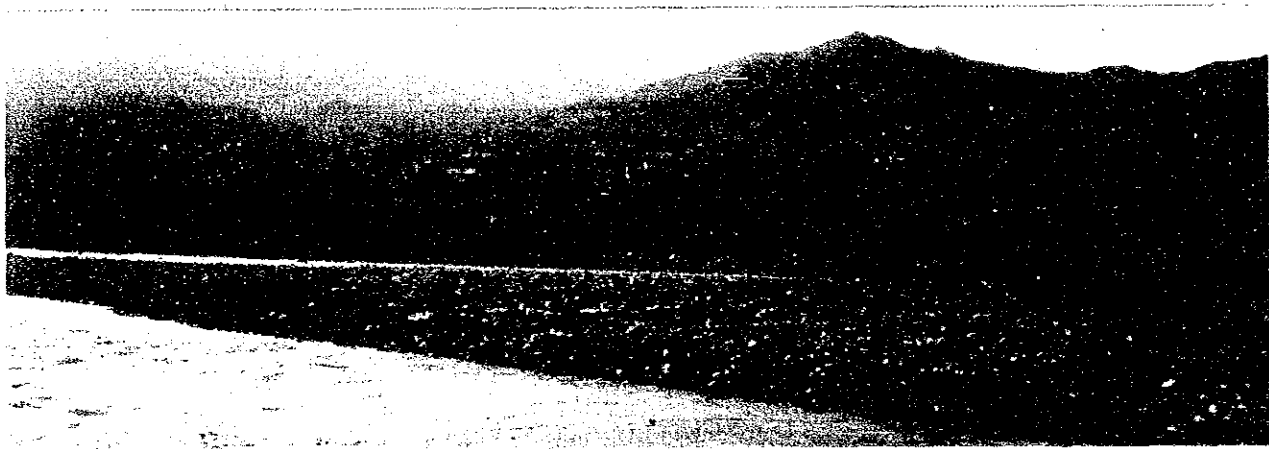
(対岸 (Panjkora川右岸) がKhalの町 (人口推定5~6千人) で、ここよりPanjkora川沿いに集落多数あり。)

- (注) ・ 架橋地点の左岸はNCC G道路からのアプローチ道路のスペースが少ない。
 ・ Panjkora川の右岸は、直接Khalの町並みに接するため、架橋地点の検討を要す。

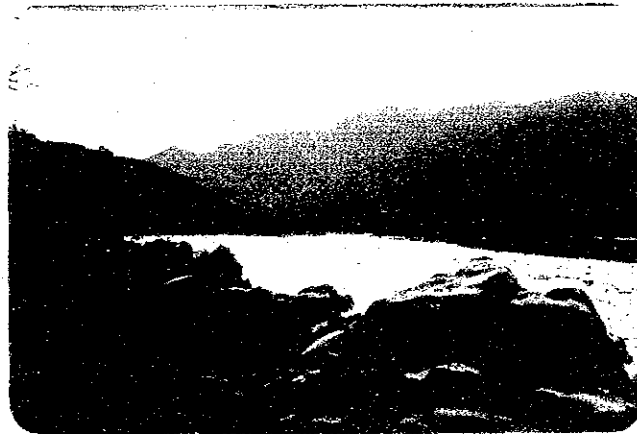
対象サイトの上流側



対象サイト対岸



対象サイト上流



(現地概要)

橋梁番号	No 13		橋梁名(仮)	
橋梁位置	地区 (DISTRICT)	Dir	道路名置	Bridge on Haya Serai, Khawar
既存橋	あり(河床の1部のみ)		構造耐久性	吊り橋、橋長45m、幅員2.5m
裨益人口	現況	15万人	将来	7万人
交通量 (ADT, PCU)	現況	—	将来	ADT 2,000PCUを見込む
土質、水位	地形	平坦		
		地区		
	土質	Gravel/Boulder		
		土質区		
	河川	形状	幅員90~100m	
		水位	河床より 1.5~2.0m	
想定橋梁	活荷重	70tons		
コンクリート橋 (RC)	橋長	100 m	幅員	5 m
	上部工	Pile		
	下部工			
現場条件	資材搬入	可 (Timargara上の約17km)		
	作業スペース	有 (右、左岸とも)		
	設備			
隣接橋への距離	上流側	車道橋 なし		
	下流側	車道橋 なし		
接続道路状況	舗装	なし	幅員	5 m
備考				

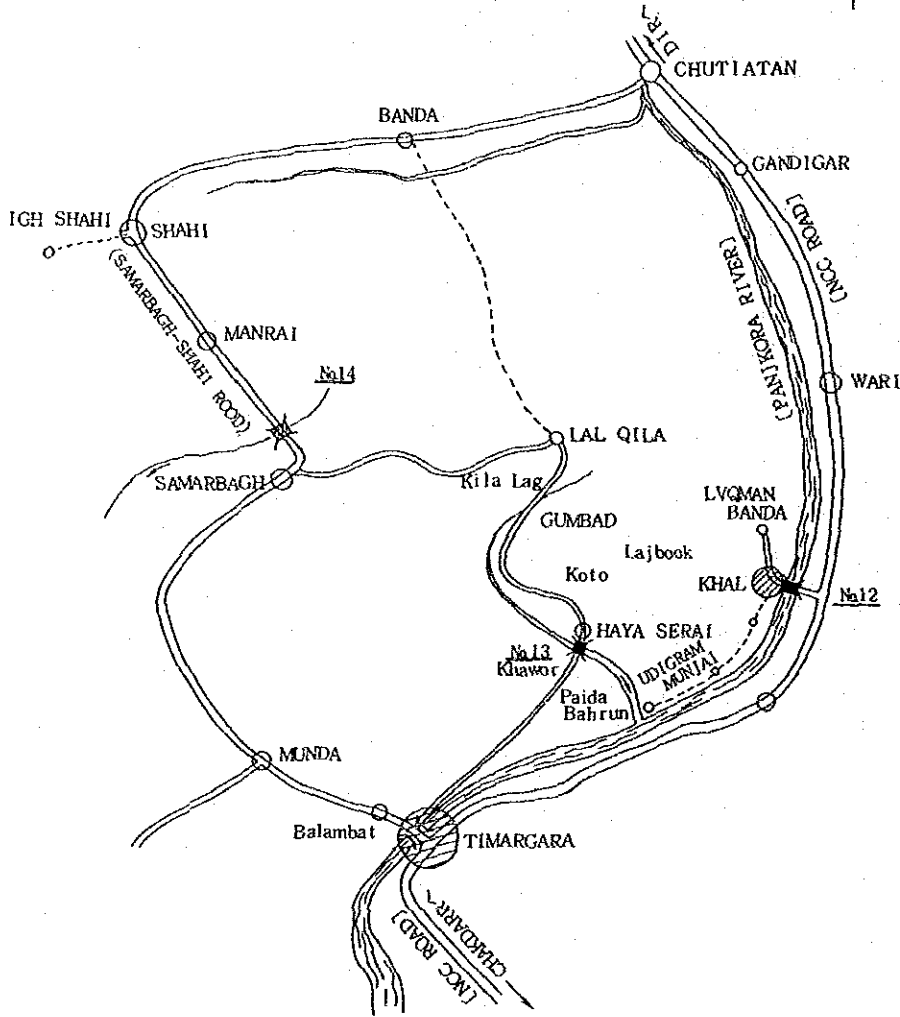
(橋梁を必要とする理由)

- 位置: TimargaraよりShingle道路をKhawarを経由し、17km地点のHaya Seraiに位置する。
Haya Serai以遠は、Qumbad Kila Dogを経由し、Lal Qilaと結んでいる。
Lal Qilaより北上し、Bandaに接続する道路計画が進行中。
- 目的: この地方は小麦、米を多く産し、又部落数も多い。
産物 } (人口約5万人) が、市場へのアクセスが悪いため、道路改良と架橋により物資、人の
人口 } 流通を改善するため。(TimargaraよりHal Qilaまでバスの運行計画あり)

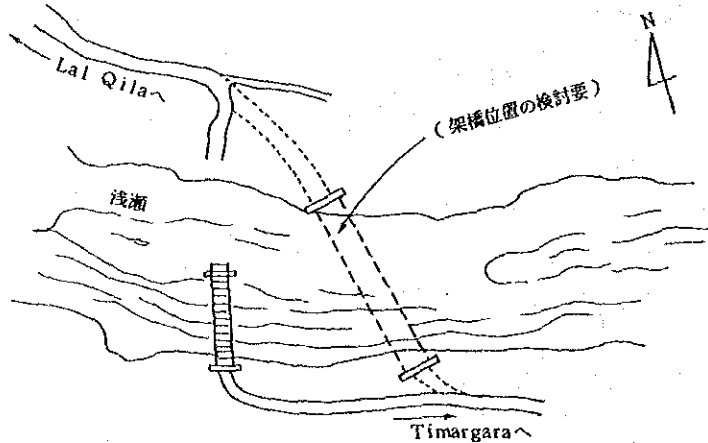
位置図

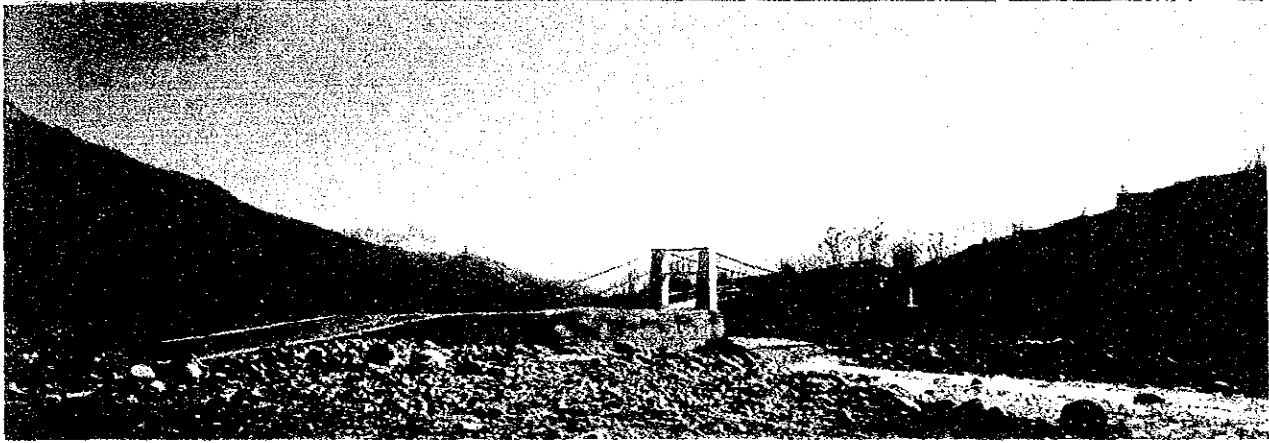
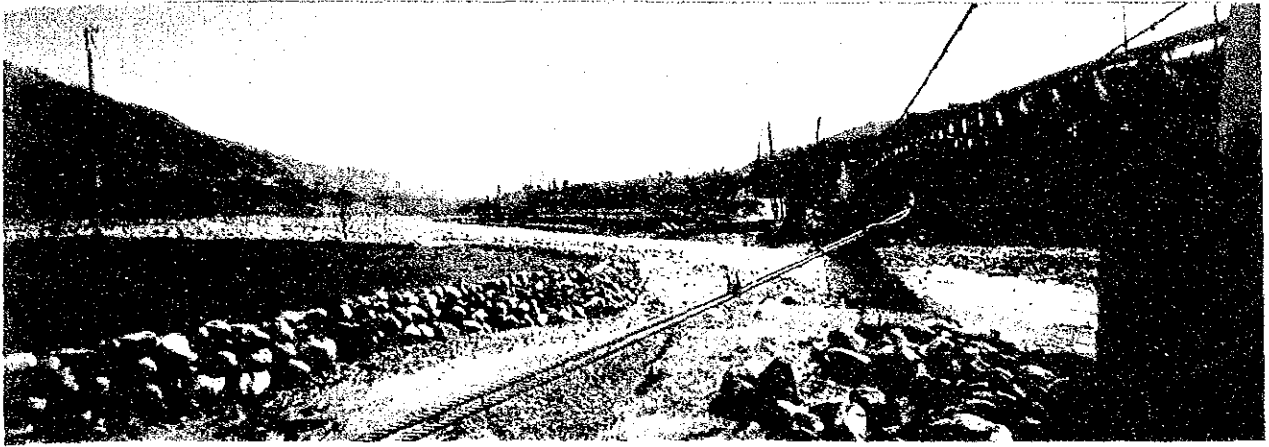
- 橋梁No12	No13	No14
- District:DIR	DIR	DIR
- 架橋位置: NCC ROAD, Km-135	BRIDGE ON HAYASERAI	SAMAR BAGH SHAHI ROAD N
KHAL ON PANJKORA RIVER	KHAWAR	Km-2~3, Bukai Khawar

4



- (注) ・ 架橋位置の検討を要す。
 ・ Timargaraよりのアクセス問題なく、サイトも平坦地である。
 ・ 土地収用の必要なし。





(現地概要)

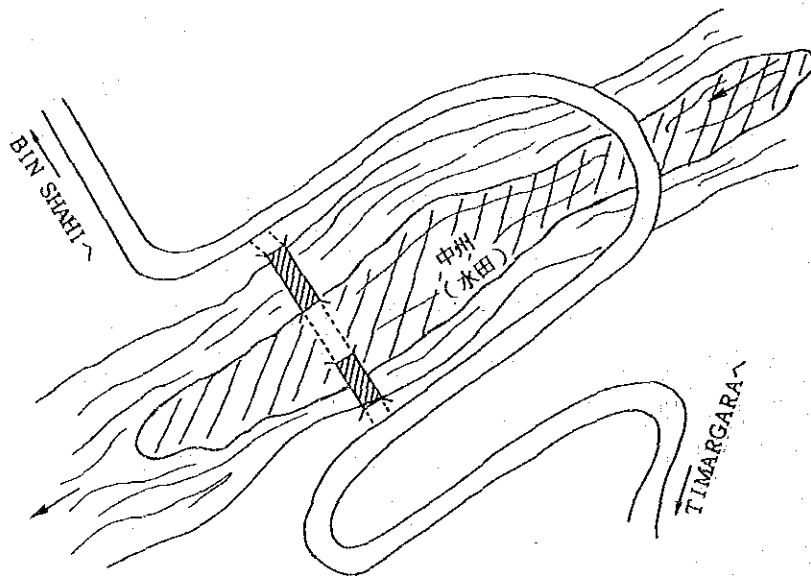
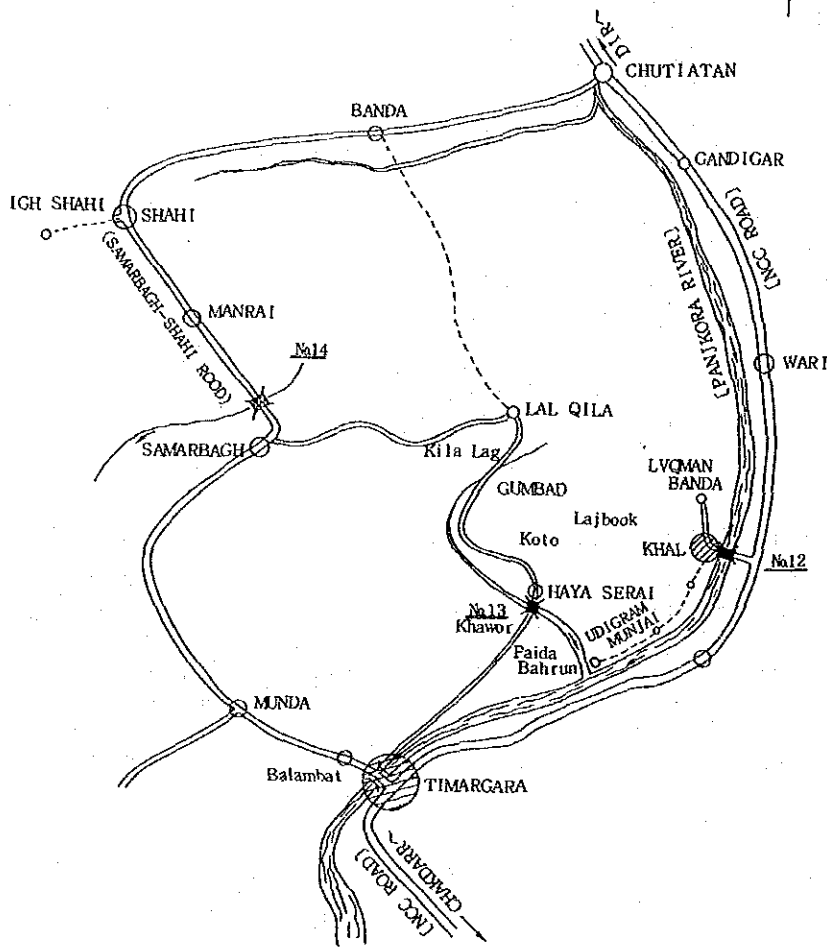
橋梁番号	No. 14		橋梁名(仮)	
橋梁位置	地区 (DISTRICT)	Dir	道路名 道位	Samar Bagh Shahi Road, KM2~3, Bukari Khawar
既存橋	なし		構造 耐久	造性
裨益人口	現況	20万人	将来	
交通量 (ADT, PCU)	現況	推定 ADT 5,000	将来	
土質、水位	地形	平坦		
		地図		
	土質	土質図		
		河川	形状	全幅で180m、河床に中洲あり
水位				
想定橋梁 コンクリート橋	活荷重			
	橋長	70m×2	幅員	5m
	上部工	PCガーダー		
	下部工			
現場条件	資材搬入	可 (Timargaraより約50km)		
	作業スペース	有 (右、左岸とも)		
	設備			
隣接橋への 距離	上流側	車道橋 なし		
	下流側	車道橋 なし		
接続道路状況	舗装	あり	幅員	7~8m
備考				

(橋梁を必要とする理由)

1. 位置 : TimargaraよりMunda経由にて、Samarbaghに至り、Samarbagh-Shahi道路を2.5km進んだ地点。
2. 目的 : NCC道路のTimargaraよりMunda, Samarbach経由にて、Manrai, Bin Shalを結ぶ重要な道路である。
(Bin Shalからは東進し、Rarawal Banda 経由でChutiatanにて、NCC道路に接続する。)
3. 現況 : 現在、橋梁が存在せず、浅い河床を迂回した道路となっているが、増水時は不通となる。及び 架橋予定地点は、川の間が中洲となり、増水時もHWLより2.5mなので、中洲を利用し、計画 橋長70mを2橋とする案とした。(準幹線上の橋梁であり優先度としては、No.13より高いと考えられる)。
4. 産物 : 小麦、米、さとうきび、とうもろこし、果物 (オレンジ、リンゴ等)

位 置 図

- 橋梁No.12
 - District: DIR
 - 架橋位置: NCC ROAD, Km-135
 - KHAL ON PANJKORA RIVER
- | | |
|---------------------|-------------------------|
| No.13 | No.14 |
| DIR | DIR |
| BRIDGE ON HAYASERAI | SAMAR BAGH SHAHI ROAD N |
| KHAWAR | Km-2~3, Bukai Khawar |

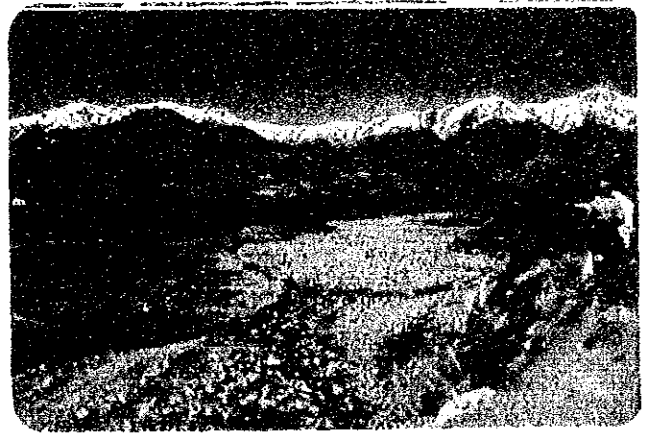


対岸の道路へ接続する



下流側

上流側



(現地概要)

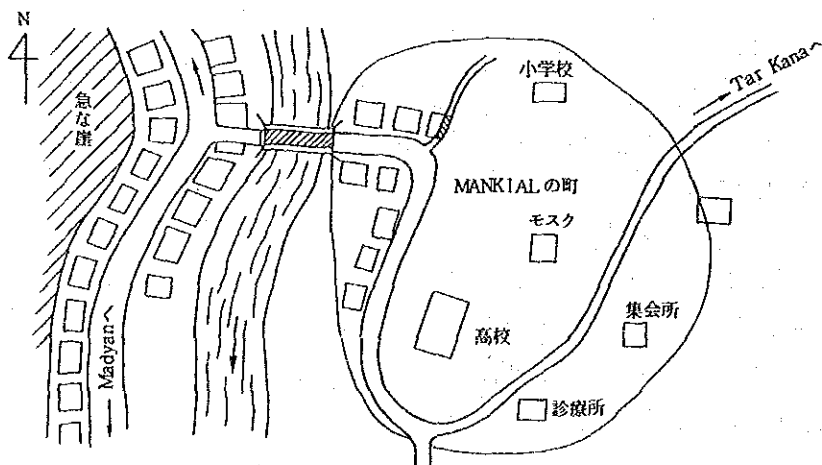
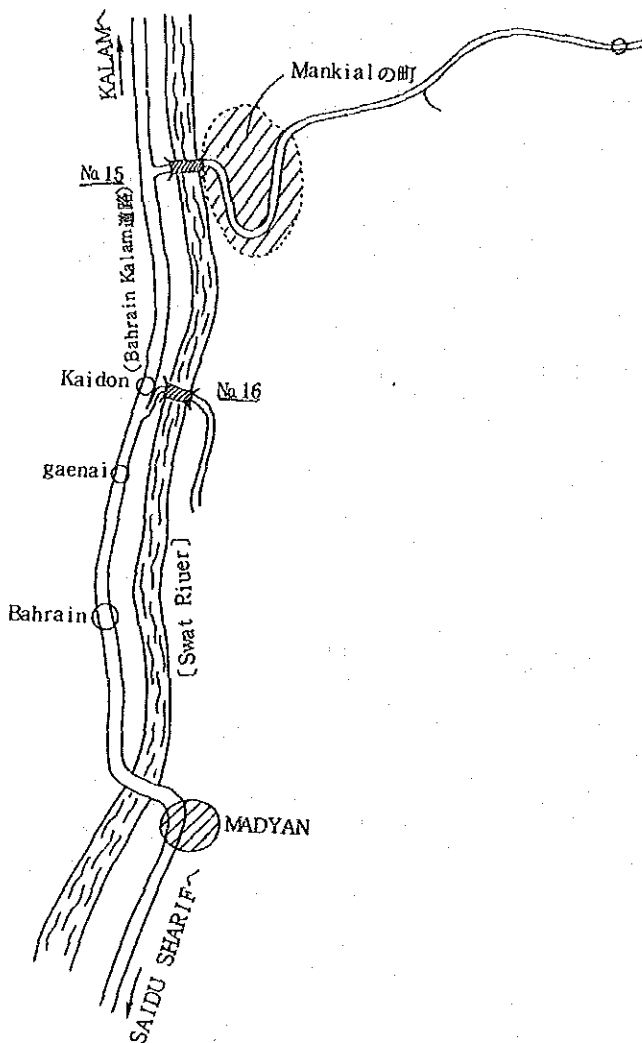
橋梁番号	No 15		橋梁名(仮)	Mankial Bridge
橋梁位置	地区(DISTRICT)	SWAT	道路名位置	Mankial Tarkana Road
既存橋	あり(人橋)		構造耐久性	木橋、橋長30m (木材によるカンティレバータイプ)
裨益人口	現況	1.6万人	将来	人口増加率 3.6%/年
交通量(ADT, PCU)	現況	人の通行多し	将来	
土質、水位	地形	山岳地		
		地図		
	土質	gravel and boulders		
		土質図		
河川 スワット川	形状	幅員40m		
	水位	河床より12m	HWL: 8 m LWL: 2 m	
想定橋梁 スチールの プレートガーダー 又は H-Beam	活荷重	35tons		
	橋長	50m	幅員	5 m
	上部工			
	下部工	Abutment / pile Rec.		
現場条件	資材搬入	可 (Madyanよりスワット川沿いに北上約60km)		
	作業スペース	右岸のスワット・カラム道路側、工事中迂回できない		
	設備			
隣接橋への距離	上流側	車道橋 なし		
	下流側	車道橋 なし		
接続道路状況	舗装	スワット・カラム道路あり	幅員	5~6 m
備考	(注) ・ Madyan-Kalam道路は交通量が多いので、工事中注意を要す。 ・ スワット川右、左岸ともスペースが狭く、人家(商店)が建てこんでいる。			

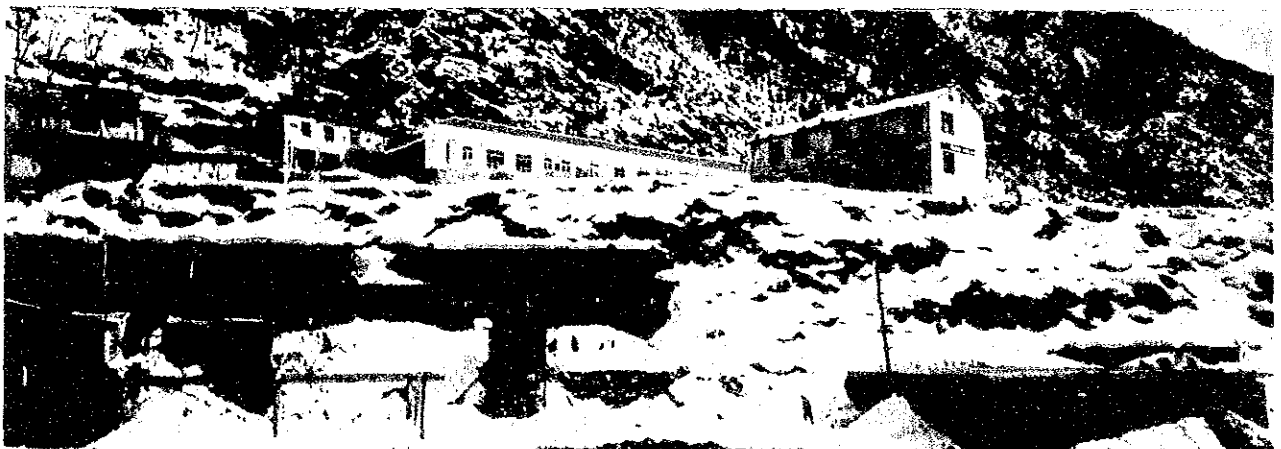
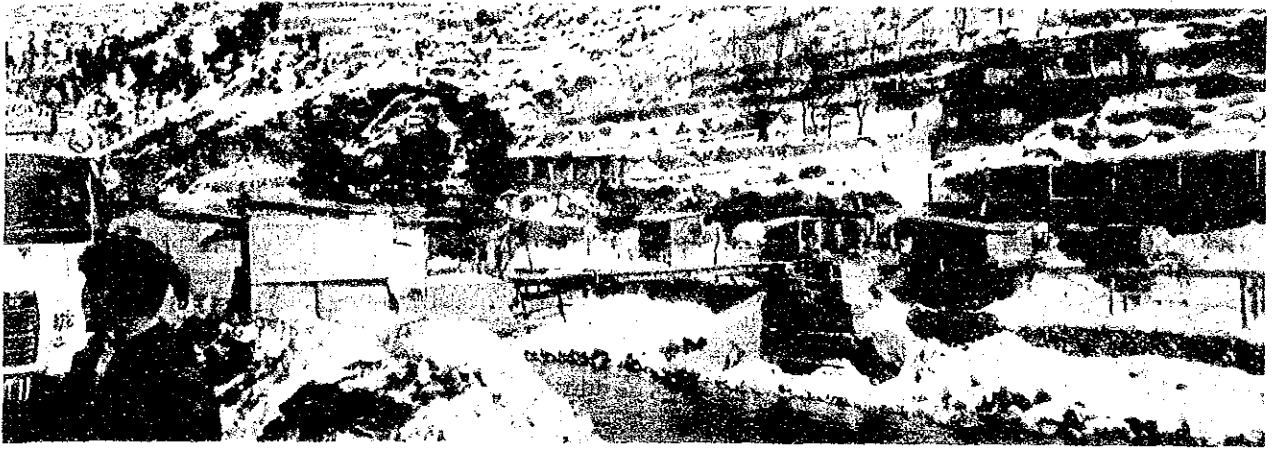
(橋梁を必要とする理由)

- 位置: Madyanよりスワット川沿いに、Kalamに向って北上し、約35km地点をMankial Tarkana道路に入り、スワット川を渡る地点。
- 現況: 現在、老朽化した構造的にも不安定な木橋があり、スワット川を渡ったところが、町になっている。
- 目的: 多くの公共施設を多し、人口も多いこの町への車輛によるアクセスを可能にし、さらに以遠の村々と結ぶため。
- 人口、施設等:
 - (スワット川左岸)
 - 対岸がMankialの町で人口約5,000人で高等学校、中学校、小学校(5ヶ所、集会所、ヘルスクリニック等の公共施設あり、手工芸がさかん。
 - Mankialの町より奥地に多数の集落あり (Tarkana, Ramet等)

位 置 図

- 橋梁No.15
- District: SWAT
- 橋梁位置: MANKIAL BRIDGE ON SWAT RIVER Km-1, Mankial-Tarkana Road,
- No.16
- SWAT
- KAIDON ON KAIDON GOORNAI ROAD, Km-1, on Swat River





(現地概要)

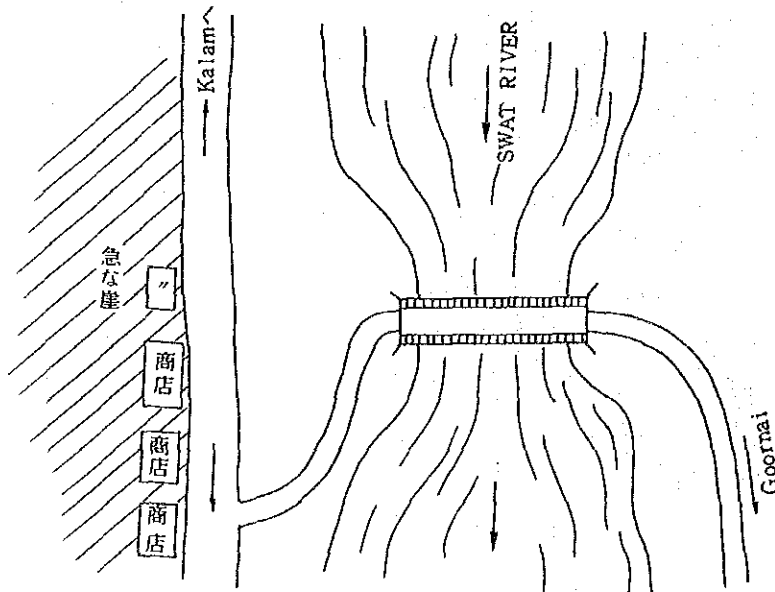
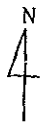
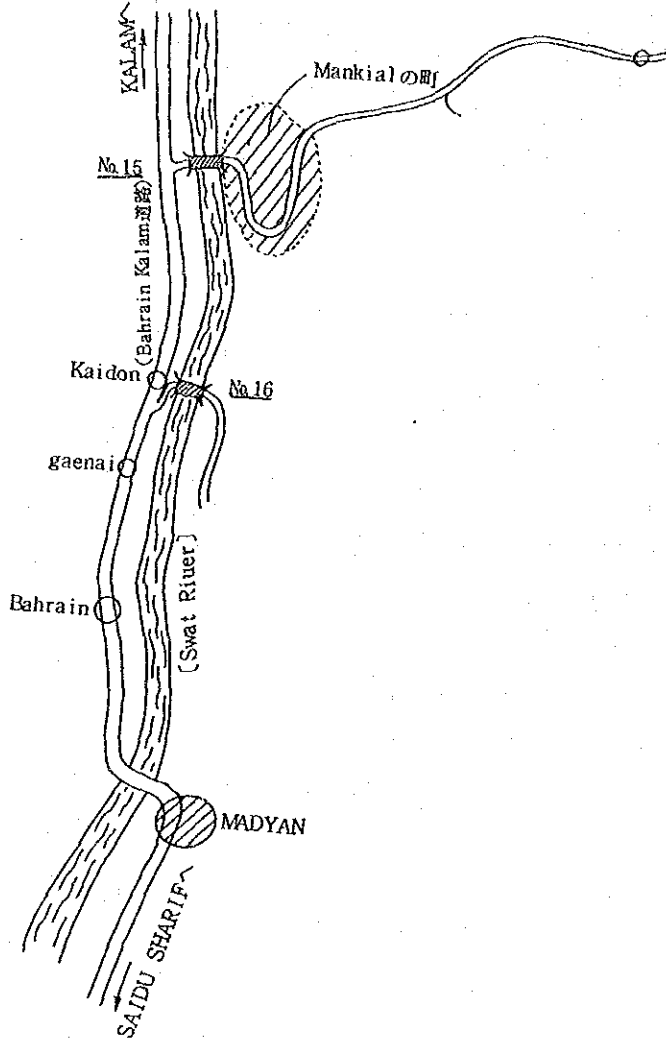
橋梁番号	No. 16		橋梁名(仮)	
橋梁位置	地区 (DISTRICT)	Swat	道路名 位置	Kaidon on Kaidon Goornai Road KM-1, Swat River
既存橋	あり(人道橋)		構耐久 造性	吊り橋、橋長35m、幅員1.0m 老朽化はなほだしい
裨益人口	現況	1万人	将来	人口伸び率 3.6%/年
交通量 (ADT, PCU)	現況	(人) 少	将来	
土質、水位	地形	Hilly		
		地図		
	土質	Gravel / Boulders		
		土質図		
河川	形状	幅員35m~50m		
	水位	河床より12m	HWL: 8.0m LWL: 2.0m	
想定橋梁	活荷重	35tons		
	II-Beam スチールプレート ガーダー橋	橋長	幅員	3m
	上部工			
	下部工			
現場条件	資材搬入	可 (Madyanよりスワット川沿いに北上約45km)		
	作業スペース	右、左岸とも有 (対岸(左岸)にセトバックスペースが少ない)		
	設備			
隣接橋への 距離	上流側	車道橋 なし		
	下流側	車道橋 なし		
接統道路状況	舗装	スワット・ガラム道路 あり	幅員	5~6m
備考				

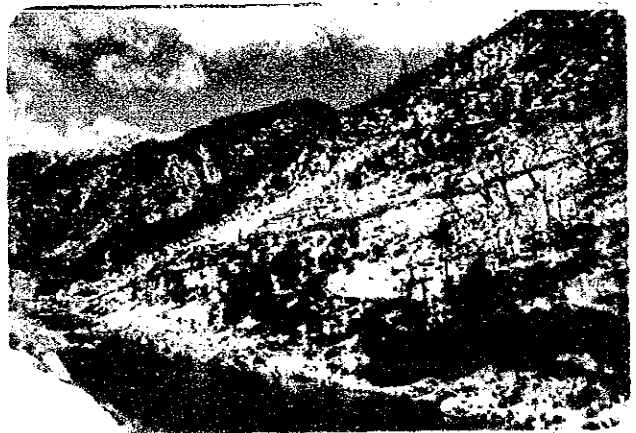
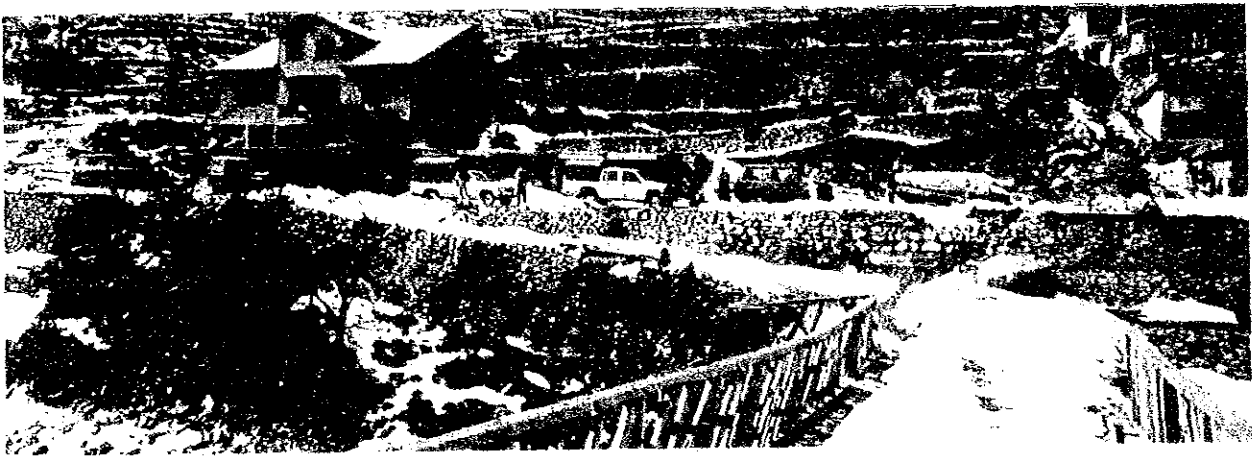
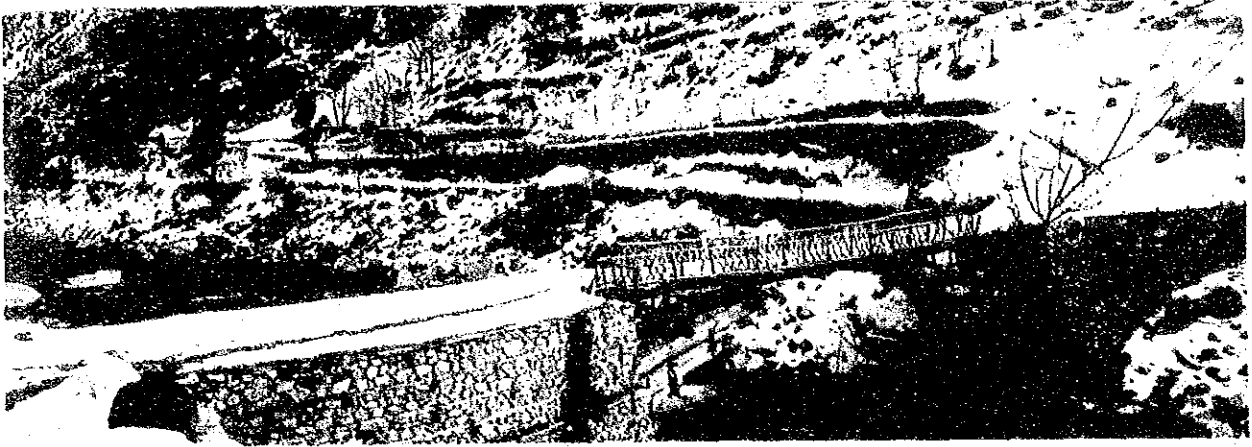
(橋梁を必要とする理由)

1. 位置: Madyanよりスワット川沿いに Kalamに向って北上し、約20kmの地点Kaidonで、Kaidon-Goornai道路に入り、スワット川を渡る地点。
2. 現況: 橋長36mの老朽化した木橋で幅員約1.0m、高らん欠落している。
この橋以遠には、Goornai他数ヶ所の集落あり。
この附近のスワット川の流速大きく、流量も多い。
3. 目的: この橋の上、下流5km以内に橋梁がなく、Kaidon, Goornai等の山間地の集落に対するアクセスを可能にし、必需品の車輛輸送を可能にするため。
4. 産物: 小麦及びタバコ。

位 置 図

- 橋梁No 15
 - District: SWAT
 - 橋梁位置: MANKIAL BRIDGE ON SWAT RIVER
 - Km-1. Mankial-Tarkana Road,
- No 16
 - SWAT
 - Kaidon ON Kaidon GOORNAI ROAD,
 - Km-1, on Swat River





(現地概要)

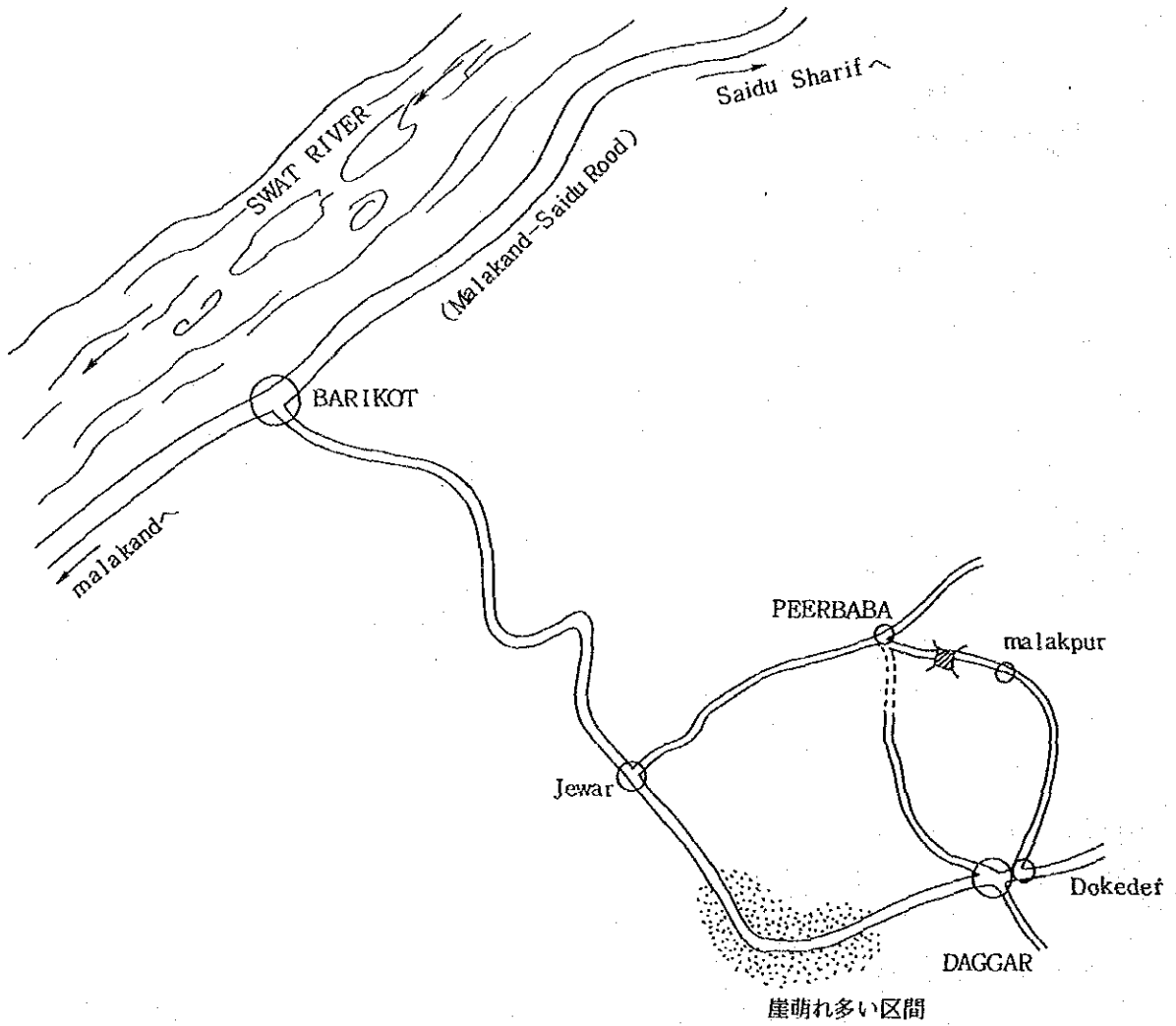
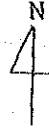
橋梁番号	No 17		橋梁名(仮)	
橋梁位置	地区 (DISTRICT)	Swat	道路名 位置	Peer Baba Palak Pur
既存橋	あり(人のみ)		構耐久 造性	橋長60m 老朽化はなほだし
裨益人口	現況	2万人	将来	4万人
交通量 (ADT, PCU)	現況	ADT 150PCU	将来	250PCU
土質、水位	地形	平坦		
		地図		
	土質	Sandy Soil with Boulders		
		土質図		
	河川	形状	幅員60m	
水位		河床より2.5m	HWL: 3 m LWL: 1 m	
想定橋梁 R.C.C.又は スチールガーダー橋	活荷重	70tons		
	橋長	45	幅員	4.8m
	上部工	Steel Plate - H. beam		
	下部工	R. C. C.		
現場条件	資材搬入	可		
	作業スペース	有		
	設備			
隣接橋への 距離	上流側			
	下流側			
接続道路状況	舗装		幅員	
備考				

(橋梁を必要とする理由)

- 位置: MalakandからSaidu Sharifに向って北上し、Barikotにて、Barikot-Daggar Roadに入り、Jewarにて左折し、Peer Babaに至り、Pearbaba-Malakpur-Dokeder RoadのKm-2の地点。
- 目的: (1) Swat郡、Buner地区の中心地であるDaggarは、Jewarからは崖崩れのため、年中不通になることが多いため、JewarからPeerbaba経由の代替ルートとして。
(2) Peerbaba、及びDaggar以遠に多くのルート及び集落があるため、この地域への車輛によるアクセスを可能にするため(奥地を入れると人口10万人)。
- 産物: 小麦、米の他に果物(りんご、オレンジ、あんず等)

位 置 図

- 橋梁No 17
- District : SWAT
- 架橋位置 : Peerbaba Palakpur ROAD



(現地概要)

橋梁番号	No 18		橋梁名(仮)	
橋梁位置	地区 (DISTRICT)	Malakand	道路名 位置	Jahazoon Dak Bridge
既存橋	あり		構造 耐久性	コンクリート橋、橋長60m、幅員3m 老朽化 (pile 15md)
裨益人口	現況	50万人	将来	人口増加率 3.2%/年
交通量 (ADT, PCU)	現況		将来	
土質、水位	地形	平坦		
		地図		
	土質	Silty Clay		
		土質図		
	河川	形状	幅員60~65m	
水位		河床まで3m	H/WL: 4 m L/WL: 1.5 m	
想定橋梁 スチールガーダー 又は R. C. C.	活荷重	Class A		
	橋長	60m	幅員	5.0m
	上部工			
	下部工	R. C. C. in situ (基礎: Pile)		
現場条件	資材搬入	可 (Mardan又はPeshawarより)		
	作業スペース	右、左岸とも有り		
	設備			
隣接橋への 距離	上流側	車道橋 なし		
	下流側	車道橋 なし		
接続道路状況	舗装	なし	幅員	7~8m
備考				

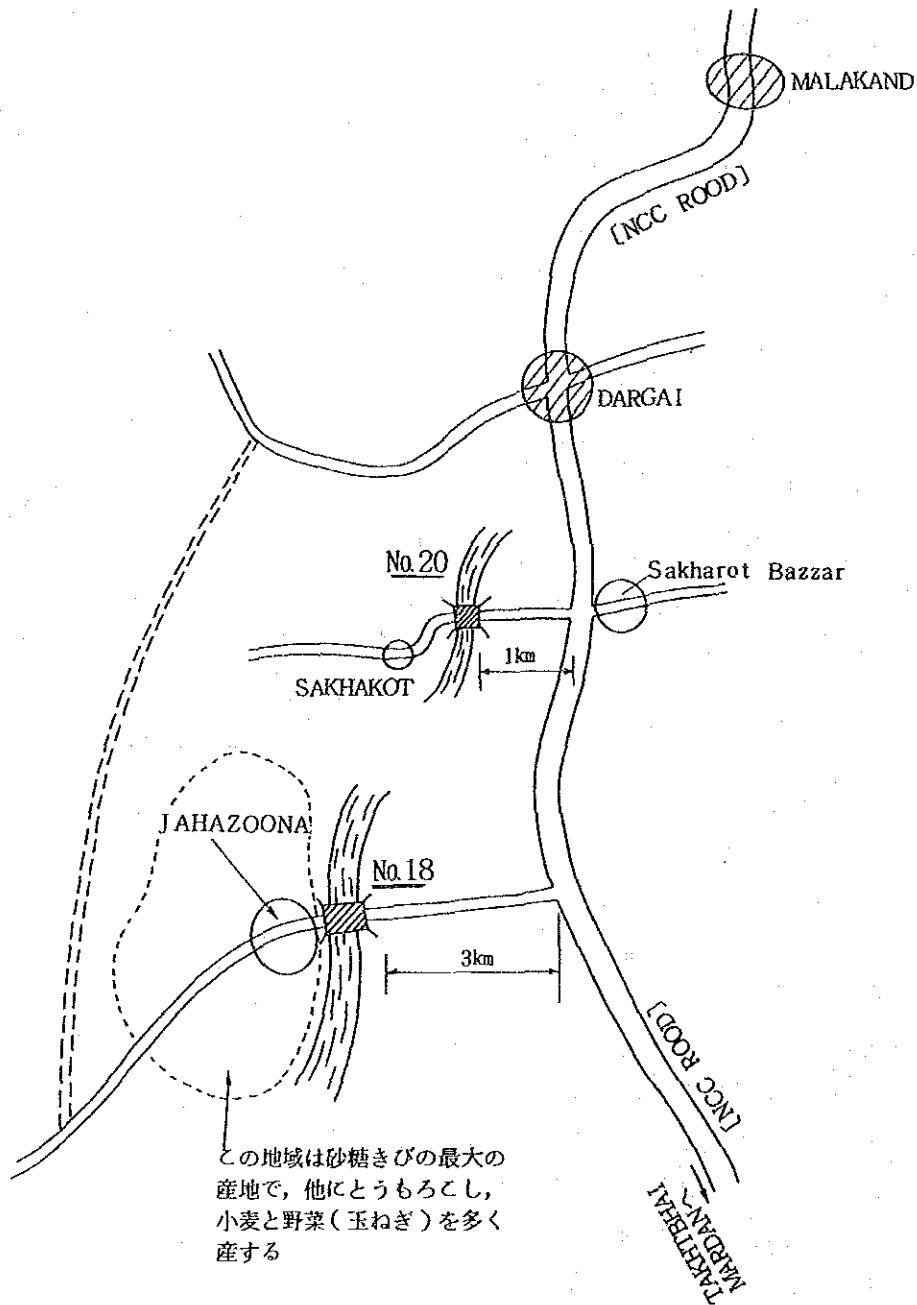
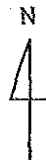
(橋梁を必要とする理由)

1. 位置: Nowsheraより、NCC Roadを北上し、Mardan, Takht Bhaiを経由し、Takht Bhaiの北方約18kmの地点を左折し3kmの地点。
2. 現況: コンクリート橋が老朽化し、ガーダーのクラック、ピア・アバットの洗掘がみられる。
3. 人口: 架橋地点以遠に多くの部落があり人口約50万人。
4. 産物: 砂糖きびの最大の産地、その他とうもろこし、小麦、玉ねぎ等の農産物を多量生産する。
5. 目的: 多種類のキャッシュクローブを大量に市場まで運ぶための車輻によるアクセスを可能にし、特に、Takht BhaiにあるNWFP最大の砂糖工場に、砂糖きびを経済的に効率良く運ぶため。

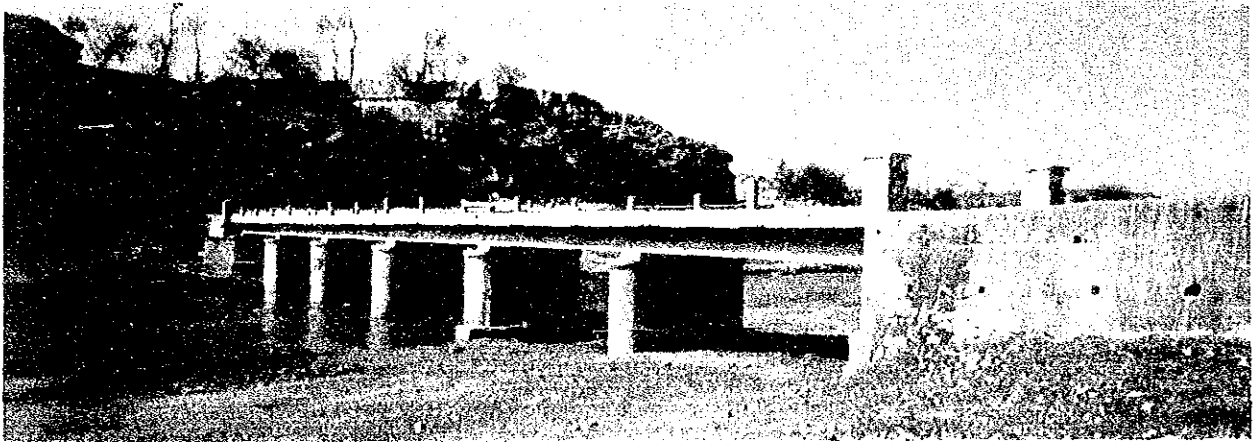
位 置 図

- 橋梁No. 18
 - District : Malakand
 - 架橋位置 : JAHAZOONA DAK BRIDGE SAKHAKOT VILLAGE

No.20
 Malakand



- (注) - 基礎及びパイル打設の検討要す。(ボーリングを慎重に)
 - 現橋が雨期に水につかる設計ミスをしており、設計に際してはHWL, LWLを良く調査し、橋梁のクリアランスを決定の必要あり。



(現地概要)

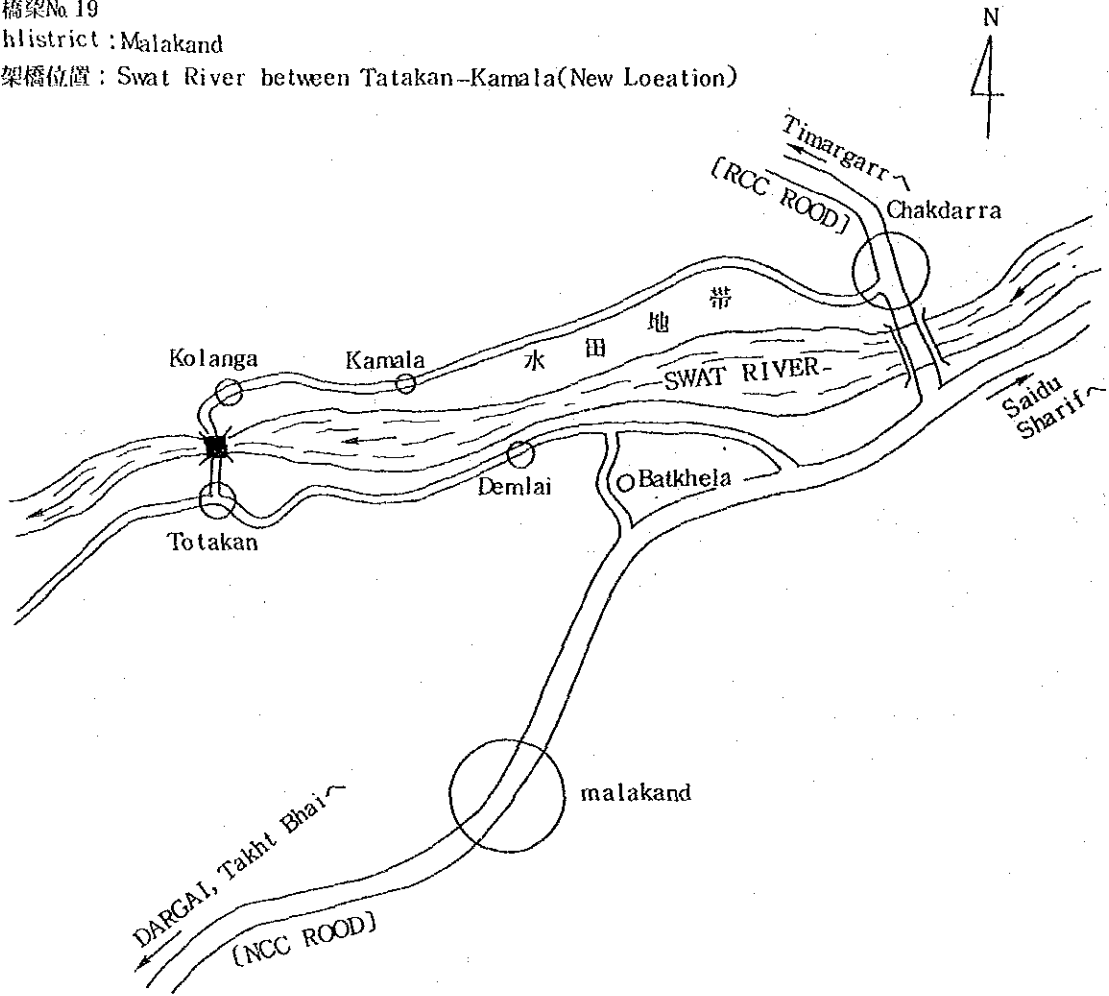
橋梁番号	No. 19		橋梁名(仮)	
橋梁位置	地区 (DISTRICT)	Malakand	道路名置	Swat River between Totakan kamala(New Location)
既存橋	あり		構造耐久性	吊り橋、橋長50m、幅2.5m かなり老朽化している
裨益人口	現況	3.5万人	将来	人口増加率 3.4%/年
交通量 (ADT, PCU)	現況		将来	
土質、水位	地形	平坦 多少 hilly		
		地図		
	土質	Gravel and Boulders		
		土質図		
河川	形状	幅員50m		
	水位	河床より10 水流急		
想定橋梁 フルトガター 又は R. C. C.	活荷重	A Class		
	橋長	70m	幅員	4 m
	上部工			
	下部工			
現場条件	資材搬入	可		
	作業スペース	右、左岸とも小さい(両岸とも商店、住宅がせまっている)		
	設備			
隣接橋への 距離	上流側	車道橋 なし		
	下流側	車道橋 なし		
接続道路状況	舗装	あり	幅員	8 m
備考				

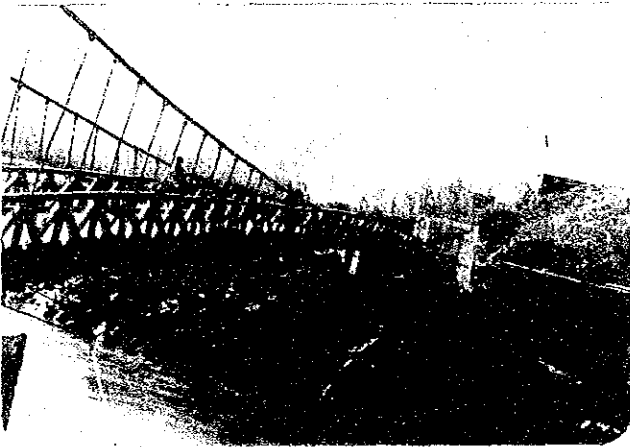
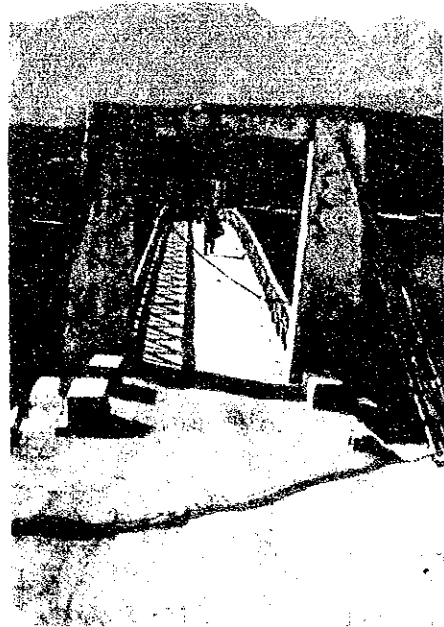
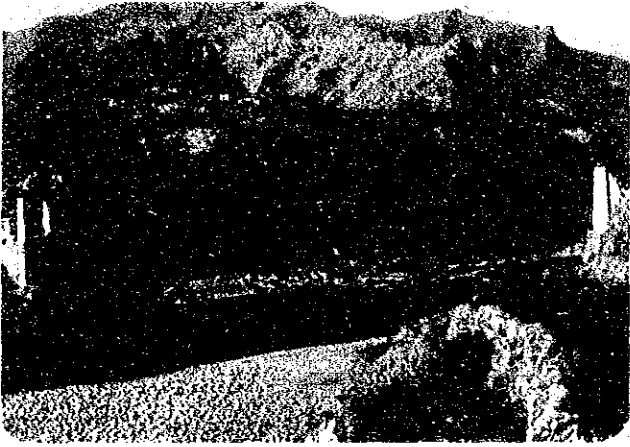
(橋梁を必要とする理由)

- 位置: MalakandよりNCC RoadをChakdarra方向に進み、Batkheleで左折し、Swat川の左岸に至り、左折してSwat川沿いの道を約14km下った。Totakanの町でSwat川に接する地点。
- 現況: 老朽化した吊り橋で幅員が狭く、軽車輛がやっと通過できる程度、この地点はSwat川の幅が急に狭くなっていて流速が大きい。
橋の両端には商店が並んでいる。
対岸へは上流約40kmのChakdarra橋まで行かないと車輛橋なし。下流はなし。
対岸(スワット川右岸)沿いに、舗装道路(幅員4~5m)が走り、チャクダラ Chakdarra と結合している。その間集落が点在し、麦、米、トウモロコシ、砂糖きび等を農作している。
- 人口: 3.5万人(人口増加率 3.4%/年)
- 産物: 米、麦、とうもろこし及び野菜
- 目的: 対岸のKamala, Kolanza等の集落にアクセスし車輛による人の交流、物流を可能にするため。

位 置 圖

- 橋梁No. 19
- District : Malakand
- 架橋位置 : Swat River between Tatakana-Kamala(New Location)





対象サイトはこの上流に存在（右側に見えるのは水田地帯）



(現地概要)

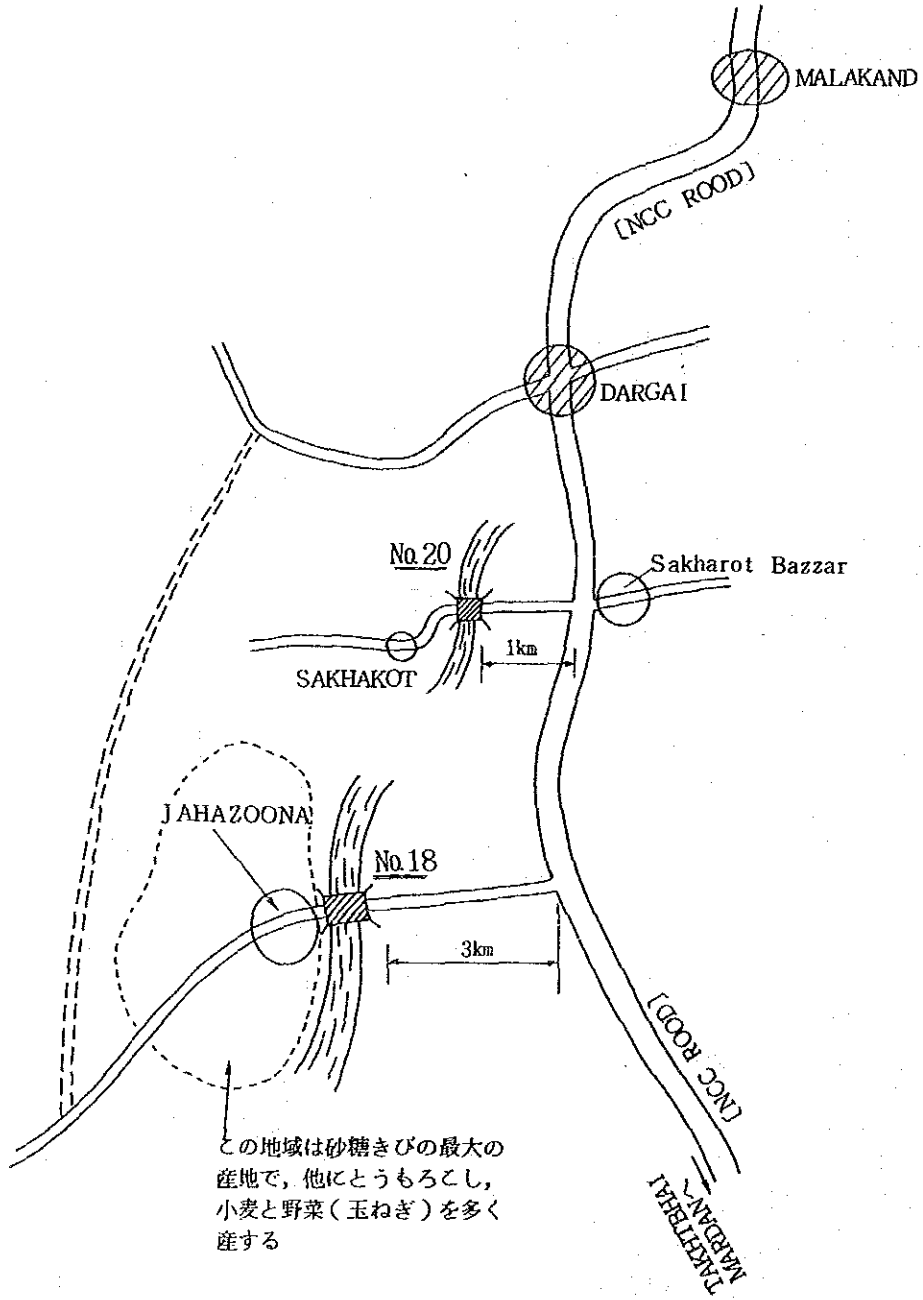
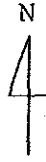
橋梁番号	No 20		橋梁名(仮)	
橋梁位置	地区 (DISTRICT)	Malakand	道路名 位置	Sakhakot Village
既存橋	あり		構耐久 造性	R. C. C. で老朽化している 橋長58m
種益人口	現況	3万人	将来	4.5万人(人口増加率 3.5%)
交通量 (ADT, PCU)	現況		将来	
土質、水位	地形	平坦		
		地図		
	土質	Silty Clay		
		土質図		
河川	形状	幅員40~45m		
	水位			
想定橋梁	活荷重	A Class		
コンクリート橋 又は プレートガーダー	橋長	40m	幅員	5.0m
	上部工			
	下部工			
現場条件	資材搬入	可(Mardan又はPeshawarより)		
	作業スペース	右、左岸とも有		
	設備			
隣接橋への 距離	上流側	車道橋 なし		
	下流側	車道橋 なし		
接続道路状況	舗装	あり	幅員	6~7m
備考				

(橋梁を必要とする理由)

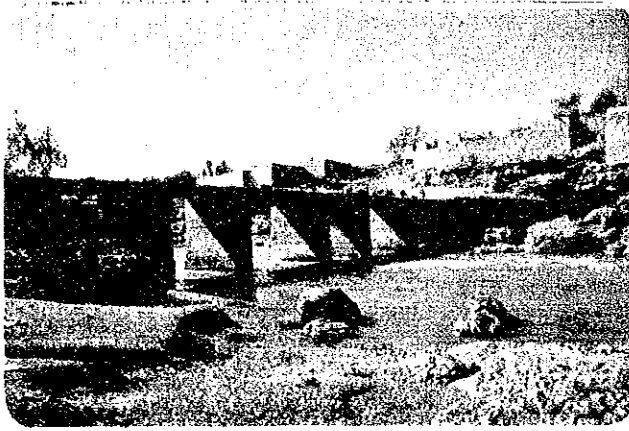
1. 位置: NCC道路をTakht Bhaiより北上し、約21kmの地点に位置するSakhakot Bazaarを左折した1kmの地点。
2. 現況: 6-spanの老朽したコンクリート橋で、増水時には、HWLが橋梁上部をオーバー(1~2m)する。また、中央部のガーダーなし。
3. 人口: 架橋地点以遠にいくつかの集落あり、人口約3万人。
4. 産物: 砂糖きび、小麦等の農産物多種。
5. 目的: Farm to Market Roadで車輛によるアクセスを可能にするため。

位 置 図

- 橋梁No 18
- District: Malakand
- 架橋位置: JAHAZOONA DAK BRIDGE
- No20
- Malakand
- SAKHAKOT VILLAGE



- (注) - ボーリングヶ所及び分析を慎重にすること。
 - HWL, LWLを良く検討すること。



第4章 結 論

4-1 無償資金協力の意義・必要性

1. 北西辺境州では、南北方向に向かって河川、山脈が発達しており、これに沿った形で南北方向の道路が比較優位で建設されている。一方、東西方向にはこれら河川を横断する橋梁は少なく、地域によっては代替の橋が数十kmに離れたところにしか架設されていないところも数多く、道路がネットワークとしての機能を果たしていない。

従って、一旦道路決壊や増水が起これば、迂回路の無い地域は孤立し、地域住民の生活に重大な支障を来すのみならず、平時でも作物の運搬、日用品の輸送にも橋が近辺にないことから輸送効率が悪く、著しく地域住民の生産意欲、農業・中小企業の進展を阻害している。

現存する橋梁も北西辺境州北部の地方道路では、国家独立以前に建設されたものがほとんどで、当時の交通状況から人道橋で設計されており、かつ老朽化のためほとんどは非常に危険な状態にあることから、これら既存の橋梁についても、緊急的な架け替えを必要としている。

2. 北西辺境州政府は、こうした状況を解決するため橋梁必要箇所400ヶ所から、優先的に整備すべき200橋を選定し、これらの橋梁建設を計画しているが、特に、同州北部は毎年頻発する高水、崖崩れ等による道路復旧に予算を費やし、新規の道路建設や橋梁の整備については、非常に限られた予算により、毎年少しずつ工事を行っている状況であり、実際には新規に多数の橋梁を建設する余裕はない。同州南部については橋梁スパンも短く、十分な経験を有しているコンクリート橋により独自で施工可能であることから比較的整備が進んでいるが、北部地域は地形的な要因から工事費も高く、高度の技術を必要とする鋼製吊橋を多数必要とする北部地域について我国に要請がなされたものである。

本計画は、既存道路のネットワークを強化し、例年頻発する道路遮断に対し、有効なバイパスを与え、地域の孤立解消、地元住民の生活の安定に貢献するのみならず、同地域の経済活動の活発化、鉱山・電力開発等により開発から取り残された地域の有効利用に活性を与えるものであり、我が国が無償資金協力を行う意義は大きいと考えられる。

3. なお、本計画には北西辺境州政府があまり経験を有しない長大スパン橋も含まれており、計画実施により、官民への技術移転の効果も期待し得る。また同様、同州が豊富な施工実績をもつコンクリート橋建設についても、効率の良い橋梁建設技術までは修得していないことから、工期短縮、施工計画等の面で技術移転が副次的効果として期待し得る。

4. なお、現地調査を行った箇所については、いずれの住民も橋梁建設を熱心に希望しており、特に環境の悪化、複雑な用地取得の問題等は本計画により生じないと判断される。ま

た、橋梁までのアクセス道路の整備（拡幅、舗装等）についても、北西辺境州政府は計画実施までに整備を行うことを表明しており、またその実行能力も有すると判断されることから、本計画実施に際して、特段の問題は生じないものと判断される。

4-2 基本設計にあたっての留意点

1. 今回要請のあった20の橋梁は、極めて広い範囲に分散して位置し、かつ各々のサイトの自然条件が大きく異なり、また無償資金協力の性格からも単年度で20橋全部を完工することは不可能であると思われる。また、本案件は北西辺境州における初めての無償資金協力による施設建設プロジェクトでもあり、北西辺境州政府が無償資金協力に不慣れであることから、期分けにより事業を行うことが適当であり、かつ初年度第1期分については、緊急性、必要性の他、工事の施工性、工期等も勘案して、いくつかの橋梁を対象を限定して行う必要がある。

当州北部においては通信状態も悪く、対象地が広範にわたることから効率的に工事を行うことは難しいと考えられ、初年度対象橋梁については北西辺境州の州都ペシャワール近郊で、地域的にまとまっており、短期間に施工可能な箇所のうち、優先度の高い橋梁を選定することが効率的かつ経済的である。地域的なまとまりで見た場合、橋梁番号①、②、③、⑭、⑮、⑯、⑰がイスラマバード、ペシャワール近郊に存在し、この内、①、②、⑭、⑮、⑰の5橋はいずれも既存橋の架替えであり、優先度も高く、その波及効果も大きいと判断されることから、初年度についてはこれら5橋について基本設計調査を行うことが望ましい。

また、これら橋梁の形態は、最終的には工期の検討結果も合わせて形態については決定されるべきものではあるが、経済性から考えると、①、②は鋼製吊橋、⑭～⑰はコンクリート橋が適切であり、調査及び工事にあたってはこれら第1年次2タイプの橋梁についての経験を第2年次にうまく活かすことが可能である。

なお、第2年次の対象橋梁については、本事前調査時に7ヶ所は確認を行えなかったこともあり、基本設計調査時に確認の上、対象橋梁を確定する必要がある。

2. 北西辺境州各郡の基本的な要望は、各橋梁とも2車線の永久道路橋であり、各橋梁の諸元については、第3章表3-2に示されるとおりである。なお、これらについては相手方の要望を確認しただけであり、各橋梁について各々その妥当性について、基本設計調査時に相手方と協議、見直しする必要がある。要請各橋のほとんどは、当分の間2車線の交通容量に達するとは考えられず、また、独自の道路設計基準に基づき、本計画対象の地方道路橋梁についてかなり厳しい荷重条件を課しているが、実態からみてほとんどの橋梁は別表記載の諸元が必要とは考えられない。また、北西辺境州は200橋の橋梁建設計画を有することからわかるとおり、一方で、できるだけ多くの橋梁建設を日本側に要望しており、

経済性とともに施工性、工期、維持管理の容易性について充分検討の上、現実的な設計を行い、場合によっては相手方の過大な要望について、十分に説得する必要がある。

3. 20橋の架橋位置での自然条件は緯度、高度（海拔）ならびに平野部、山岳部によりそれぞれ異なり、同一郡内にあるサイトでもこれらの要因により、かなり異なってくる。各位置についての資料入手は不可能と思われるので、類似した箇所あるいは郡都のデータを入手して、各サイトの自然条件を類推する必要がある。特に、水文では、モンスーン時、雪解け期におけるH.W.L.の推定を慎重に行う必要がある。

4. ボーリングは、既往の資料（Geological Survey of Pakistan）を考慮し、1サイト当たり調査ボーリング1～2孔、素掘ボーリング1孔が望ましい。掘進長については、15～20m程度で充分であると思われるが、実施にあたっては現地カウンターパートの情報・経験を基に決定することが望ましい。

5. 資機材の輸送路については、通常カラチ港に陸揚げし、トラックによりN-5で約1,700kmペシャワールの本部基地まで運ぶが、コンテナ化できるものはペシャワールの Inland Freight Station（ドライポート）で通関手続きを行うことが可能である。バラ積みでカラチ港で通関する場合、関税のかからないように注意する必要がある。

工事本部より、サイトまでの輸送路については実査を行うことが必要で、サイトへのアクセス道路については雨期、冬季の過去の道路閉鎖実態についてヒアリングの上、必要あれば代替路線についても充分調査、検討すること。特に山岳地域にあるサイトについては、アクセス道路で崖崩れが頻発し、交通障害を起こす箇所が大体決まっており、これらについては過去の復旧所要日数等、データ収集の上、工程計画策定に反映する必要がある。

6. 地図についてはSurvey of Pakistan（国土地理院）で1/50,000（場所により1/25,000）を、また北西辺境州C&Wの地方事務所で担当地域の道路地図（計画道路記載）が入手できる。市販の地図では各橋梁位置の確定は難しく、また、地方事務所所有の地図でも詳細な部分では道路のアライメント、位置が異なることもあり、架橋付近は実査による確認が必要である。

7. 本計画の対象範囲は広範にわたり、また、特に北部地域については通信状態が悪いこともあり、基本設計調査を効率的に行うためには、NWFP側カウンターパートを積極的に活用することが必須である、特に調査初期の段階で行うサイト調査、自然条件調査を効率的に行うためには、対象各郡より本計画専従のカウンターパートの配置を依頼し、他郡、調査本拠地への移動、連絡、自然条件調査の監督等につき、協力を得ることが必要である。

付 属 資 料

附属資料-1 議事録

MINUTES OF DISCUSSIONS
PRELIMINARY STUDY OF THE PROJECT
FOR
CONSTRUCTION OF BRIDGES IN NWFP/FATA
IN
THE ISLAMIC REPUBLIC OF PAKISTAN

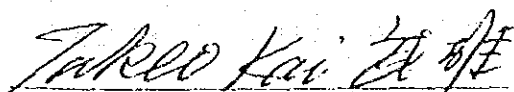
In response to a request from the Government of Islamic Republic of Pakistan, the Government of Japan decided to conduct a preliminary study on the Project for Construction of Bridges in NWFP/FATA (herein after referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent Pakistan the study team, which is headed by Mr. Takeo KAI, Civil Engineering Development Specialist, JICA and is scheduled to stay in the country from February 10 to 25, 1992.

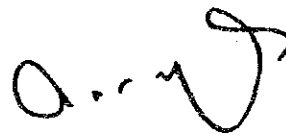
The team held discussion with the officials concerned of the Government of Pakistan and conducted a field survey at the Project sites.

As a result of discussions and field survey, both parties confirmed the main items described on the attached sheets. On condition that the Government of Japan approves the implementation of Basic Study on the Project, JICA will prepare the study, including dispatchment of a survey team.

Peshawar, February 22, 1992



Mr. TAKEO KAI
LEADER
PRELIMINARY STUDY TEAM



ADAM KHAN
SECRETARY TO GOVT. OF NWFP
COMMUNICATION & WORKS DEPARTMENT

ATTACHMENT

1. Objective

The objective of the Project is to construct and replace the new and dilapidated bridges in remote area of NWFP (North-West Frontier Province) for the improvement of socio-economic condition and living standard of people in the areas.

2. Executing Organization.

Communication & Works Department, Government of NWFP is responsible for the administration and execution of the Project.

3. Request by the Government of Pakistan

The requested bridges by the Government of Pakistan are shown in the Annexure-1 which includes 13 new bridges in addition to the 7 bridges officially requested through diplomatic channel.

4. Project Sites

The sites of the Project are in the North-West Frontier Province as shown in Annexure-2.

5. Japan's Grant Aid system

- 1) The Government of Pakistan has understood the system of Japan's Grant Aid Programme by the team.
- 2) The Government of Pakistan will take necessary measures, described in Annexure-3 for smooth implementation of the Project on condition that the Grant Aid Assistance by the Government of Japan is extended to the Project.

6. Schedule of the Study

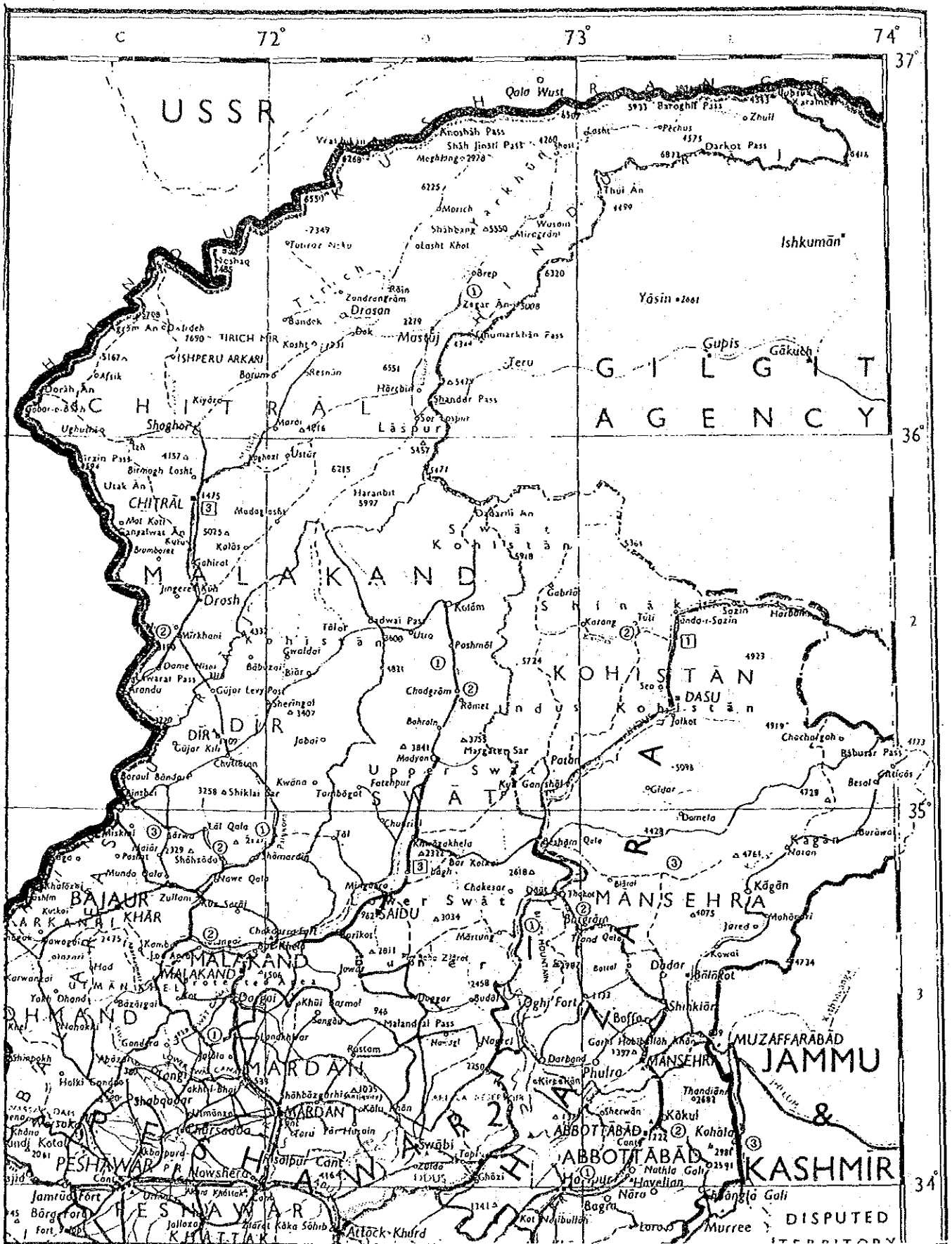
If the Project is found feasible as a result of the Preliminary Study, JICA will send the basic design study team for the project around the end of June, 1992.

7. The Government of Pakistan shall provide all necessary information and data in case that the basic design study team visits Pakistan.

Annexure-I

REQUESTS BY THE GOVERNMENT OF PAKISTAN

District	Location	Popula- tion million	Bridge Length (m)	New/Rep- lacement
<u>Abbottabad</u>	1. Pind Gali Road (River Siran at Narlai).	0.200	100.00	Replace- ment
	2. Abbottabad Murree Road (Harno Nullah at Desal).	0.02	60.00	Replace- ment
	3. Sawar Gali Eoi Road at Kuniar Kass.	0.025	60.00	-do-
<u>Mansehra</u>	1. Shagai in Km-29 Thakot Darband Road.	0.18	185.00	New
	2. Pashorai in Km-171 (Karakurram Highway).	0.05	70.00	New
	3. Jabrai in Km-11 Dadar Sachan Road.	0.08	67.00	New
<u>Kohistan</u>	1. Bridge over River Indus Km-1 Kandia Valley Road.	0.03	175.00	Replace- ment
	2. Jajshoe Km-18 Kandia Valley Road.	0.03	54.00	-do-
<u>Chitral</u>	1. Mastuj Broghal Pass Darband.	0.017	70.00	New
	2. Km-1 NCC Naggar West Road.	0.010	70.00	Replace- ment
	3. NCC Chitral Town Road.	0.025	100.00	-do-
<u>Dir</u>	1. Khal on Panjkora River at NCC Road Km-135.	0.150	120.00	-do-
	2. Bridge on Haya Serai Khawar.	0.050	100.00	-do-
	3. Samar-Bagh Shahi Road Km-2-3 Bukari Khawar.	0.200	2x70.00	New
<u>Swat</u>	1. Mankial Bridge on Swat River Km-1 Mankial Tarkana Road.	0.016	50.00	Replace- ment
	2. Kaidon on Kaidon Coornai Road Km-1 Swat River.	0.01	36.00	-do-
	3. Peer Baba Palak Pur	0.02	45.00	-do-
<u>Malakand</u>	1. Jahazoon Dak Bridge	0.500	60.00	-do-
	2. Swat River between Totakan Kamala (New location).	0.035	70.00	-do-
	3. Sakhakot Village.	0.030	40.00	-do-



Annexure-3

Necessary measures to be taken by the Government of Pakistan in case Japan's Grant is executed.

1. to provide data and information necessary for the project.
2. to secure land necessary for the execution of the Project and provide enough space for construction, such as temporary offices, working areas, stock-yards and others.
3. to construct/develop access roads/detours up to the sites prior to the commencement of the construction, for transportation of materials and equipment necessary for the project.
4. to demolish or remove existing facilities, if required for the execution of works.
5. to bear commission (banking charge) to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement.
6. to exempt taxes and to take necessary measures for customs clearance of the materials, equipment and supplies brought for the project at the ports of disembarkation in Pakistan including dry port in Peshawar NWFP.
7. to accord Japanese Nationals whose services may be required in connection with the supply of projects and the services under the verified contract such facilities as may be necessary for their entry into Pakistan and stay therein for the performance of their work.
8. to maintain and use properly and effectively the facilities constructed under the Grant.
9. to bear all the expenses other than those to be borne by the Grant, necessary for execution of the Project.

附属資料-2 面会者リスト

今回の事前調査を通じて調査団が現地において面談した関係者は以下に示すとおりである。

(A) 北西辺境州政府 (Government of North West Frontier Province (NWF P))

1. Mr. Adam Khan Secretary,
Communications and Works Department (C&W Dept.)
2. Mr. Muhammad Afzal Khan Chief Engineer, C&W.,
C&W Dept.
3. Mr. Abdul Qayyum Deputy Secretary,
C&W Dept.
4. Mr. Hazrat Sultan Superintending Engineer, Highway Circle Peshawar,
C&W Dept.
5. Mr. Umar Khan Superintending Engineer, C&W Circle Malakand,
C&W Dept.
6. Mr. Habib Ali Executive Engineer, C&W Division Malakand,
C&W Dept.
7. Mr. Ahmed Jam Executive Engineer, C&W Division Kohistan,
C&W Dept.
8. Mr. Mohammad Shafi Executive Engineer, C&W Division Mohmand,
C&W Dept.
9. Mr. Ahmad Nabi Sultan Assistant Engineer, Highway Subdivision Warri,
District Dir, C&W Dept.
10. Mr. Bahadar Said Assistant Engineer, Highway Subdivision Timargara,
District Dir, C&W Dept.
11. Mr. Mohammad Hamayen Assistant Engineer, Highway Subdivision Matta,
District Swat, C&W Dept.
12. Mr. Jan-c-Alam Assistant Engineer, Highway Subdivision Saidu
Sharif, District Swat, C&W Dept.
13. Mr. Alta Ullah Assistant Engineer, C&W Subdivision Dassu,
District Kohistan, C&W Dept.
14. Mr. Shakir Habib Assistant Engineer, Education Project Dassu,
District Kohistan, C&W Dept.
15. Mr. Sirajuddin Afridi Section Officer (Roads), Headquarters,
C&W Dept.
16. Mr. Khalid Aziz Additional Chief Secretary,
Planning and Development Department (P&D Dept.)
17. Mr. Abdul Galil Mughal Additional Secretary,
P&D Dept.
18. Mr. M. Fashihuddin Chief, Transport and Communication,
P&D Dept.
19. Mr. Niamat Shak Bukhari Executive Engineer, Highway Division Abbottabad,
C&W Dept.

(B) 中央政府 (Federal Government)

1. Mr. Akhtar Iqbal Deputy Secretary, Economic Affairs Division (E. A. D),
Ministry of Finance and Economic Affairs (MFBA)
2. Mr. Sadiq Swati Senior Chief, National Transport Research Center (NTRC)
Ministry of Planning and Development (MPD)
3. Mr. Abdul Majeed Chief, NTRC, MPD

(C) 駐パキスタン日本国政府機関

1. 村瀬 光 一 駐パキスタン日本国大使館 一等書記官
2. 御手洗 章 弘 JICAパキスタン事務所 所長
3. 石橋 隆 介 " 次長
4. 吉村 浩 司 "

(D) コンサルタント

1. Mr. A. Nabi Pathan A. A. Associates, Karachi

附屬資料- 3 道路設計基準

DESIGN OF BRIDGES IN PAKISTAN

The bridges in Pakistan are designed according to IRC (Indian Road Congress) which have been adopted for used in Pakistan. There are three types of loadings, namely, Class AA, Class A and Class B.

- Bridges on main Highways, Motorways : Class A, AA as per West Pakistan Highway Department Code of Practice for Bridges 1967. In addition, the deck slabs shall be designed for N.H.A. abnormal wheel load of 9,525 Kg. over a contact area of 305 mm x 610 mm.
- Bridge on secondary (district) roads : Class A as per West Pakistan Highway Department Code of Practice for Bridges 1967. In addition, the bridge deck slab shall be designed for N.H.A. abnormal wheel load as stated above.
- Bridge on Tertiary (Village) roads : Class B as per West Pakistan Highway Department Code of Practice for Bridges 1967. In addition, the bridge deck slab shall be designed for 60% of N.H.A. abnormal wheel load as described above.

The impact factors, longitudinal forces due to braking/traction, wind loading and forces due to stream flow shall be as per the above mentioned West Pakistan Code.

Seismic forces shall be calculated and analysis carried out following the procedure stipulated in Guide Specifications for Seismic Design of Highway Bridges, Section 3.21 of Standard Specifications for Highway Bridges 1983 except that the seismic zones as stipulated in the National Building Code of Pakistan shall be used.

Load combination and limit state design approach shall be followed as per AASHTO 1983.

As regards the design of members and load combination AASHTO specifications for design of bridges are used. In some cases BS (British Standard) specifications are also used.

The most of the bridges consist of prestressed concrete post tensioned girders with reinforced concrete deck slab. Two systems are popular in Pakistan, namely, Freyssinet and Stronghold. Both the systems are based on the use of strands which are manufactured locally.

For reinforcement plain mild steel bars of 250 KN/sq.mm. yield strength and cold-worked deformed bars of 410 KN/sq.mm. yield strengths are extensively used.

For the foundations cast-in-place reinforced concrete piles are extensively used. The common pile diameters are 550 mm, 660 mm, 710 mm, 750 mm, 1 m and in exceptional cases even 2 m piles are used on major bridges.

11.3.7.4 Provision shall also be made for carrying any concentrated equipment loads while the equipment is being installed or moved for servicing and repairing.

11.3.8 Snow Loads

Where snow loads occur, full or unbalanced, the roofs shall be designed for such loads or for the live loads specified in the Table 11.2 whichever is more severe.

Actual load due to snow will depend upon the shape of the roof and its capacity to retain the snow; and each case shall be treated on its own merits. In the absence of any specific information, the loading due to the collection of snow may be assumed to be 25 N/sq.m (1.3 lbs/sq.ft) per in (cm) depth of snow. The possibility of total or partial snow load should be considered, that is, one-half of the roof fully loaded with the design snow load and the other half loaded with half the design snow load. In the case of roofs with slopes greater than 50 degree snow load may be disregarded; where, however, there are possibilities of formation of snow pockets, these shall be taken into account. Where data on ground snow load is available the specified snow load shall be determined by multiplying the ground snow load by 0.8.

Snow load in excess of 0.96 kN/sq.m (20 lb/sq.ft) may be reduced for each degree of pitch over 20 degrees by R_s as determined by the following formula:

$$R_s = S/40 - 1/40$$

R_s = Reduction in snow load in kN/sq.m per degree of pitch over 20 degrees.

S = Total snow load in kN/sq.m

The formula for reducing snow loads in FPS units will be:

$$R_s = S/40 - 1/2$$

R_s = Reduction in snow load in lb/sq.ft per degree of pitch over 20 degrees.

S = Total snow load in lb/sq.ft.

11.4 WIND LOADS

All loads due to the effect of wind pressure or suction are called wind loads. The force due to wind on a structure depends on the velocity of the wind and the shape and size of exposed members. The velocity depends on the district in which the structure is erected, the height of the structure, and the shelter afforded by buildings or hills in the neighbourhood.

11.4.1 Wind Velocity for Various Parts of Pakistan

Until detailed wind data is available, all the structures inland shall be designed to resist a wind velocity of not less than 40 m/sec (131 ft/sec) at a height of 10 m (33 ft) and all the structures along the coast shall be designed to resist a wind velocity of not less than 50 m/sec (160.05 ft/sec) at a height of 10 m (33 ft). Lower wind velocities shall not be used unless approved by the authority.

11.4.2 Variation of Wind Velocity with Height

The velocity of wind usually increases with the height above the ground. Velocity increase with different heights are given in Table 11.5.

11.4.3 Pressure of Wind

11.4.3.1 Flat Surface

The pressure due to wind varies as the square of velocity V , and on a flat surface the characteristic pressure can be calculated by the expression:

$$\text{Characteristic wind pressure } q = K V_s^2$$

$$V_s = \text{design wind speed} = V \times S$$

$$V = \text{Basic wind speed (as given in subsection 11.4.1)}$$

$$S = \text{Multiplying factor relating to height above ground and wind breaking}$$

$$K = 0.0625 \text{ in metric units}$$

$$= 0.00256 \text{ in imperial units}$$

11.4.4 Wind Forces

11.4.4.1 In the preceding subsection 11.4.3 the method of assessing the dynamic pressure q is given. In order to determine the forces on a building or structure, or part thereof, the pressure has to be multiplied by a coefficient that is dependent on the shape of the building or structure and by the area of the building or structure or part thereof.

There are two types of coefficients as follows:

1) pressure coefficients, C_p

2) force coefficients, C_f

Values of these coefficients for some building shapes are given in Tables 11.6 to 11.14. These tables may be used for other buildings of

generally similar shape.

These coefficients are of necessity, obtained mainly from measurements on models in wind tunnels, and the great majority of data available have been obtained in conditions of relatively smooth flow. Where sufficient field data exist as in the case of rectangular buildings, values have been adjusted to allow for turbulent flow.

TABLE 11.5

Ground roughness, building size and height above ground, factor S

H	(1) Open country with no obstructions			(2) Open country with scattered windbreaks			(3) Country with many windbreaks; small towns; outskirts of large cities			(4) Surface with large and frequent obstructions, e.g. city centres		
	Class			Class			Class			Class		
	A	B	C	A	B	C	A	B	C	A	B	C
m												
3 or less	0.83	0.78	0.73	0.72	0.67	0.63	0.64	0.60	0.55	0.56	0.52	0.47
5	0.88	0.83	0.78	0.79	0.74	0.70	0.70	0.65	0.60	0.60	0.55	0.50
10	1.00	0.95	0.90	0.93	0.88	0.83	0.78	0.74	0.69	0.67	0.62	0.58
15	1.03	0.99	0.94	1.00	0.95	0.91	0.88	0.83	0.78	0.74	0.69	0.64
20	1.06	1.01	0.96	1.05	0.98	0.94	0.95	0.90	0.85	0.79	0.75	0.70
30	1.09	1.05	1.00	1.07	1.03	0.98	1.01	0.97	0.92	0.90	0.85	0.79
40	1.12	1.08	1.03	1.10	1.06	1.01	1.05	1.01	0.96	0.97	0.93	0.89
50	1.14	1.10	1.06	1.12	1.08	1.04	1.08	1.04	1.00	1.02	0.98	0.94
60	1.15	1.12	1.08	1.14	1.10	1.06	1.10	1.06	1.02	1.05	1.02	0.98
80	1.18	1.15	1.11	1.17	1.13	1.09	1.13	1.10	1.06	1.10	1.07	1.03
100	1.20	1.17	1.13	1.19	1.16	1.12	1.16	1.12	1.09	1.13	1.10	1.07
120	1.22	1.19	1.15	1.21	1.18	1.14	1.18	1.15	1.11	1.15	1.13	1.10
140	1.24	1.20	1.17	1.22	1.19	1.16	1.20	1.17	1.13	1.17	1.15	1.12
160	1.25	1.22	1.19	1.24	1.21	1.18	1.21	1.18	1.15	1.19	1.17	1.14
180	1.26	1.23	1.20	1.25	1.22	1.19	1.23	1.20	1.17	1.20	1.19	1.16
200	1.27	1.24	1.21	1.26	1.24	1.21	1.24	1.21	1.18	1.22	1.21	1.18

Class A: All of cladding, glazing and roofing and their immediate fixings and individual members of unclad structure.

Class B: All buildings and structures where neither the greatest horizontal nor the greatest vertical dimension exceeds 50 m (165 ft).

Class C: All buildings and structures whose greatest horizontal dimension or greatest vertical dimension exceeds 50 m (165 ft).

TABLE 11.6

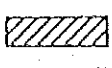
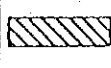
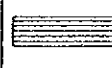



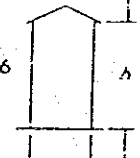
Pressure coefficients C_{pe} for the walls of rectangular clad buildings

Building height ratio	Building plan ratio	Elevation	Plan	Wind angle α	C_{pe} for surface				Local C_s
					A	B	C	D	
$\frac{h}{w} \leq \frac{1}{2}$	$1 < \frac{l}{w} \leq \frac{3}{2}$			degrees					-0.8
				0	+0.7	-0.2	-0.5	-0.5	
				90	-0.5	-0.5	+0.7	-0.2	
	$\frac{3}{2} < \frac{l}{w} < 4$			0	+0.7	-0.25	-0.6	-0.6	-1.0
				90	-0.5	-0.5	+0.7	-0.1	
$\frac{1}{2} < \frac{h}{w} \leq \frac{3}{2}$	$1 < \frac{l}{w} \leq \frac{3}{2}$			0	+0.7	-0.25	-0.6	-0.6	-1.1
				90	-0.6	-0.6	+0.7	-0.25	
	$\frac{3}{2} < \frac{l}{w} < 4$			0	+0.7	-0.3	-0.7	-0.7	-1.1
				90	-0.5	-0.5	+0.7	-0.1	
$\frac{3}{2} < \frac{h}{w} < 6$	$1 < \frac{l}{w} \leq \frac{3}{2}$			0	+0.8	-0.25	-0.8	-0.8	-1.2
				90	-0.8	-0.8	+0.8	-0.25	
	$\frac{3}{2} < \frac{l}{w} < 4$			0	+0.7	-0.4	-0.7	-0.7	-1.2
				90	-0.5	-0.5	+0.8	-0.1	

NOTE. h is the height to eaves or parapet, l is the greater horizontal dimension of a building and w is the lesser horizontal dimension of a building.

TABLE 11.7

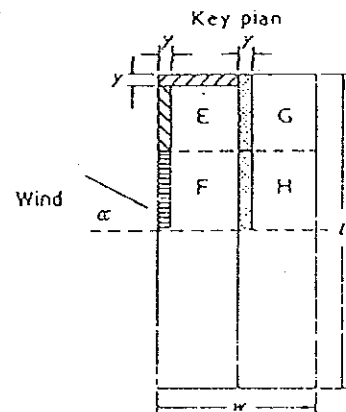
Pressure coefficients C_{pe} for pitch roofs of rectangular clad buildings

Building height ratio	Roof angle	Wind angle α 0°		Wind angle α 90°		Local coefficients			
		EF	GH	EG	FH				
$\frac{h}{w} \leq \frac{1}{2}$ 	degrees								
	0	-0.8	-0.4	-0.8	-0.4	-2.0	-2.0	-2.0	—
	5	-0.9	-0.4	-0.8	-0.4	-1.4	-1.2	-1.2	-1.0
	10	-1.2	-0.4	-0.8	-0.6	-1.4	-1.4		-1.2
	20	-0.4	-0.4	-0.7	-0.6	-1.0			-1.2
	30	0	-0.4	-0.7	-0.6	-0.8			-1.1
	45	+0.3	-0.5	-0.7	-0.6				-1.1
60	+0.7	-0.6	-0.7	-0.6				-1.1	
$\frac{1}{2} < \frac{h}{w} < \frac{3}{2}$ 	0	-0.8	-0.6	-1.0	-0.6	-2.0	-2.0	-2.0	—
	5	-0.9	-0.6	-0.9	-0.6	-2.0	-2.0	-1.5	-1.0
	10	-1.1	-0.6	-0.8	-0.6	-2.0	-2.0	-1.5	-1.2
	20	-0.7	-0.5	-0.8	-0.6	-1.5	-1.5	-1.5	-1.0
	30	-0.2	-0.5	-0.8	-0.8	-1.0			-1.0
	45	+0.2	-0.5	-0.8	-0.8				
	60	+0.6	-0.5	-0.8	-0.8				
$\frac{3}{2} < \frac{h}{w} < 6$ 	0	-0.7	-0.6	-0.9	-0.7	-2.0	-2.0	-2.0	—
	5	-0.7	-0.6	-0.8	-0.8	-2.0	-2.0	-1.5	-1.0
	10	-0.7	-0.6	-0.8	-0.8	-2.0	-2.0	-1.5	-1.2
	20	-0.8	-0.6	-0.8	-0.8	-1.5	-1.5	-1.5	-1.2
	30	-1.0	-0.5	-0.8	-0.7	-1.5			
	40	-0.2	-0.5	-0.8	-0.7	-1.0			
	50	+0.2	-0.5	-0.8	-0.7				
60	+0.5	-0.5	-0.8	-0.7					

NOTE 1. h is the height to eaves or parapet and w is the lesser horizontal dimension of a building.

NOTE 2. The pressure coefficient on the underside of any roof overhang should be taken as that on the adjoining wall surface.

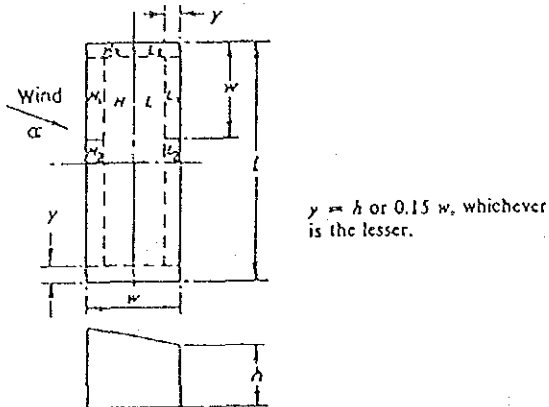
Where no local coefficients are given the overall coefficients apply.



$y = h$ or $0.15w$, whichever is the lesser.

TABLE 11.8

Pressure coefficients C_{pe} for monopitch roofs of rectangular clad buildings with $h/w < 2$



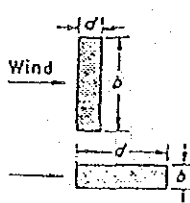
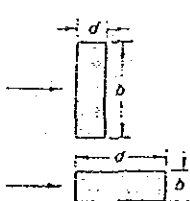
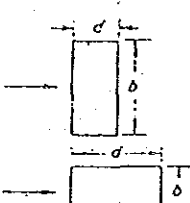
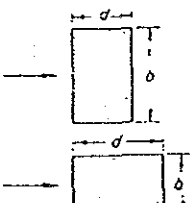
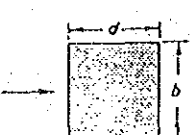
NOTE. Area H and area L refer to the whole quadrant.

Roof angle	Wind angle α										Local C_{pe}					
	0°		45°		90°		135°		180°		H_1	H_2	L_1	L_2	H_e	L_e
degree	H	L	H	L	$H \& L$	$H \& L$	H	L	H	L	H_1	H_2	L_1	L_2	H_e	L_e
5	-1.0	-0.5	-1.0	-0.9	-1.0	-0.5	-0.9	-1.0	-0.5	-1.0	-2.0	-1.5	-2.0	-1.5	-2.0	-2.0
10	-1.0	-0.5	-1.0	-0.8	-1.0	-0.5	-0.8	-1.0	-0.4	-1.0	-2.0	-1.5	-2.0	-1.5	-2.0	-2.0
15	-0.9	-0.5	-1.0	-0.7	-1.0	-0.5	-0.6	-1.0	-0.3	-1.0	-1.8	-0.9	-1.8	-1.4	-2.0	-2.0
20	-0.8	-0.5	-1.0	-0.6	-0.9	-0.5	-0.5	-1.0	-0.2	-1.0	-1.8	-0.8	-1.8	-1.4	-2.0	-2.0
25	-0.7	-0.5	-1.0	-0.6	-0.8	-0.5	-0.3	-0.9	-0.1	-0.9	-1.8	-0.7	-0.9	-0.9	-2.0	-2.0
30	-0.5	-0.5	-1.0	-0.6	-0.8	-0.5	-0.1	-0.6	0	-0.6	-1.8	-0.5	-0.5	-0.5	-2.0	-2.0

NOTE. h is the height to eaves at lower side, l is the greater horizontal dimension of a building and w is the lesser horizontal dimension of a building.

TABLE 11.9

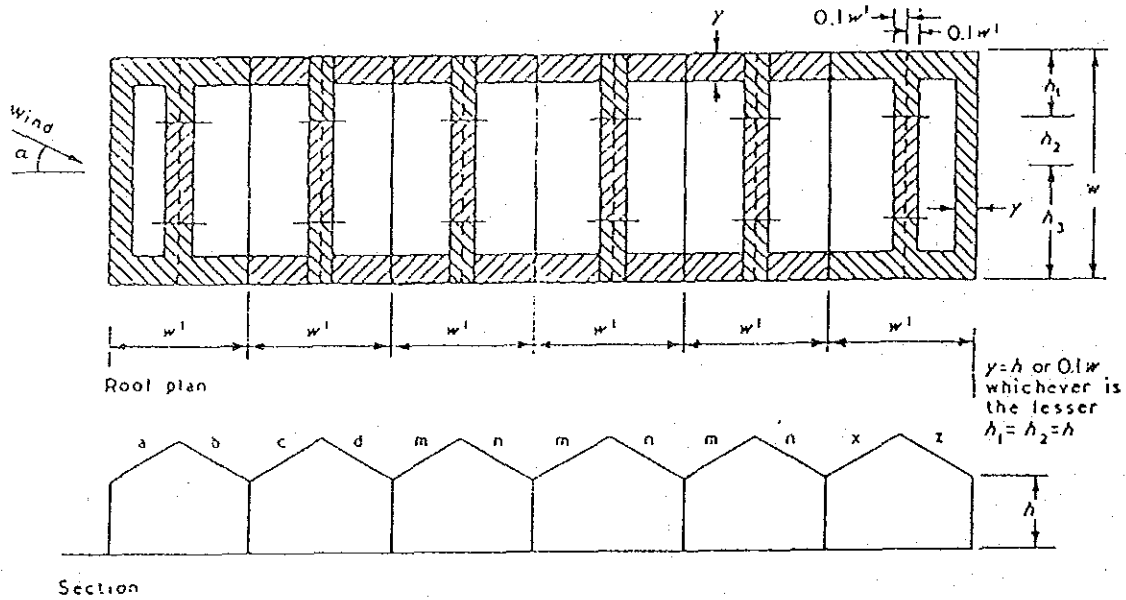
Force coefficients C_f for rectangular clad buildings with flat roofs (acting in the direction of the wind)

Plan shape	$\frac{l}{w}$	$\frac{b}{d}$	C_f for height/breadth ratio:						
			Up to $\frac{1}{2}$	1	2	4	6		
	≥ 4	≥ 4	1.2	1.3	1.4	1.5	1.6		
		$\leq \frac{1}{2}$	0.7	0.7	0.75	0.75	0.75		
	3	3	1.1	1.2	1.25	1.35	1.4		
		$\frac{1}{3}$	0.7	0.75	0.75	0.75	0.8		
	2	2	1.0	1.05	1.1	1.15	1.2		
		$\frac{1}{2}$	0.75	0.75	0.8	0.85	0.9		
	$1\frac{1}{2}$	$1\frac{1}{2}$	0.95	1.0	1.05	1.1	1.15		
		$\frac{2}{3}$	0.8	0.85	0.9	0.95	1.0		
Plan shape	$\frac{l}{w}$	$\frac{b}{d}$	C_f for height/breadth ratio:						
	1	1	Up to $\frac{1}{2}$	1	2	4	6	10	20
			0.9	0.95	1.0	1.05	1.1	1.2	1.4

NOTE. b is the dimension of the building normal to the wind, d is the dimension of the building measured in the direction of the wind, l is the greater horizontal dimension of a building and w is the lesser horizontal dimension of a building.

TABLE 11.10

Pressure coefficients C_p for pitch roofs of multi-span buildings
(all spans equal) with $h > w$



Roof angle	Wind angle α	First span		First intermediate span		Other intermediate spans		End span		Local coefficient	
		a	b	c	d	m	n	x	z		
degrees	degrees										
5	0	-0.9	-0.6	-0.4	-0.3	-0.3	-0.3	-0.3	-0.3	-2.0	-1.5
10		-1.1	-0.6	-0.4	-0.3	-0.3	-0.3	-0.3	-0.4		
20		-0.7	-0.6	-0.4	-0.3	-0.3	-0.3	-0.3	-0.5		
30		-0.2	-0.6	-0.4	-0.3	-0.2	-0.3	-0.2	-0.5		
45		+0.3	-0.6	-0.6	-0.4	-0.2	-0.4	-0.2	-0.5		

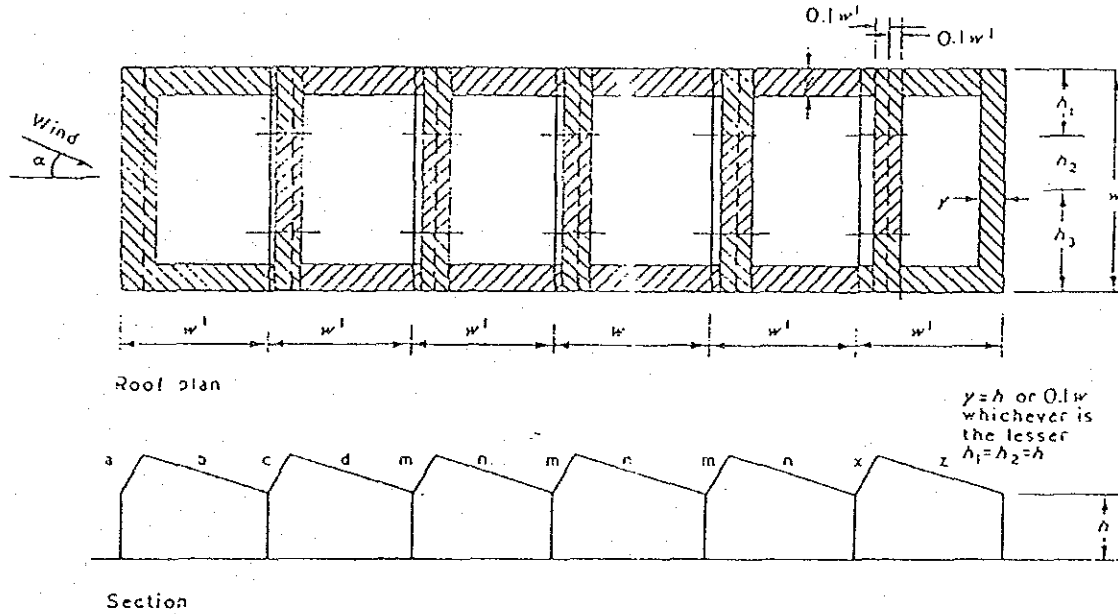
Roof angle	Wind angle α	Distance		
		h_1	h_2	h_3
degrees	degrees			
Up to 45	90	-0.8	-0.6	-0.2

Frictional drag: when wind angle $\alpha = 0^\circ$ horizontal forces due to frictional drag are allowed for in the above values;
when wind angle $\alpha = 90^\circ$ allow for frictional drag in accordance with clause 11.4.4.4

NOTE. Evidence on these buildings is fragmentary and any departures from the cases given should be investigated separately.

TABLE 11.11

Pressure coefficients C_p for saw-tooth roofs of multi-span buildings (all spans equal) with $h \geq w'$



Wind angle α	First span		First intermediate span		Other intermediate spans		End spans		Local coefficient	
	a	b	c	d	m	n	x	z		
degrees 0	+0.6	-0.7	-0.7	-0.4	-0.3	-0.2	-0.1	-0.3	} -2.0	-1.5
180	-0.5	-0.3	-0.3	-0.3	-0.4	-0.6	-0.6	-0.1		

Wind angle α	Distance h_1	h_2	h_3
degrees 90	-0.8	-0.6	-0.2
270	Similarly, but handed		

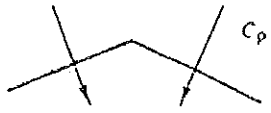
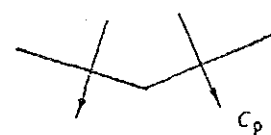
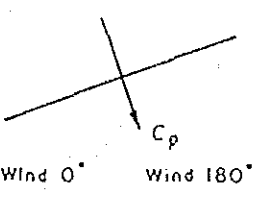
Frictional drag: when wind angle $\alpha = 0^\circ$ horizontal forces due to frictional drag are allowed for in the above values;

when wind angle $\alpha = 90^\circ$ allow for frictional drag in accordance with clause 11.4.4.4

NOTE Evidence on these buildings is fragmentary and any departures from the cases given should be investigated separately.

TABLE 11.12

Pressure coefficients C_p for canopy roofs with $\frac{1}{2} \leq \frac{h}{w} < 1$

Section	Roof angle	Windward slope	Leeward slope
	degrees		
	5	-0.8 or +1.2	-1.0
	10	-0.6 or +1.4	-1.0
	15	-0.4 or +1.6	-1.0
	20	-0.2 or +1.8	-0.7
	25	0 or +2.0	-0.2
	30	0 or +2.0	0
	5	-1.2 or +0.8	+1.0
	10	-1.4 or +0.6	+1.0
	15	-1.6 or +0.4	+1.0
	20	-1.8 or +0.2	+0.7
	25	-2.0 or 0	+0.2
	30	-2.0 or 0	0
		Wind 0°	Wind 180°
	0	-1.0 or +1.0	-1.0 or +1.0
	5	-1.0 or +1.05	-1.05 or +1.0
	10	+1.1	-1.1
	15	+1.15	-1.15
	20	+1.2	-1.2
25	+1.25	-1.25	
30	+1.3	-1.3	

The coefficients take account of the combined effect of the wind on both upper and lower surfaces of the canopy. Where alternative coefficients are given the canopy should be designed to accept both loading conditions. In addition to the uplift forces, there will be horizontal loads on the canopy due to the wind pressure on any fascia and to wind friction over the surface of the roof. For any wind direction, only one of these two, the more onerous, need be taken into account. Fascia loads should be calculated on the area of the surface facing the wind, using a force coefficient of 1.3.

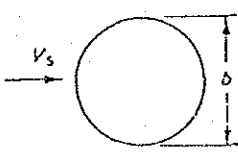
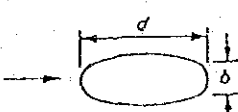
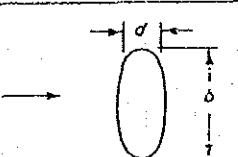
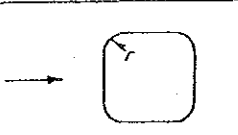
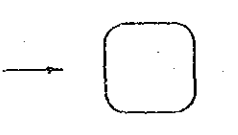
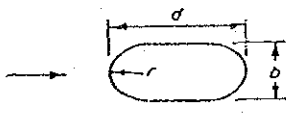
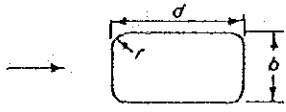
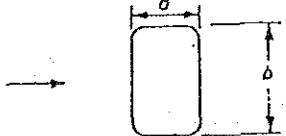
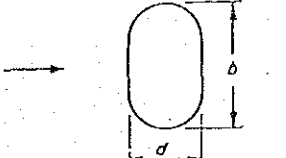
Frictional drag should be calculated using the coefficients given in clause 11.4.4.4

C_p for individual cladding panels should be taken as ± 2.0 .

For monopitch canopies the centre of pressure should be taken as acting at 0.25 of the span from the windward edge. For double pitch canopies the centre of pressure should be taken as acting at the mid-point of each slope.

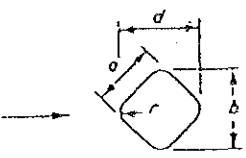
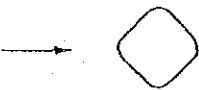
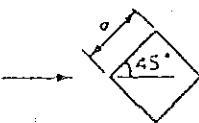
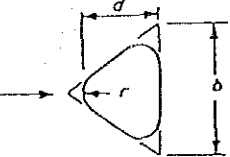
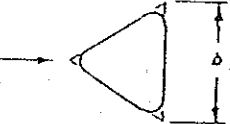
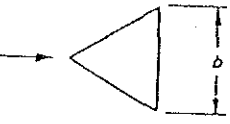
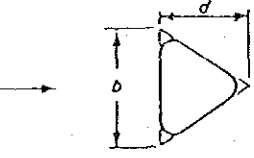

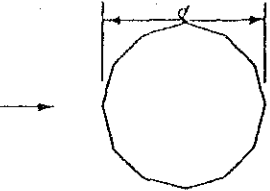
TABLE 11.13

Force coefficients C_f for clad buildings of uniform section
(acting in the direction of the wind)

Plan shape	$V_s b^*$	C_f for belght/breadth ratio:							
		Up to $\frac{1}{4}$	1	2	5	10	20	∞	
	All surfaces $m^2/s < 6$	0.7	0.7	0.7	0.8	0.9	1.0	1.2	
	Rough or with projections ≥ 6								
See also Appendix G	Smooth ≥ 6	0.5	0.5	0.5	0.5	0.5	0.6	0.6	
	Ellipse $b/d = 1/2$	< 10	0.5	0.5	0.5	0.5	0.6	0.6	0.7
		≥ 10	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Ellipse $b/d = 2$	< 8	0.8	0.8	0.9	1.0	1.1	1.3	1.7
		≥ 8	0.8	0.8	0.9	1.0	1.1	1.3	1.5
	$b/d = 1$ $r/b = 1/3$	< 4	0.6	0.6	0.6	0.7	0.8	0.8	1.0
		≥ 4	0.4	0.4	0.4	0.4	0.5	0.5	0.5
	$b/d = 1$ $r/b = 1/6$	< 10	0.7	0.8	0.8	0.9	1.0	1.0	1.3
		≥ 10	0.5	0.5	0.5	0.5	0.6	0.6	0.6
	$b/d = 1/2$ $r/b = 1/2$	< 3	0.3	0.3	0.3	0.3	0.3	0.3	0.4
		≥ 3	0.2	0.2	0.2	0.2	0.3	0.3	0.3
	$b/d = 1/2$ $r/b = 1/6$	All values	0.5	0.5	0.5	0.5	0.6	0.6	0.7
	$b/d = 2$ $r/b = 1/12$	All values	0.9	0.9	1.0	1.1	1.2	1.5	1.9
	$b/d = 2$ $r/b = 1/4$	< 6	0.7	0.8	0.8	0.9	1.0	1.2	1.6
		≥ 6	0.5	0.5	0.5	0.5	0.5	0.6	0.6

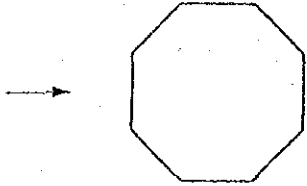
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TABLE 11.13 (Cont'd)

Plan shape	$V_{c,0}^*$	C_f for height/breadth ratio						
		Up to 1	1	2	5	10	20	∞
 $r/a = 1/3$	$m^2/s < 10$	0.8	0.8	0.9	1.0	1.1	1.3	1.5
	≥ 10	0.5	0.5	0.5	0.5	0.5	0.6	0.6
 $r/a = 1/12$	All values	0.9	0.9	0.9	1.1	1.2	1.3	1.6
 $r/a = 1/48$	All values	0.9	0.9	0.9	1.1	1.2	1.3	1.6
 $r/b = 1/4$	< 11	0.7	0.7	0.7	0.8	0.9	1.0	1.2
	≥ 11	0.4	0.4	0.4	0.4	0.5	0.5	0.5
 $r/b = 1/12$	All values	0.8	0.8	0.8	1.0	1.1	1.2	1.4
 $r/b = 1/48$	All values	0.7	0.7	0.8	0.9	1.0	1.1	1.3
 $r/b = 1/4$	< 8	0.7	0.7	0.8	0.9	1.0	1.1	1.3
	≥ 8	0.4	0.4	0.4	0.4	0.5	0.5	0.5
 $1/48 < r/b < 1/12$	All values	1.2	1.2	1.2	1.4	1.6	1.7	2.1
 12-sided polygon	< 12	0.7	0.7	0.8	0.9	1.0	1.1	1.3
	≥ 12	0.7	0.7	0.7	0.7	0.8	0.9	1.1

Cont'd.....

TABLE 11.13 (Cont'd)

Plan shape	V, b^*	C_f for height/breadth ratio						
		Up to $\frac{1}{2}$	1	2	5	10	20	∞
	<p>m/s</p> <p>All values</p>	1.0	1.0	1.1	1.2	1.2	1.3	1.4

*For chimneys see DD . . . †.

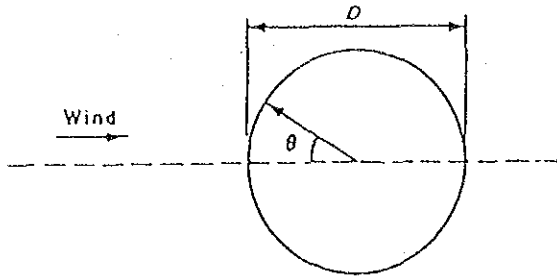
Where strakes are used, b may be taken as the breadth over the strakes. Structures that, because of their size and the design wind velocity, are in the supercritical flow regime may need further calculation to ensure that the greatest loads do not occur at some wind speed below the maximum when the flow will be subcritical.

The coefficients are for buildings without projections, except where otherwise shown.

In this table V, b is used as an indication of the airflow regime.

TABLE 11.14

Pressure distribution around cylindrical structures



Position on periphery θ	Pressure coefficient C_{pe}			
	Surface: rough or with projections		Surface: smooth	
degrees	$h/D = 10$	$h/D \geq 2.5$	$h/D = 10$	$h/D \geq 2.5$
0	+1.0	+1.0	+1.0	+1.0
10	+0.9	+0.9	+0.9	+0.9
20	+0.7	+0.7	+0.7	+0.7
30	+0.4	+0.4	+0.35	+0.35
40	0	0	0	0
50	-0.5	-0.4	-0.7	-0.5
60	-0.95	-0.8	-1.2	-1.05
70	-1.25	-1.1	-1.4	-1.25
80	-1.2	-1.05	-1.45	-1.3
90	-1.0	-0.85	-1.4	-1.2
100	-0.8	-0.65	-1.1	-0.85
120	-0.5	-0.35	-0.6	-0.4
140	-0.4	-0.3	-0.35	-0.25
160	-0.4	-0.3	-0.35	-0.25
180	-0.4	-0.3	-0.35	-0.25

For the purpose of calculating the wind forces that act in such a way as to deform a cylindrical structure the values of C_{pe} in table 15 may be used. They apply only in supercritical flow (i.e. they should only be used where $D > 0.3$ m). They may be used for wind blowing normal to the axis of cylinders having their axis normal to the ground plane (i.e. chimneys, silos) and to cylinders having their axis parallel with the ground plane (i.e. horizontal tanks) provided that the clearance between the tank and the ground is not less than D .

h is the height of a vertical cylinder or length of a horizontal cylinder. Where there is a free flow of air around both ends, h is to be taken as half the length when calculating h/D . Interpolation may be used for intermediate values of h/D .

In the calculation of the load on the periphery of the cylinder, the value of C_{pi} shall be taken into account.

For open ended cylinders where $h/D \geq 0.3$ C_{pi} may be taken as -0.8 .

For open ended cylinders where $h/D < 0.3$ C_{pi} may be taken as -0.5 .

11.4.4.2 Pressure Coefficients

Pressure coefficients are always given for a particular surface or part of the surface of a building. The area of that surface or part of the surface when multiplied by the pressure coefficient and the dynamic pressure q gives the wind load acting in a direction normal to that particular surface or part thereof. The total wind load on a building can then be obtained by vectorial summation of the loads acting on each of the surfaces or parts of the surfaces of the building.

Average values of the pressure coefficients are given in the Tables for critical wind directions in one or more quadrants. In order to determine the maximum wind load on the building the total load should be calculated for each of the critical directions shown from all quadrants.

Where considerable variation of pressure occurs over a surface, it has been subdivided and mean pressure coefficients given for each of its several parts.

In addition, areas of high local suction frequently occurring near the edges of walls and roofs are separately shown. Coefficients for local effects should only be used to calculate the loads on these local areas. They should not be used for calculating the load on entire structural elements such as roof, walls or the structure as a whole.

NOTE: For the design of cladding or its fixings to a structural member, Class A should be used with the pressure coefficient applicable to the particular area in which the cladding lies.

For the design of a structural member carrying the cladding, Class B or C should be used with the pressure coefficient applicable to the area in which member lies. In considering the design against high local pressures of the structural member carrying the cladding, the secondary effects such as distribution due to the stiffness of the cladding should be taken into account.

For main structural members the design should be Class B or C using the normal coefficients for the whole area.

When calculating the wind load on individual structural elements such as roofs and walls, and individual cladding units and their fixings, it is essential to take account of the pressure difference between opposite faces of such elements or units. For clad structures it is therefore necessary to know the internal pressure as well as the external pressure. The following distinguishing pressure coefficients are therefore used:

1. external pressure coefficient C_{pe}
2. internal pressure coefficient C_{pi}

The load F acting in a direction normal to the individual structural element or cladding unit therefore is $F = (C_{pe} - C_{pi}) qA^*$

where A is the surface area of the structural elements or cladding unit. A negative value of F indicates that the resultant force is outwards. Values of C_{pe} are given in Tables 11.6. to 11.14. and a method of assessing the values of C_{pi} is given in clause 11.4.4.5.

11.4.4.3 Force Coefficients

Force coefficients, when given, apply to a building or structure as a whole, and when multiplied by the effective frontal area A_e of the building or structure and by the dynamic pressure q give the total wind load on that particular building or structure thus:

$$F = C_f q A_e^*$$

where F is the force acting in a direction specified in the Tables and C_f is the force coefficient for the building.

It should be noted that the value of the force coefficient differs for the wind acting on different faces of a building or structure. In order to determine the critical load, the total wind load should be calculated for each wind direction.

If the wind load is calculated by dividing the area into parts, the value of C_f applied to each

part should be that for the building as a whole.

11.4.4.4 Frictional Drag

In certain buildings of special shape a force due to frictional drag should be taken in addition to those loads calculated from Tables 11.6 and 11.7. For rectangular clad buildings this addition is necessary only where the ratio d/h or d/b is greater than 4. The frictional drag F' in the direction of the wind is given by the following:

$$\text{If } h < b. \quad F' = C'_f q b (d-4h) + C'_f q 2h(d-4h), \text{ or}$$

$$\text{If } h > b. \quad F' = C'_f q b (d-4b) + C'_f q 2h(d-4b)$$

The first term in each case gives the drag on the roof and the second the drag on the walls. The terms are given separately to allow for the use of different values of C'_f and q on the different surfaces.

*The design wind speed and therefore q depends on S which varies with height.

$$C'_f = 0.01 \text{ for smooth surfaces without corrugations or ribs across the wind direction.}$$

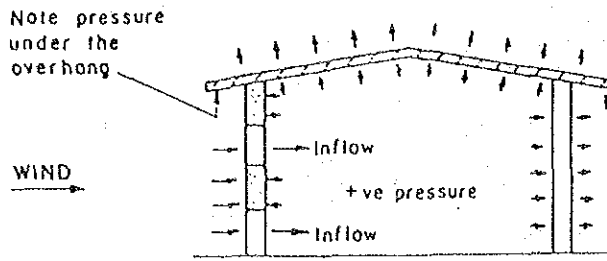
$$C'_f = 0.02 \text{ for surfaces with corrugations across the wind direction.}$$

$$C'_f = 0.04 \text{ for surfaces with ribs across the wind direction.}$$

For other buildings the frictional drag will be indicated, where necessary, in the Tables of pressure coefficients and force coefficients.

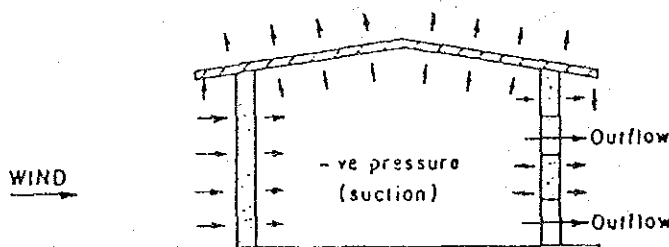
11.4.4.5 Estimation of Internal Pressure Coefficients

The total wind force on a wall or roof depends on the difference of pressure between the outer and inner faces. Open doors, windows or ventilators on the windward side of a building will increase air pressure inside the building and this will increase the loading on those points of the roof and walls that are subjected to external suction and may affect the pressure on floors.



Internal pressure coefficient (1)

Conversely, openings at positions that are experiencing external suction will reduce the pressure inside the buildings thus increasing total loads on a windward wall, as shown in Fig. below:



Internal pressure coefficient (2)

In practice, conditions are generally not so simple. Most buildings have some permeability on each face, through windows, ventilation louvres, leakage gaps around doors and windows and to some extent through the cladding itself; and if there are chimneys, these can provide a low-resistance path for air flow. Permeability in this context is measured by the total area of such openings in a face. The problem is to determine the resulting internal balance of all the contributing leakage points for all critical wind directions, and, for design purposes, to assess the worst possible combination of external and internal pressures that may be developed on each wall or roof unit.

The following examples indicate approximately the values of C_{pi} that apply to a building with a reasonably open interior plan and are to be applied

to the same values of q as the building in which they occur. If the interior is divided by relatively impermeable partitions the pressure difference between windward and leeward faces of the building will be broken down in steps, and will impose loads on the partitions.

- | | | |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| (1) | Two opposite faces equally permeable;
other faces impermeable | C_{pi} |
| | a. wind normal to permeable face | +0.2 |
| | b. wind normal to impermeable face | -0.3 |
| (2) | Four faces equally permeable | -0.3 |
| (3) | With equal permeability on all faces except for a dominant opening on one or other face, of size and position as follow: | |
| | a. on windward face, making the permeability of the windward face equal to the following proportions of the total distributed permeability of all the faces subject to suction. | |
| | Proportion 1 | +0.1 |
| | Proportion 1 1/2 | +0.3 |
| | Proportion 2 | +0.5 |
| | Proportion 3 or more | +0.6 |
| | b. on leeward face: any dominant opening | -0.3 |
| | c. on a face parallel to the wind | |
| | (i) any dominant opening not in an area of high local C_{pe} | -0.4 |
| | (ii) in an area of high local C_{pe} :
if the area of the opening equals the following proportion of the total other distributed permeability of all the external faces subject to suction: | |
| | 1/4 or less | -0.4 |
| | 1/2 | -0.5 |
| | 3/4 | -0.6 |
| | 1 | -0.7 |
| | 1 1/2 | -0.8 |
| | 3 or more | -0.9 |

The distributed permeability should be assessed in each case as accurately as is practicable. As a guide it can be said that

the typical permeability of a house or office block with all windows nominally closed is in the range of 0.01% to 0.05% of the face area, depending on the degree of draughtproofing.

Where it is not possible, or is not considered justified, to estimate the value of C_{pi} for a particular case, the coefficient should be based on one of the following paragraphs for any determination of wall or roof loading.

- (1) where there is only a negligible probability of a dominant opening occurring during a severe storm, C_{pi} should be taken as the more onerous of +0.2 and -0.3.
- (2) for situations where a dominant opening is likely to occur, C_{pi} should be taken as 75% of the value of C_{pe} outside the opening. The extreme conditions should be determined for the various wind directions that give rise to critical loadings and it should be noted that especially severe internal pressures may be developed if a dominant opening is located in a region of high local external pressure.

There is a further complication in a wall or roof element that comprises several layers. For example, a roof may be boarded and felted and covered with tiles. The pressure difference between outside and inside will then be broken down into steps, across each layer; these steps will depend on the relative permeability of the various layers and the access of air to the spaces between them. Each case needs careful study to ensure that the whole of the wind load is not accidentally transferred to a single membrane such as a thin metal sheet that may not be designed to carry it.

Control of Internal Pressure: The value of C_{pi} can sometimes be limited or controlled to advantage by the deliberate distribution of permeability in the walls and roof or by the deliberate provision of a venting device that can serve as a dominant opening at a position having a suitable external pressure coefficient. An example of such an application is a ridge ventilator on a low pitch roof which, under all directions of

wind, will reduce the uplift force on the roof.

11.5 SEISMIC LOADS

11.5.1 General

Every building or structure and every portion thereof shall be designed and constructed to resist stresses produced by lateral forces as provided in this section. Stresses shall be calculated as the effect of a force applied horizontally at each floor or roof level above the base. The force shall be assumed to come from any horizontal direction.

Structural concepts other than set forth in this section may be approved by the building official when evidence is submitted showing that equivalent ductility and energy absorption are provided.

Where prescribed wind loads produce higher stresses, such loads shall be used in lieu of the loads resulting from earthquake forces.

11.5.2 Symbols and Notations

The following symbols and notations apply only to the provisions of this section:

C = numerical coefficient as specified in subsection 11.5.3.

C_p = numerical coefficient as set forth in Table 11.15.

D = the dimension of the structure, in m (ft), in a direction parallel to the applied forces.

F_i, F_n, F_x = lateral force applied to level i , n or x , respectively.

F_p = lateral force on a part of the structure and in the direction under consideration.

F_t = that portion of V considered concentrated at the top of the structure in addition to F_n .

h_i, h_n, h_x = height in m (ft) above the base to level i , n or x respectively.

I = occupancy importance factor as set forth in Table 11.17

K = numerical coefficient as set forth in Table 11.15.

Level i

l = l level of structure referred to by the subscript i

i = l designates the first level above the base.

Level n = that level which is uppermost in the main portion of the structure.

Level x = that level which is under design consideration.

x = l designates the first level above the base.

N = the total number of stories above the base to level n .

S = numerical coefficient for site-structure resonance.

T = fundamental elastic period of vibration of the building or structure in seconds in the direction under consideration.

T_s = characteristic site period.

V = the total lateral force or shear at the base.

W = the total dead load including the partition loading where applicable.

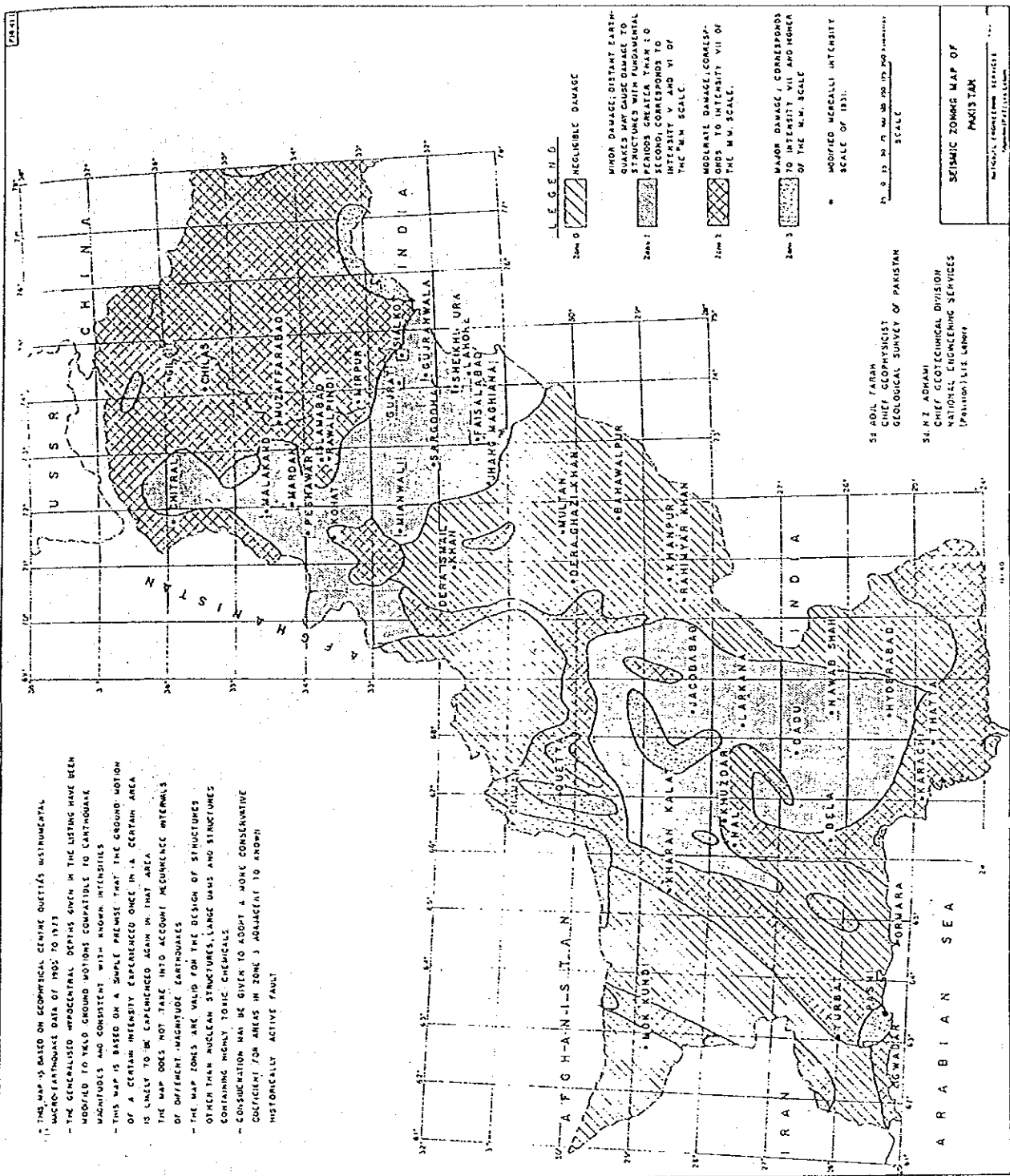
EXCEPTION: W shall be equal to the total dead load plus 25 percent of the floor live load in storage and warehouse occupancies. Where the design snow load is 1.44 kN/sq.m (30 lbs/sq.ft) or less, no part need be included in the value of W . Where the snow load is greater than 1.44 kN/sq.m (30 lb/sq.ft), the snow load shall be included; however, where the snow load duration warrants, the building official may allow the snow load to be reduced upto 75 percent.

w_y, w_x = That portion of W which is located at or is assigned to level i or x respectively.

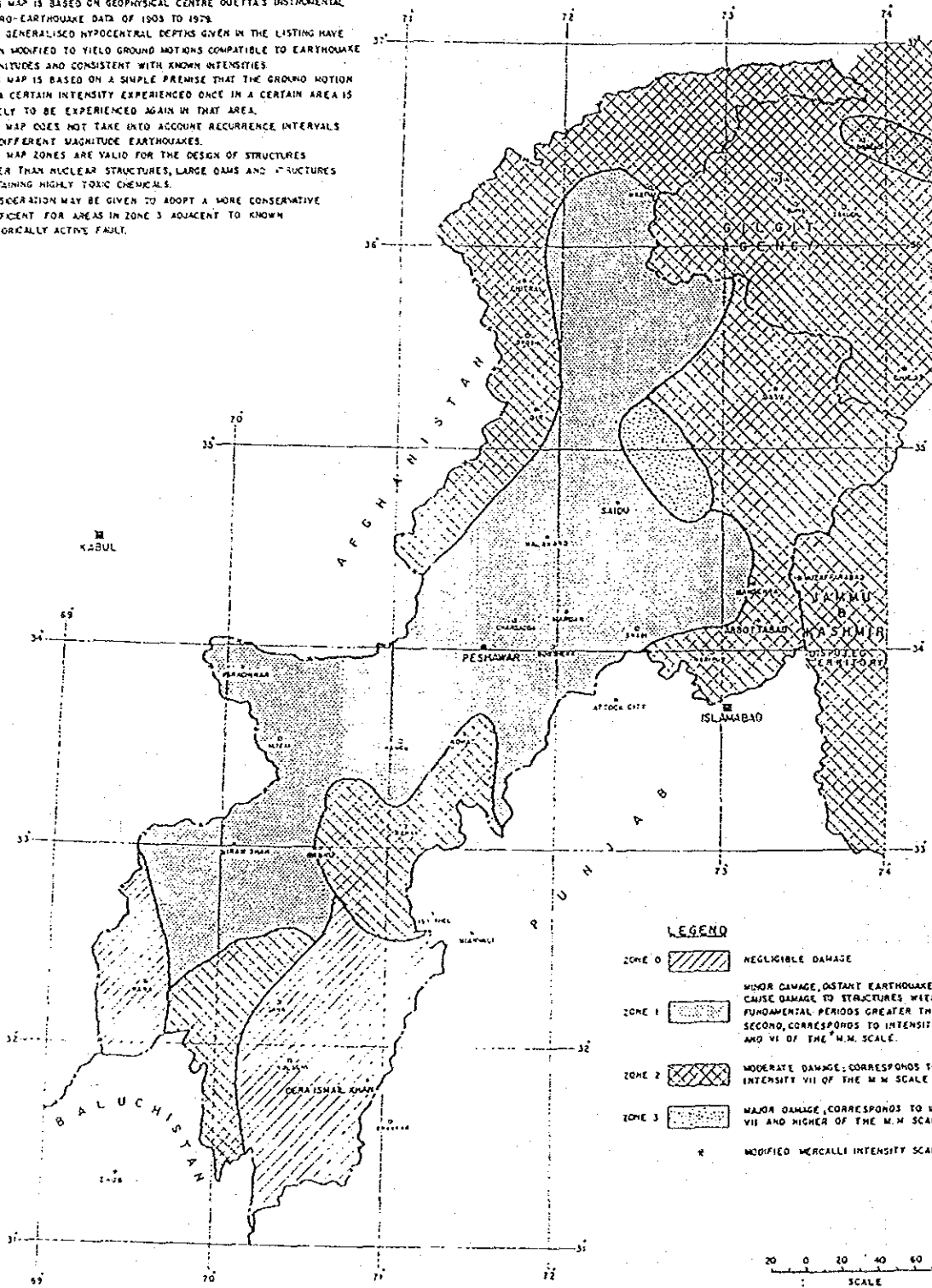
w_p = The weight of a portion of a structure or nonstructural component.

Z = Numerical coefficient dependent upon the zone as determined by Figs. 11.1 to 11.5. For locations in Zone No. 0, $Z = 3/32$. For locations in Zone No. 1, $Z = 3/16$. For locations in Zone No. 2, $Z = 3/8$. For locations in Zone No. 3, $Z = 3/4$. For locations very close to known active faults, $Z = 1$.

- THIS MAP IS BASED ON GEOPHYSICAL GEMING QUETTA'S INSTRUMENTAL MACROEARTHQUAKE DATA OF 1905 TO 1973
- THE GENERALISED HYPOCENTRAL DEPTHS GIVEN IN THE LISTING HAVE BEEN MODIFIED TO YIELD GROUND MOTIONS COMPATIBLE TO EARTHQUAKE MAGNITUDES AND CONSISTENT WITH KNOWN INTENSITIES
- THIS MAP IS BASED ON A SIMPLE PREMISE THAT THE GROUND MOTION OF A CERTAIN INTENSITY EXPERIENCED ONCE IN A CERTAIN AREA IS LIKELY TO BE EXPERIENCED AGAIN IN THAT AREA
- THE MAP DOES NOT TAKE INTO ACCOUNT OCCURRENCE INTERVALS OF DIFFERENT MAGNITUDE EARTHQUAKES
- THE MAP ZONES ARE VALID FOR THE DESIGN OF STRUCTURES OTHER THAN NUCLEAR STRUCTURES, LARGE DAMS AND STRUCTURES CONTAINING HIGHLY TOXIC CHEMICALS
- CONSIDERATION MAY BE GIVEN TO ADOPT A MORE CONSERVATIVE COEFFICIENT FOR AREAS IN ZONE 3 ADJACENT TO KNOWN HISTORICALLY ACTIVE FAULT

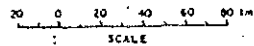


- THIS MAP IS BASED ON GEOPHYSICAL CENTRE QUETTA'S INSTRUMENTAL MACRO-EARTHQUAKE DATA OF 1903 TO 1978.
- THE GENERALISED HYPOCENTRAL DEPTHS GIVEN IN THE LISTING HAVE BEEN MODIFIED TO YIELD GROUND MOTIONS COMPATIBLE TO EARTHQUAKE MAGNITUDES AND CONSISTENT WITH KNOWN INTENSITIES.
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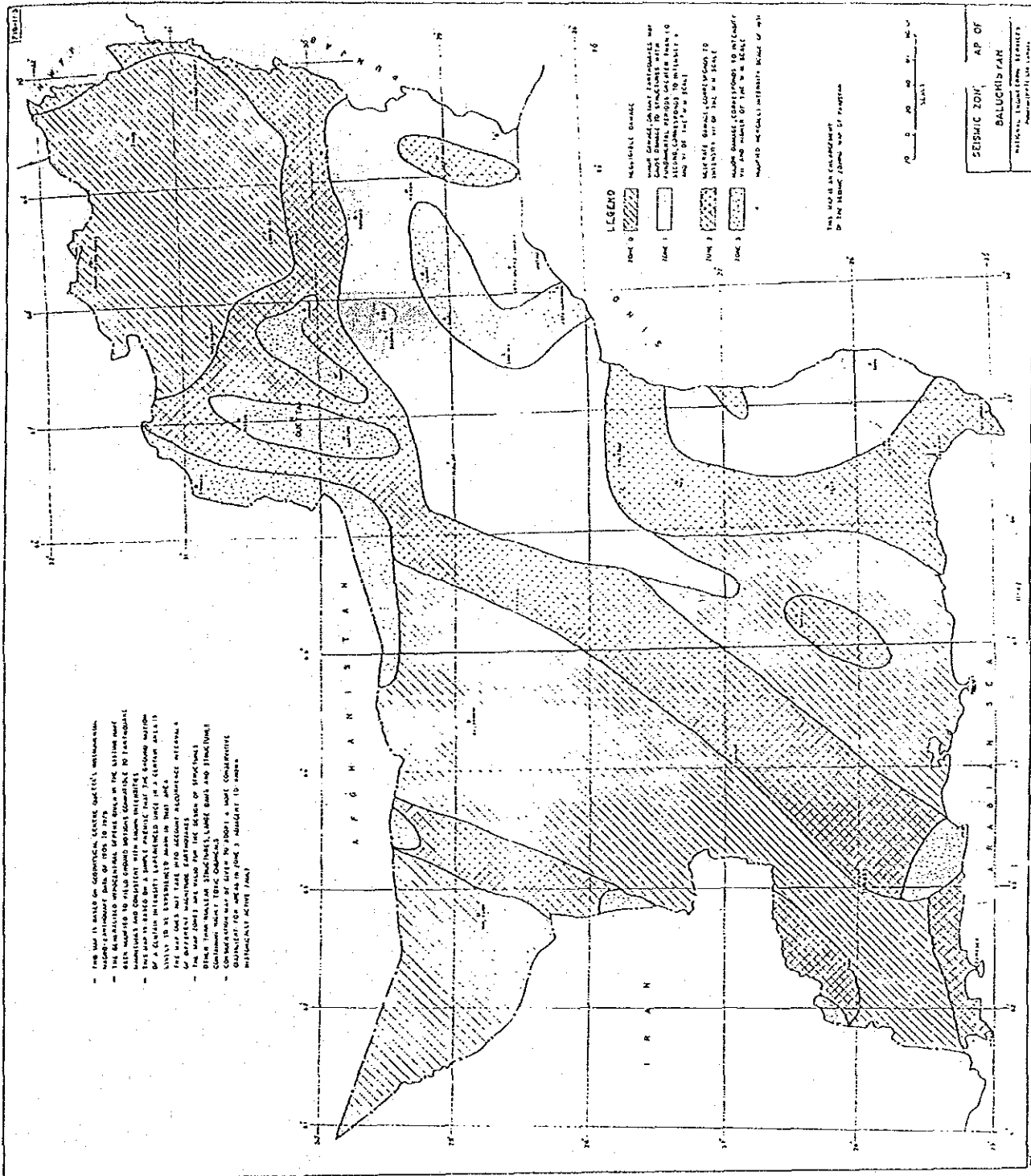
LEGEND

- ZONE 0 NEGLIGIBLE DAMAGE
 - ZONE 1 MINOR DAMAGE, OASTANT EARTHQUAKES MAY CAUSE DAMAGE TO STRUCTURES WITH FUNDAMENTAL PERIODS GREATER THAN 1.0 SECOND, CORRESPONDS TO INTENSITY V, AND VI OF THE M.M. SCALE.
 - ZONE 2 MODERATE DAMAGE, CORRESPONDS TO INTENSITY VII OF THE M.M. SCALE.
 - ZONE 3 MAJOR DAMAGE, CORRESPONDS TO INTENSITY VII AND HIGHER OF THE M.M. SCALE.
- * MODIFIED MERCALLI INTENSITY SCALE OF 1931



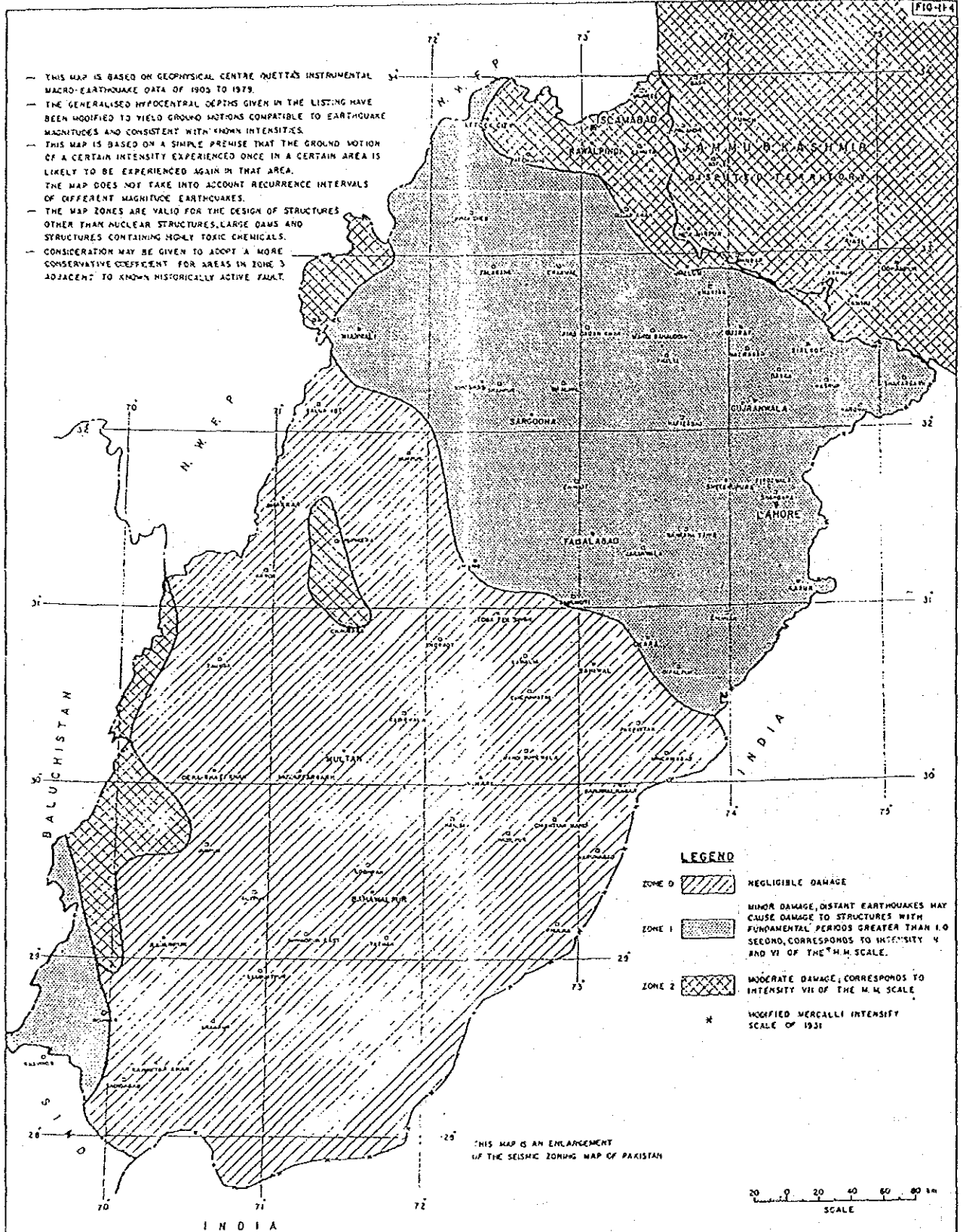
THIS MAP IS AN ENLARGEMENT OF THE SEISMIC ZONING MAP OF PAKISTAN

SEISMIC ZONING MAP OF
N. W. F. P.
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 PAKISTAN (PVT) LTD. LAHORE



- This map is based on geological, seismic, and tectonic data available up to 1975.
 - The boundaries shown are approximate and are subject to change as more data becomes available.
 - The map is based on the work of various geologists and geophysicists.
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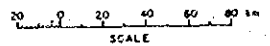
- THIS MAP IS BASED ON GEOPHYSICAL CENTRE (NETTA'S INSTRUMENTAL MACRO-EARTHQUAKE DATA OF 1903 TO 1979.
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LEGEND

- ZONE 0 NEGLIGIBLE DAMAGE
- ZONE 1 MINOR DAMAGE, DISTANT EARTHQUAKES MAY CAUSE DAMAGE TO STRUCTURES WITH FUNDAMENTAL PERIODS GREATER THAN 1.0 SECOND, CORRESPONDS TO INTENSITY V AND VI OF THE M.M. SCALE.
- ZONE 2 MODERATE DAMAGE, CORRESPONDS TO INTENSITY VII OF THE M.M. SCALE
- MODIFIED MERCALLI INTENSITY SCALE OF 1931

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