Introductory Remarks: A bridge may be defined as a structure spanning rivers, marshes, declivities etc., and providing a passage-way for pedestrian and wheeled traffic. The first man-made bridge was probably a tree trunk or flat stone laid across a stream, but we can only speculate on such beginning. What we know for certain is that from the earliest times three prominent types of bridges familiar to us have been beam-bridges, suspension bridges and arch bridges. These three types have been varied or combined to assist each other in the same structure. Thus in their simplest form beam bridges are called simple spans, but quite often two or more of these spans are joined together over the piers to make them continuous. Two important variations of beam bridges are cantilever and boat bridges. In a cantilever bridge successive layers of beams are piled upon one another in such manner that each upper layer juts out slightly over the layer immediately below it. At the top, therefore, only a small space remains to be covered with a beam. The boat bridges are basically beam type sustaining on floating supports. The idea may have originated through the lashing together of a few boats to maintain a river crossing, either to meet a special need or when the stream had dwindled in the dry season and was narrow. Suspension
bridges were usually built to span narrow gorges by stretching a rope or such material across the gorge and tying it to tree trunks on either side. Arch bridges used the technique of making curved formations in bricks or stones with the help of a reliable binding material such as gypsum or lime mortor. This peculiar formation was obtained with the help of voussoirs which were tapered or wedge-shaped stones; quite a sizeable portion of the weight of this superstructure resting on piers was transferred to the end points known as abutments.¹

As it would be shown in the ensuing discussion the beam bridges in their various forms as well as suspension bridges were known in India from ancient times, but the arch bridges were introduced here only after the 'lurkish conquest, the earliest surviving specimen being a bridge built on the river Gambhir below Chittor during the reign of Alauddin Khalji.² It is interesting to note that with the passage of time bridges in India came to acquire a categorization which was dictated by the material of construction rather than being based on the principles of engineering

¹ Cf. Shirley Smith, 1-3.
² See B, No. 16 for the description of this bridge.
involved. Depending upon the availability of the different types of materials used in the construction of bridges, each one of these categories also came to flourish in particular regions and topographical settings. Thus the cantilever bridges needing mostly wood for their construction flourished in Kashmir and other hilly areas where suitable timber for their construction was abundant. At the same time boat bridges built on the same principle, which were used as an immediate device for crossing large rivers in the plains, came to represent a distinct category. Similarly masonry bridges were accepted as another category notwithstanding the fact that besides a large number of arch constructions these also included a few that were built exclusively on the trabeate technique. But one must note here that an arched bridge would only be a masonry bridge and that from the thirteenth century onwards a majority of masonry bridges built in India were arched bridges. This circumstance would justify the treatment of masonry bridges as a distinct category from the point of view of the material used in their construction.

Here it is intended to give a detailed account of the various categories of bridges extant in the Mughal period, namely Suspension Bridges, Wooden Bridges, Boat Bridges and Masonry Bridges, and also to trace the different stages of the development of their construction.
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technique. This part of the thesis is therefore arranged under two sub-heads viz. 'A' and 'B'. This division is on the similar pattern as we have seen in the first part of this thesis dealing with the sarais. The sub-head A here contains a general discussion on the various types of bridges reportedly existing in the Mughal period. In the other sub-head B I have arranged the descriptions of ten masonry bridges which were surveyed by us. These bridges have reportedly survived from the Mughal period. Notably some of them were even built in the period prior to the establishment of the Mughal rule in India. One of these structures has been recorded to have been built in the pre-Turkish period. Yet all these structures were extant in the Mughal period and have survived even to the present day. Along with the descriptions I have also given detailed measurements of all these bridges.

But before we begin with the descriptions of major types of bridges surviving in the Mughal period we must state that there does not survive much evidence on bridge-building prior to Turkish invasion. One may, however, surmise that in the absence of a true arch before coming of the lurks, larger spans could not be easily covered by masonry bridges. As is well known,
the use of the arches with voussoirs, and the use of lime mortar as the binding material by the Turks in the thirteenth century revolutionized the construction technology in masonry. The incorporation of this new technique in the bridges built after the Turkish conquest distinguished them in their conception as well as design from the earlier specimens. Invariably now the spans of a bridge were covered by arches, giving a greater flexibility to the architects in the use of building material and in the location of sites. Still the number of bridges built during the Sultanate period is very small. Perhaps the necessary impetus for a wider application of the new technique of bridge-building was not forthcoming during this period. The two major factors promoting bridge-building activity during the Sultanate period were still probably the considerations of philanthropy and an unhindered march of the imperial entourage along the highways. Apparently as yet there did not exist any appreciable economic motivation for bridge building.

The beginning of the sixteenth century then seems to mark the beginning of a new trend in this respect. Under the impact of a growing process of monetization, which became prominent from the second half of the sixteenth century, it is conceivable that trade and commerce al
over the sub-continent received great impetus. There was apparently a sizeable increase in the movement of men and goods, especially on land, and the roads had now begun to cater to a larger volume of traffic comprising pack-animals and wheeled carts besides the foot-traveller. There also survives some evidence to suggest an anxiety on the part of the Mughal rulers to improve the logistics of the frontier regions and trouble prone areas by providing a secure line of communication connecting the heartland of the empire with these regions. As the major arteries of land communication in Mughal India radiated from the capital cities of Agra and Delhi and

1 For a detailed discussion on the intensification of long distance and local commerce in the Mughal empire see Agrarian System op. cit., Ch. II.

2 The following evidence may be cited in support of this contention:

a. Munim Khan endeavoured to provide bridges on rivers at the points of strategic importance in the east during his governorship at Jaunpur to strengthen communication in the trouble prone eastern sector at this time (Cf. Iqtidar Alam Khan, The Political Biography of a Mughal Noble: Munim Khan Khan-i Khanan, A. Delhi, 1973, 120-21).

b. The Kabul-Lahore highway did not possess a masonry bridge till the early years of Shahjahan's reign. The construction of several masonry bridges on this route in the earlier half of Shahjahan's reign may then be ascribed to the mounting Mughal offensive in Balkh and Badakhshshan during this period. (For details of these bridges see infra)

c. The Margla pass was improved during Aurangazeb's reign to secure communication across this region (Cf. Mohan Lal, 65, 339-40; Indian Antiquary, ed. J. Burgess, 1874, III, 205-265.)
connected with the farthest points in the empire, a large number of new masonry bridges sprang up on these trunk-routes. Some of the masonry structures surviving from the earlier period were at the same time restored to the use of traffic.

Throughout the medieval period the major rivers of large spans in the Panjab as well as in the Gangetic valley were without masonry bridges. The most common device used for crossing these rivers by common travellers were boats, sometimes plying as ferry service on important rivers. Often the travellers resorted to a crossing of these rivers at the points where they were easily fordable. But during an army expedition these rivers were spanned with pontoon bridges which were usually temporary structures raised for the immediate use of the troops and dismantled soon after. There are also a few references suggesting the existence of bridges of boats as points of access to important towns situated on large rivers. Similarly we also have evidence suggesting the existence and use of wooden and suspension bridges, mainly in the hilly tracts. The sub-head A is therefore divided in the following four sections. The specific evidence surviving from the Mughal period on each one of the above four categories of bridges is analysed separately for discerning the techniques used in their construction. In this analysis, as already stated, attention shall also be paid to the development or absence of any particular
feature in the basic techniques and skills available for constructing bridges. Here we propose to arrange separate sections dealing with individual categories in order of their relative significance; beginning with the least important the arrangement is as follows:

I Suspension Bridges, II Wooden Bridges, III Bridges and of Boats, IV Masonry Bridges. The sub-head B, as has been said earlier, gives the description and measurements of some masonry bridges surveyed by us. Investigation on these lines is undertaken with an aim at locating the specific features of design development and the evolution of the technique of construction during the Mughal period. In the end it is attempted to measure the technical viability of the Mughal masonry bridges by comparing their design and architecture with those built contemporaneously in Europe. This would help us in testing the validity of the observation made by some of the British engineers and archaeologists of the nineteenth century regarding the defects of Mughal bridges which according to them continued down to the end of eighteenth century. There are three appendices attached at the end of various sections in A. The appendix 1 quotes a letter suggesting improvements in the bridge of boats on Jamuna at Delhi. The letter is addressed to the Commissioner of the Delhi Division by the Secretary to the Government of the North Western Provinces and is datelined at 22 June, 1842. It
is preserved in the Central Record Office, U.P., Allahabad. The appendix 2 records in a tabular form the measurements of twenty medieval bridges, gleaned from different sources while appendix 3 reproduces a correspondence dating between 1815-1842, regarding the Jajau ka Pul located near Agra on river Utangan, which is also preserved in the Central Record Office, Allahabad. At the end of B there is the appendix 4 containing detailed notices of all the masonry bridges found extant during the Mughal period. Since the masonry bridges represent the core of the surviving specimen chosen for this study we have given detailed notices to these structures and compiled all the available information regarding them at one place. This in effect forms a directory of the extant masonry bridges of the Mughal period, some of which undoubtedly may have survived from an earlier period. It should be stated here that the specific information furnished in B as well as that pieced together in appendices 2 & 4 has been used in the discussion of the masonry bridges in section IV.
Suspension Bridges: The suspension bridges are perhaps the simplest of all the primitive types of bridges. These were commonly found in difficult mountainous terrain where the rivers flow in deep gorges and it is a very difficult task to construct other types of bridges. In their simpler forms suspension bridges consisted of three cables, two on either side acting as handrails and a third, possibly the stouter one, on which the passenger walked. The cables were made up of a variety of materials such as creepers, oxhide, ropes and in a later period even iron. In construction, writes Shirley-Smith, 'the cables are towed or floated across the river, hauled up and anchored to posts set in the ground, or are tied round large trees'.

We have mainly three references giving details of the method of construction used in such bridges. These relate to the region of Krshtwar in Kashmir, the

1 Shirley-Smith, 9
Assam and the Srinagar-Baarinath section of the Tibet route. The first of these comes from Jahangir, who has described the technique of making rope bridges in Krshtwar between the rivers Marau and Chinab, which is a distance of two bow-shots, and on the bank of the Chenab there is a lofty hill. He writes that in this region 'The crossing of the water is a difficult matter, and, with a view to the coming and going of people on foot, they attach strong ropes, and place planks of the width of a cubit (0.45 m to 0.55 m) between two ropes, and fasten one rope's end to the top of the hill, and the other on the other side of the water. Then they attach two other ropes, a gaz (0.80 m, approximately) higher than these, that foot-passengers may place their feet on the planks, and taking hold of the upper ropes, may descend from the top of the hill to the bottom, and so cross the river'. The technique detailed by Jahangir seems to have been continued in the construction of similar bridges in this region for a very long time. In a

1 See Habib, Atlas, 31, b who cites Antonio de Andrade, 47-63, and Azvedo, 95-6 in Wessels, Early Jesuit Travellers for the route between Srinagar and Chaparang in Tibet during the seventeenth century.

2 T J, II, tr., 137.

3 T J, II, tr. 137; Maathir-ul Umra, I, tr., 489.
nineteenth century travel account relating to this region, we find descriptions of suspension bridges built on almost the same pattern. Some of them, however, incorporated slight modifications in the design so that a sliding cabin, in a crude form of course, was introduced. For the travellers this obviated the necessity of walking over the bridge. The account of these bridges is given below:

'These suspension-bridges are of two kinds; one such as that at Dodah, is thus composed: a strong cable is tightly stretched across from one side of the river to the other, and fixed firmly in the rock at both ends. Upon this slides a wooden framework, somewhat resembling the seat of a swing; to this are attached other ropes, by which it is pulled backwards and forwards across the river. The other kind is walked over. A very thick cable, composed of several others, of twisted birch twigs, is suspended from one side to the other; this forms a narrow support to the feet of the passenger, being not more than seven or eight inches in width; but being roughly woven, the projecting ends of the twigs prevent the foot from slipping. On either side of this, about four feet above it, and so wide apart that a person stepping on the large cable can hold one in either hand, is suspended another rope of the same material, and these two
again are connected with the large cable by side ropes, fastened at regular intervals of about a yard'.

Similar bridges seem to have been noticed by travellers as in use by pilgrims on Srinagar-Badrinath route during the seventeenth century.²

In a slightly later reference from Alamgir Nama and pertaining to the Assam campaign undertaken by Mir Jumla in 1661, there is mention of the use of iron chains as the cables of a suspension bridge. The chronicler, Muhammad Kazim records them 'in Assam the rivers are fast but narrow. Instead of bridge, there is an iron chain, the ends of which are tied to the stones on both sides of the river. Another chain at the height of a man is placed above the earlier one. Foot is rested on lower chain while the upper one is held in the hands - thus pass men over this bridge across the river'.³ He further adds that the horses and other articles were also carried over the bridge across the river.⁴

4. Ibid.
Wooden Bridges: Wooden bridges are essentially structures built in wood, though sometimes the piers or supports for the superstructure were built in masonry. That then wooden bridges should flourish in the regions where the supply of superior quality wood was abundant is understandable. During the Mughal period most of the structures belonging to this type were built in the region of Kashmir. Deodar, a very fine quality wood available in plenty in Kashmir, was used as the building material for these bridges. There are numerous references in our sources to the existence of wooden bridges in Kashmir. Akbarnama records that in the Kashmiri language these bridges were called Kadal, and there were many of this type spanning streams all around the valley of Kashmir.¹

In a similar notice Lahori states that there were ten such bridges over the river Bihat (Jhelum) in Kashmir valley; their actual locations are, however, not mentioned.²

¹ Cf. AN, III, tr., 822-23, 850. There was one bridge on Kishanganga river, which Akbar crossed in 1589 on his return from Kashmir expedition. In 1619 Jahangir had also taken note of this structure which was '5¾ yards long and 1½ yards wide'. According to his orders 'another bridge was prepared parallel to this, in length 53 yards and breadth 3 yards' (TJ, II, tr., 128).

² Cf. Lahori, I, ii, 23; Habib, Atlas, 7, b. For a similar bridge on Bihat near Soonpur see Firishta, 346.
These wooden bridges were essentially beam bridges, and these could be used for spanning long stretches. The architectural principle used in this formation is called cantilever, which, as already alluded, is essentially a bracket that juts out. 'A cantilever bridge is made up of two such brackets, or arms, which stand on the piers of the bridge and jut out towards each other from opposite sides of the river. Each of them is counter-balanced or tied back to an anchorage behind the pier; the two ends in the middle are joined by a short simple span'. At least for wooden bridges built in the town of Srinagar, we have evidence suggesting the adaptation of cantilever in their construction. Jahangir mentions the existence of four 'stone- and- wooden bridges' in the city of Srinagar and an early nineteenth century travel account describes the technique employed in the construction of these bridges in the following words:

"The same valuable material (Deodar) is employed in the formation of bridges over canals and rivers of the country. Very commonly the breadth of these (canals and rivers) requires merely a platform resting upon haunches; but in many places it is necessary to support the roadway by piers in the stream. In this case the

1 Shirley-Smith, 6.
2 TJ, 298; Bernier, 397-8 says there were two wooden bridges in Srinagar.
piers are formed of four pieces of the trunk of the Wodear, laid at right angles over each other, and leaving in the centre a hollow square of about two feet. Each pier consists of a shaft, a basement, and a capital: the shaft is usually from twenty to twenty-five feet in breadth, the height varies with the depth of the stream. The foundation is constructed on the same principle, but extends beyond the shaft, and presents to the current a pointed extremity: it is also filled with heavy stones to prevent its being carried away. The capital consists of five graduated tiers of beams, crossing the water line, and forming the support of the platform connecting them at top, which is formed of layers of Wodear timbers, crossed and fastened together by pins.¹ The structures of these bridges were so strong that upon one of them in Srinagar, there existed a whole market, the best in the town, with a line of shops built of wood.² A major factor contributing much to the stability of these bridges was the design of their piers. Unlike the solid piers offering great resistance to the flow of water under the bridge, the piers in these structures were of skeleton type - hollow in the middle - and therefore provided a much larger passage, especially during the floods.³

¹ Moorcroft & Trebeck, II, 121-3.
² Ibid., 123.
³ Shirley-Smith, 7.
Other than the region of Kashmir, the wooden bridges, apparently, were not common in the sub-continent. We have only three references to wooden bridges outside Kashmir, two of which belong to Panjab and one to the town of Machhlipatan. Father Monserrate while accompanying Akbar on latter's expedition against Mirza Hakim in 1581 noticed one such bridge near Machhiwara. According to him Akbar had halted on the bank of Sutlej for some time as the 'wooden bridge was being built'. References in Akbarnama to Akbar's crossing Sutlej at Machhiwara by a 'noble bridge' in 1581 and again in 1585 apparently relate to the same structure as described by Monserrate. From this one may infer that this bridge, which even after four years of its construction was in a good enough shape for the entire army to cross the river, was well maintained through regular repairs by the state authority.

It was again in his account of Akbar's journey in 1581 that Monserrate noticed another wooden bridge on the river Beas in Panjab. He writes: 'Fording a small river the army marched for two days along the Bibasis which is now called the Beas, searching for a ford which the elephants could cross and for a narrow place in

1 Monserrate, 103.
2 Anw, III, tr., 509, 546, 706.
the river, where a wooden bridge could be erected. When the scouts found a suitable place for their purposes, the camp was pitched there...the army crossed the Bibasis by a wooden bridge and advanced nearly ten miles, to the neighbourhood of the town of Pachangarum in the district of Peytanum (Pathankot)'.

Apparently this particular bridge was of the same type as the one used by Akbar while crossing the river Kishanganga in Kashmir.

The evidence for the existence of a wooden bridge at Machhlipatan dates back to the second half of seventeenth century. Writing in 1668 about the town of Machhlipatan, Marshall says: 'In winter time this towne for about 6 months is invironed round with water having a Bridge of wood about 6 or 7 yards broad and 1 mile long to passe out of the towne with'.

A few years later, Bowrey, recounting memories of Machhlipatan, wrote: 'This towne is famous also for a bridge that was built at the Charge of one (of) the Kings of Golcondah, who in his Progresse, found the way out of the Country into the towne, for a great space surrounding it, very difficult through the deep mudddle and water, which was no little hinderance to the Merchants, as well as to poore people for the bringeinge in of goods and

1 Monserrate, 104. The exact site of this bridge on Beas could not be located.

2 For the site of this bridge see Habib, Atlas, sheet 3B, 34+, 73+.

provisions &c., which bridge reacheth from the great
gate of Metchlipatam over to Guddorah (practically
part of the town of Masulipatam), which is one English
mile in length and of a considerable breadth, and is
called by the Name of Guddorah bridge'. Since this
bridge provided the lone passageway into the town, a
natural security against an invader from outside could
be provided to the town by removing the bridge from its
place. In fact the account of this bridge as given by
Hamilton clearly suggests that in such an eventuality
the town was protected from the invaders by dividing
the bridge into two sections, one of which possibly
forming the approach near the mainland, could be
collapsed.  

1 Bowrey, 62-3.
2 Hamilton, Pinkerton, 397
Boat Bridges: The history of the bridges made of boats dates back to a very early period as Herodotus describes a bridge of this nature built by Xerxes, the king of Persia, in his expedition against Greece in 481 B.C.\(^1\) In India too, we can imagine, the boat bridges were used from an early period, and from the middle of the fifth century A.D. there is definite evidence for the construction of such bridges on the rivers for effecting passage to the wayfarers.\(^2\) Most of these references, however, are in the form of brief notices suggesting the construction of boat bridges by individual kings or their nobles. They do not provide us with the details of the technique used in their construction. In the period following the Turkish conquest, however, the references to boat bridges become both, more frequent and elaborate. Interestingly all such references during this period relate to major rivers e.g. Indus and five-rivers in Panjab, Jamuna and Ganga in Uttar Pradesh and Bihar and Mahi in Gujarat.

We have recorded earlier that most of the references to pontoon bridges in the medieval chronicles are to those built to enable the imperial troops cross larger rivers.

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1 As cited in Shirley-Smith, 10.
falling in the route of military expeditions. Permanent pontoon bridges on Jamuna at Delhi and Agra during the sixteenth and seventeenth centuries may be cited as the only exceptions to this rule. At both these places bridges were needed across Jamuna so as to provide the incoming traffic from the east, access to the capital towns. This traffic, it may be presumed, would mainly comprise the traders, merchants, troops and state functionaries. But more importantly at both these places the boat bridges also facilitated the movement of the local population across the river. It is suggested by stray references in the chronicles that there were sizeable settlements on the eastern side of the river, both at Delhi as well as at Agra.

The pontoon bridge on Jamuna at Delhi finds only an incidental notice in Bernier. Describing the city of Dehli he writes that it is situated on the 'banks of the Gemma... and built on one bank only in such a manner that it terminates in this place: very much in the form of a crescent, having but one bridge of boats to cross the country.'

In the case of Agra, however, which remained the capital of the Mughal empire throughout the reigns of

1 Bernier, 241.
Akbar and Jahangir, the evidence suggesting the existence of a permanent pontoon bridge is much more convincing. Its existence is implied in the manner it is referred to in Akbar Nama in connection with an incident involving Akbar. It is suggested that in 1561 during a fight between two of Akbar's mighty elephants, Hawai and Han Bagha at the polo ground situated in front of the fort, Hawai personally driven by Akbar chased Han Bagha across the pontoon bridge which was apparently located at a short distance from there. This incident has also been made subject of an interesting miniature in Akbar Nama where the two elephants are shown mounted on the bridge of boats and undergoing severe undulations under the weight of the two elephants. Almost a year later than this incident the bridge again finds mention in connection with Munim Khan's flight from Agra after the mu'addar of Shihabuddin Ahmad by Adham Khan. It is recorded that the bridge was broken by him while fleeing so as to delay his pursuit by the imperial troops. The incident relating Akbar's elephants makes it clear that this bridge of a permanent nature was provided with considerable strength in view of its regular use by the town population.

1 AN, MS, at Victoria & Albert Museum, I.S. No. 117, Plates 21-22.
2 N. Ahmad, Tabaqat-i Akbari, Calcutta, 1913, II, 158-9. Also see Iqtidar Alam Khan, op. cit. 67.
An early reference to the construction of a pontoon bridge for the immediate use of the army troops comes from Babur Nama. It dates back to the year 1528 and relates to Babur's expedition against the Afghans in the east. He had to order building of a bridge of boats at Wannaj on Ganga and even in the wake of a stiff opposition by Afghan insurgents from across the river Babur's raftsman Mir Muhammad succeeded in accomplishing the task within a fortnight. Mir Muhammad was bestowed with dagger in recognition for the excellent bridge he had made over the river Ganga. There are, however, instances in which the bridges of boats had to be made ready for the use of the marching army under emergency conditions within the time space of a day or two. Thus during Akbar's march from Agra to Jaunpur, a bridge of boats on Ganga at Manikpur (Kara) was made ready for the army to cross by in a day's time only. It was perhaps in view of similar emergencies that Humayun had devised certain innovations in the design of boat bridges. The description of this improved design has been given by Khwandmir who writes that one of the works of general welfare was the construction of a movable bridge. It was built of many boats.

1 BN, 599-600.

2 Ibid, 632-3.

3 AN, II, tr., 399.
which were tied with each other in such manner that they could be parted away in the form of a few groups with great ease. These several parts would then sail swiftly along with the Imperial march, and wherever needed would be quickly reassembled to form a bridge for the army to crossover.¹ One major advantage of this device would be that the army shall be saved the difficulty of procuring boats locally for building a bridge. These various parts of the bridge, each one of which comprised several boats, would sail along as long as the march would be taking place by the side of a river.

Since these bridges had utility, the technique employed in their construction was geared to meet these requirements. Thus despite some constraints, special care was taken in their construction on two counts particularly: the site was selected at such a place where sufficient space for the encampment of the army was available on both the banks of the river, and there had to be sufficient strength in the bridge to be able to sustain the movement of the traffic. The construction technique of boat bridges has been variously described.

¹ Khwandmir, Qanun-i Humayuni, Calcutta, 1941, 65.
The description given by Khwandmir is one of the early references. It says that in the construction of the bridge of boats several boats were tied together with hooks and iron chains in the river, and they were covered with wooden boards which were so firmly fixed to them by iron nails that they would not shake at all whether riders or passengers crossed over them.¹ But this technique seems to have been used in the construction of boat bridges of a permanent nature such as that at Delhi and Agra. The temporary bridges used by the army were much simpler structures. Monserrate suggests that in these temporary bridges, boats were 'tied together only by grass ropes' and the roadway laid over these bridges was 'made of branches of trees, bushes and hay.'² He is supported by Bernier who observed that 'earth and straw mingled together are thrown upon the planking forming the footway' of these bridges.³ Near the ends perhaps the boats were secured by fastening them to some support, like the poles or stakes on the ground.

¹ Khwandmir, op. cit.
² Monserrate, 81.
³ Bernier, 380.
The use of the anchores for stabilising boats does not seem to have come into practice at this time. In fact this was one of the major deficiency of boat bridges noticed by Major Roberts in an article written in 1785-86. He asserted that the natives 'did not make use of grapnelas. Instead of these, they followed the tedious mode of driving stakes into the river bed. The result, was a bridge less secure; and what might have been ready in one day took eight or ten days to complete.'

On the basis of some medieval paintings depicting boat bridges S.P. Verma has contended that special type of boats were used for making pontoon bridges. These were flat bottomed shallow boats whose one end was square and the other pointed. He identifies them as punts. But he seems to rely on the miniatures showing boat bridges of a permanent type only. In another painting from Jami-ut Tawarikh, a similar bridge has been shown as built of


2 S.P. Verma, Art & Material Culture in the Paintings of Akbar's Court, New Delhi, 1980, 109. The two miniatures depicting the boat bridges are from MS cited earlier and from Tarikh-i Khandan-i Timuriya, MS at the Oriental Public Library, Patna.
ordinary boats only. The wooden planking has also been missing and this bridge resembles more closely the description given by Monserrate and Bernier. Clearly then Verma's suggestion that special boats were used in the pontoon bridges seems to hold valid for only the permanent structures such as at Agra and Delhi. The common type of temporary pontoon bridges, used mostly by the army during the medieval period, were built of ordinary boats only. In this connection we may also refer to a letter written to the Commissioner of the Delhi Division in 1842, suggesting certain improvements in the pontoon bridge at Delhi on Jamuna. An important recommendation contained in the letter relates to the use of flat-bottomed boats in this bridge to make it more lasting and strong.


2 This letter has been reproduced here in appendix 1.
To ensure against a possible mishap the movement of the army contingents crossing a pontoon bridge was strictly regulated under the imperial orders. Monserrate's description of the manner in which Akbar's army marching to Kabul in 1581 crossed the rivers brings this fact out clearly. He records: 'The king, however, gave orders that care should be taken to see that only one type of troops or transport should approach the bridges at a time: and that the cavalry, the infantry, the camels, the other baggage-animals, the flocks and the herds should pass over both separately and in a single file, so that if a bridge parted, the river should take no great toll of men or supplies. Wherefore on nearing a river, a small block-house was set up and occupied by the King's officers, who took care that a large number should not carelessly crowd the bridge at one end the same time, and so sink the boats. Moreover, elephants were not allowed to cross such bridges, lest they should sink them by their weight'.

A similar description by Bernier at the crossing of Chinab in 1665 by Aurangzeb's army also merits attention. Incensed at the hardship caused to him by the prevailing disorder in crossing a river by a bridge of boats, Bernier has generalized the

1 Monserrate, 81. There are at least two instances of crossing the rivers Indus and Chinab, where Akbar had given specific orders to the soldiers to cross them "division by division" (AN, III, tr., 818 & 867).

2 Bernier, 386-7.
situation for all such bridges in India. He writes: 'The great rivers are commonly without bridges. The army crossed them by means of two bridges of boats, constructed with tolerable skill, and placed between two or three hundred paces apart. Earth and straw mingled together are thrown upon the planking forming the footway, to prevent the cattle from slipping. The greatest confusion and danger occur at the extremities; for not only does the crowd and pressure occur most there, but when the approaches to the bridge are composed of soft moving earth, they become so broken up and so full of pits, that horses and laden oxen tumble upon one another into them, and the people pass over the struggling animals in the utmost disorder. The evil would be much increased if the army were under the necessity of crossing in one day; but the King generally fixes his camp about half a league from the bridges of boats, and suffers a day or two to elapse ere he passes to the opposite side of the river; when, pitching his tents within half a league from the bank, he again delays his departure so as to allow the army three days and nights at least to effect the passage'.

Bernier's assertion that the army usually crossed the rivers 'by means of two bridges of boats' is corroborative of two similar references in Akbar Nama regarding the

1 Bernier, 380. Also see 386-7 where he describes the chaotic conditions of crossing over a pontoon bridge on Chinab.
construction of twin bridges of boats by Akbar on Jhelum near Kasulpur and on Chinab at Bani Kabin during his march to Kabul in 1590.¹ We note from Monserrate's description that the elephants were not allowed to cross over the pontoon bridge for the fear of the sinking of boats under their weight. However, the trial of the strength of a pontoon bridge and the test of its load bearing capacity for the safe passage of army was made by carrying elephants across it. One instance in which such a test was carried out relates to the bridge of boats built on the river Mahi in Gujarat at the behest of Jahangir. The incident has been recorded by Jahangir in Tuzuk in the following words: 'I crossed the Mahi by the bridge that had been made... By way of testing it I ordered the elephants Gun Sundar Khass which is one of the large and strong elephants, with three females, to be sent across it. It was so firmly built that it supports did not shake with the weight of elephants of mountainous form'.²

The description given above makes it clear that there was a great need for pontoon bridges in the Moghul period in the wake of frequent military expeditions that the rulers had to undertake in different parts of the empire. The dependence on pontoon bridges had become all

¹ AN, III, tr. 869-70
² I.A. II, tr. 41.
the more important in view of the fact that the construction technology of that period was unable to provide masonry structures of permanent nature on major rivers in India. However in view of the need for constant repair and shorter life of the structures, in the long-term perspective, the pontoon bridges were likely to be uneconomical in comparison to the masonry bridges.
APPENDIX 1

Suggestions regarding the bridge of Boats on Jamuna at Delhi

Central Record Office, U.P., Allahabad

Serial No. 1    Old No. 56
Name of the Office: C.O.V. (Varanasi)
Name of Group:    C.O.A.1
Name & No. of Series: Mainpuri Judicial/6/118.

Sir,

Your letter of the 30th ultimo, No.1373, with its enclosures from the Offg. Magistrate of Delhi, reporting the damages sustained by the Bridge of Boats on the Jummnah found the effects of the late stored, and applying for 35 Hempen and 2 chair cables to be furnished from the Govt. stored at the Presidency, having been submitted for orders, I am directed by the Hon. Lieutt. Governor to communicate to you the following remarks and suggestions thereon.

2. His Honour is of opinion that, previous to applying for the cables, which Mr. Gubbins proposes getting from Calcutta, it would be proper to ascertain their cost, for it is apprehended that both the chain and the Hempen cables will prove very expressive before procuring any number, however, an experiment should be made with one or two of each kind — a length of 50 yds of chain would be of sufficient for a first experiment: the moving cables now in use are very cheap, and if well made and laid down with care just before the River rises in the rains, ought to last throughout the year.

3. It appears from the account given by Mr. Gubbins of the damage occasioned by the late storm and that
there was no want of strength in the cables, which sustained the whole strain without giving, so that instead of the boats getting a drift, they actually sank at their moorings from the pressure of the amount of debris, choppers when thus filled with water.

4. The only sufficient measure, which could provide against accidents of a similar nature, appears to His Honour to have good decked boats, and 20 or 30 of these might be constructed before the next Rainy season. Decked Boats of a proper description 15 x 60 might be built, it is believed at Raj Ghaut near the Forest in the Seharanpore District, where wood is very cheap, at an expense, varying from 400 to 600 Rs. each, when completed by dropping them down the River laden with wood for the Bridge, a considerable saving of expense might be effected.

5. The average hire of the present Boats is said to be about 10 Rs. a month, or 120 Rs. each in the year - in the course of four years, the amount of the Hire, would cover the cost of the new Boats, and from the new boats being decked, a considerable monthly saving in making the road-way and in other materials now requiring constant renewals, would be effected.

6. If it be determined to build Boats, as suggested, Great care should be taken, that well-seasoned wood was used in their construction, and it would be advisable
not to have the decks fastened down, until after arrival at Dehlee, where the inside work could be properly examined. In fastening the deck, provision should be made, by having some moveable planks for bailing out the water and caulking the inside.

7 The accompanying rough sketches show the kind of boats, which are suggested, as likely to be found best-suited for the purpose, there or measure would be 15 ft by 60 with flat bottoms like the Jumna boats, the road-way in the centre to be 24 feet wide, the sides for this distance should run straight of the boats meeting close. In the road-way the thickness of the planks should be around two to three inches.

8 From October to June, the boats should be close to each other, as shown in Sketch No. 1 for during this season, heavy Hackeries must be crossed over but during the rains, when no heavy Hackeries are on the roads, with really good decked Boats, half the number now used, would be sufficient with connecting platforms of 15 ft. between the boats, as showed in sketch No. 2.

9 A Bridge of Boats constructed on the plan would, His Honour conceives, if found to answer, cost much less than a Bridge of Boats made in the common way, from the clear water-way allowed would be much safer.
there would be much less stress laid upon the cable, and they would not be so liable to get covered and down by the grass, branches of trees. Sea which are a source of danger to all bridges over the rivers in this part of the country.

10 You are requested to forward a copy of this letter to the Magt. and the Local Committee and to submit your sentiments on the above suggestions, and on any of the plan that may be proposed, should it before impracticable to construct a Bridge and the plan herein described.

11 The Original Enclosures of your letter, are herewith returned, copies having been retained for record.

I have the honour to be

R.C.E. Hamilton
Secy to Gt. NWP

Agra

the 22nd June, 1842.
Masonry Bridges: We have argued in our introductory remarks that from the beginning of the sixteenth century accelerated growth of trade and commerce was accompanied by the coming into existence of a large number of masonry bridges all over the Mughal empire which tended to concentrate along the trunk routes emanating from Agra and Delhi. Most of these structures were built at points where the routes were intersected by rivers or by streams flowing in a natural declivity and revived only during the rainy season. As Bernier specifically points out masonry bridges, throughout the medieval period, were absent from major rivers.¹ It seems the engineering skill of Mughal India was as yet insufficiently developed for attempting the construction of a bridge on such large a scale. An investigation of the factors responsible for this snag is important, but before we take up this problem for a detailed discussion it seems appropriate for the sake of clarity of subsequent arguments to answer the question posed by an uneven geographical distribution of bridges in Mughal India.

A study of the geographical distribution of masonry bridges extant during the Mughal period reveals a feature of singular importance. The numerical incidence of masonry bridges in the region denoted as

¹ Bernier, 380
northern plains and in the rest of the empire differs very sharply, the ratio being roughly three to one. This cannot be adequately explained with reference to the 'backwardness' of certain regions in the skills pertaining to masonry bridges. There is no basic difference in the architectural technology employed in the construction of bridges in different regions during this period. One may, however, seek an explanation for this phenomenon in the varying geographical conditions, especially of the river behaviour that is discernible in the different regions of the subcontinent. Spate brings out the distinction in the nature of rivers flowing in the northern plain and those of the rest of the regions quite perceptively. His differentiation between the 'rivers of the Peninsula and those of the Himalayas' is based on the following two features:

(a) According to Spate, erosion in the Himalayan rivers is extremely active, while the Peninsular rivers flow in broad shallow valleys, graded almost to their heads and with only slight interruptions of profile;

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1 The information on this subject has been gleaned from Habib's Atlas, where in various 'economic' sheets, have been depicted the masonry bridges located on trunk-routes. The region of 'northern plains' corresponds roughly with the regional divide denoted as 'The Indo-Gangetic Plains' by Spate. It comprises mainly the region covered in Sheets 4B, 8B, 10B & 11B by Habib (O.H.K. Spate, A.T.A. Learmonth, B.H. Farmer, India, Pakistan and Ceylon: The Regions, N. Delhi, 1973, 414-16).
b) Besides the monsoon months, Himalayan rivers have a supply from the melting of the Himalayan snow also. As a result, even at the height of the hot-weather, these rivers carry a considerably large volume of water. By contrast, the Peninsular rivers are entirely dependent on a rainfall concentrated in five or six months of the year. They are, therefore, almost dry in the hot-weather.\(^1\) It can be deduced thus, that the upkeep of a continuous line of communication along the land-routes in 'northern plains' would necessitate building of masonry bridges on the rivers and streams at several places. On the contrary, in the Peninsular, even major rivers should be fordable over a larger part of the year. Not many structures in masonry would, therefore, be required.

The architecture of bridges in Mughal India was composed basically of arches resting on piers, a series of which carried the road across the stream. With the exception of a few structures surviving from the pre-Turkish period in which the arches were raised on the principle of corbelling, in most of the surviving bridges of the medieval period are used true arches with voussoirs and key-stone. In terms of the load bearing strength of the bridge and the width of the spans covered, these had a decided advantage over other

\(^1\) Spate et al, op. cit, 42-3.
architectural forms in masonry which is the reason why
masonry bridges with arches continued to be built
extensively throughout the medieval period, and were
supplanted in the nineteenth century only, when iron
was substituted for stone as the principal building
material.

A medieval masonry bridge consists of the
following four structural elements which involve the
basic skill of arch constructions:
(a) the foundations in the bed of the rivers, on
which the piers were raised, (b) the piers themselves
sustaining the vertical thrust of the arches and the
pressure of the water flowing past them, (c) the
arches, raised on the piers and forming the super­
structure carrying the road and (d) lastly the
abutments at the two ends, bearing, in a large measure,
the lateral thrust of the superstructure. For a proper
understanding of the evolution and adoption of different
designs of bridges and also of their insufficiency
discernible during the Mughal period it would be useful
to trace the technique and designs adopted with respect
to the individual components from time to time. In the
ensuing paragraphs, therefore, we have focussed on the
four component structures of the Mughal bridges under
separate sub-heads.

Foundations: Foundations are the most important
part of a masonry bridge. A secure foundation capable
of sustaining the weight of the piers and arches has to
be laid on a firm base such as a rock below the bed of the river. Evidence on the nature and technique of laying foundations in medieval bridges in India is scarce. It is only in the survey reports by Cunningham that a few scattered references on this subject are available. In the case of the famous Jaunpur bridge, which was subjected to an extensive survey by Cunningham, the information about the laying of its foundation comes from a chronicle Tarikh-i Jaunpur. This local history of Jaunpur, compiled by Khairuddin Allahabadi in early nineteenth century, gives an account of the building of the bridge which is obviously based on traditions current in his own time as well as on some of the earlier histories extinct now. He specifically refers to a work entitled Tarikh-i Munimi which might have been a collection of anecdotes about Munim Khan who supervised the building of the bridge during 1567-73. The information furnished by Khairuddin on the building of Jaunpur bridge, therefore, must be attached significance. Describing the bridge Khairuddin tells us that the spot where the bridge was to be built was decided by Munim Khan after considerable deliberation and the foundations were sought to be laid after diverting the river. He maintains that even after diverting the river upstream in another channel, there remained one spot in the bed of the river from where water could not be driven out. They therefore made
many strong and stout boats, brought them to the spot, and piled them up with stones made fast with lead. These boats were chiefly supported by anchors and ropes, by which they were let slowly down. When one boat had sunk another was placed in the same way on the top of it, and soon until a platform was raised above the water. They then prepared several more of the same kind, and united them to each other with large beams of brass, 20 yards in length, and prepared at the expense of thousands of rupees. Both sides of these beams were made fast with lead and iron. On this foundation they commenced the building, and completed three arches.¹ About the two bridges on the river Black Bein at Sultanpur in Panjab, Cunningham remarks that they 'were built on well foundations'² but has not given any details of this technique. One may, however, imagine that it essentially resembled the primitive method of driving a cylindrical pile by means of a stone with handles. A number of men stand on a platform fixed below the head of the pile and ram the stone lustily up and down on top of it.³

¹ Khairuddin Allahabadi, Tarikh-i Jaunpur, tr. Pogson and cited in Arch. Survey Reports, AIV, 121-3.
² Arch. Survey Reports, AIV, 57.
³ Cf. Shirley-Smith, 5.
It seems from the above that by sinking the boats or drilling a well an attempt was made by the medieval architects to arrive at a point under the bed of the river where the ground would be firm. An observation by Cunningham that the site of the bridge on Sind at Dongri is at a point where 'the bed of the river is rocky throughout, and offers every advantage for the construction of a permanent bridge',\(^1\) supports this contention. In the absence of a deep excavated trench near the foundations, the amount of success achieved by the architect in their endeavours remains largely a matter of speculation. However, they seem to have appreciated the necessity of spreading the base of the foundation over a wide area, thereby compensating partly for their failure, if any, to go deep into the bed. An interesting structure illustrative of this kind of a formation in the foundations is a bridge of Akbar's period, located at Chhaparghat on the river Sengur.\(^2\) Here the foundations are raised almost level with the bed of the river and are wider by nearly two m. than the piers which rise over them.

\(^1\) Arch. Survey Reports, II, 325.
\(^2\) See infra, No. 35.
Simple techniques used by Indian masons in lowering the foundations ceased that the sites of such work should be dry. The device, commonly used in the West for this purpose was cofferdam, but it could not be perfected in India. They therefore resorted to an arduous method of diverting the flow of water in an alternative channel by raising an embankment at a suitable place upstream. Two different ways in which this could be done were (a) to select a site at an elbow or bend of the river and cutting a channel through the neck of the peninsula, dam off the flow in the old course; and (b) to restrict the flow of the river to only half of its span alternately. It seems both methods were used depending upon the local convenience.

In the case of Munim Khan's bridge on Gomti at Jaunpur, we find that at the time of construction the river was diverted into a new channel by raising an embankment upstream. Khairuddin records that 'at first they built a strong bridge to the south, and made an embankment in the river towards the north, with stones, mortar, and a small quantity of earth. They then turned the course

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1 A cofferdam is a box made by driving four rows of timber sheet piles, open of course at the top and bottom, but completely surrounding the site of the proposed pier. The cofferdam was emptied to obtain a dry river bed for excavation work. A systematic and large scale use of cofferdams was made for the first time by Romans in bridge-building. The technique then passed on to their successors (Shirley-Smith, 4-5).
of the river from the west, conducted it under this bridge, and let the water out by the road of the Nakhas; ...

1 'But the architect', writes Cunningham 'having diverted the river into another channel, which he had dug a short distance to the south, found himself unable to close it, when the bridge over the river was finished. He was therefore obliged to build a second bridge over the diversion channel,...' In another instance during the reign of Shahjahan a saint Shah Daula (to whom is ascribed the building of a number of Mughal masonry bridges in Central Panjab) is said to have built a bund to keep back the water of Degh Nala from the site of construction of a bridge over this stream. It seems very doubtful, however, whether rivers could have been successfully diverted in those days, unless the flow was seasonal and reduced to a trickle in dry weather. A problem would actually arise in the case of major rivers which carried a considerable volume of water in dry weather also. Perhaps the device of restricting the flow of the river in only one half of the span, keeping the other part dry, had not been perfected. In the case of major rivers, therefore, it would be very difficult to obtain a dry area for the construction of a masonry bridge.

1 Khairuddin Allahabadi, op. cit, 120-21.
3 Cf. Habib, Atlas, 12, a.
4 Chronicles of Gujrat, 158-9.
It is important to note that by the beginning of the sixteenth century in the West, a fairly advanced technique for piling foundations was practised. Indian masons, however, do not seem to have adopted any significant improvement and the above primitive and insufficient devices with which they worked remained more or less unchanged down to the end of 18th century.

Piers: The piers of the Mughal bridges were made very thick, the average width being about two thirds of the span. They were not raised very high above the water level unless warranted by peculiar geographical conditions; the idea apparently, being that during the floods bridge should be submerged thus lessening the pressure of gushing water on the total structure. The breadth of the piers excluding the thickness of cutwaters on both sides seldom exceeded 10 m. In a multi-arch bridge, therefore, every pier was strong enough to carry all the vertical thrust exerted by the superstructure. In this design, in fact the piers served the role of abutments also, so that each individual arch of the bridge was an independent unit having as its supports, the two piers. This extra measure of thickness in the design of the piers was

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1 e. g. Jaunpur bridge which was repeatedly submerged in Gomti floods. Perhaps it owes its survival to this feature in a large measure.

2 See Appendix 2.
persisted despite some obvious disadvantages. It seems the architects were not confident about the strength of a slender pier for sustaining the load of the superstructure and tried to ensure against possible damage to the arch by increasing the width of the piers. There was an advantage in this design. Since each pair of piers was sustaining practically the entire load of arched superstructure, and only a very small proportion of lateral thrust of this arch was transmitted to its neighbour, the destruction of one or more of these would not bring down the remainder. It was for this reason perhaps that the destruction of two arches of a bridge located on Sai by the retreating forces of Bahadur Khan, brother of Khan Zaman, during latter's rebellion in 1566, did not affect the remaining structure. These two arches were restored by Munim Khan during his governorship of Jaunpur.¹

The practice of adopting extra thick piers in the masonry bridges, however, proved to be very disadvantageous in the longer run. It was observed that in some of the bridges over a period of time the arches had begun to be silted, which would result in the river flowing under the bridge cutting its way past the bridge through one of the banks. This problem did attract the notice of medieval architects, but since it was limited to

¹ Cf. District Gazetteer, Jaunpur, 231
a few structures, it was thought that the problem lay in the unruly behaviour of the rivers, especially during floods. Seemingly an answer to this problem was sought in the following two measures: (a) the height of the bridge, wherever possible, was lowered to allow the flood waters to pass over the structure, and (b) an additional passage for the flood waters was provided by creating arched piercings in the spanorels. Rendering the bridge serviceable needed an extension. But quite often these extensions also met with the same fate. Sometimes the river eroded the two banks alternately. The measure of providing an extension in one particular case was thus resorted to three times. This was despite adapting the two corrective measures mentioned above in the designs of the extensions. That there was a basic fault imminent in the designs of the piers, had perhaps not occurred to the medieval architect.

The credit for drawing attention to an intrinsic defect in the design of the medieval bridges in India, which had resulted in the scouring of some of these structures, is generally given to Cunningham. However, a perusal of official correspondence dated between 1814 and 1841 on the subject of restoring to public use an

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1 This feature is obtained in three bridges of Aurangzeb's period located at Sultanpur on Black Bein river in Panjab at Longri and at Warwar in Central India, both on the river Sandh. For a detailed discussion see the descriptions of these structures given in B.

2 See the description of Sultanpur bridges infra.

abandoned bridge situated at Jajau on the river Utangano preserved in the Allahabad Record Office goes to indicate that the detection of this structural defect of the Mughal bridges was made by some of the British officials decades before it was highlighted by Cunningham in his reports. Accordingly, it was as a result of the extra thickness of the piers that the waterway under the bridge was made narrow which caused a heavy deposit of silt. Later the river in its effort to find a passage for smooth flow cut through one of the banks and bypassed the bridge.

These observations of Cunningham and other British administrators of nineteenth century are borne by the measurements for the thickness of the piers and the width of the arch spans available to us for twenty masonry bridges. It is significant that on an average the space covered by the piers is nearly half of the total waterway under the bridge. The bridges at Chaparghata and at Mir Kadim are the only exceptions in this regard where the space blocked by the piers is only one third of the

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The letters and reports of this correspondence are contained in files No. 85 and 86, Agra Division, Miscellaneous, and their texts are reproduced in Appendix 3. I must state here that I did not get an opportunity to examine the records personally. The texts given in the appendix here have been very kindly supplied to me by Mr. Iqtidar Alam Khan, my supervisor.
total waterway. Incidentally, this tally also includes a pre-Turkish bridge built on corbelled arches. Even in this particular case the ratio between the pier width and the waterway is nearly 1 to 2. It is, therefore, likely that in the construction of medieval arch bridges using voussoirs, the basic design of piers was adopted from the earlier corbelled structures. In the absence of any positive evidence on this point, it is, however, difficult to suggest anything with certainty in this regard.

Arches: The use of voussoirs in arches was apparently introduced in India in the thirteenth century and was almost immediately adopted by the masons here as a premier architectural form. As has already been noticed, barring a few cases surviving from the pre-Turkish period, the superstructures of masonry bridges in the medieval period were built on the principle of true arch. But it is worth noting that in these structures the shape of the arches is that of a pointed horse-shoe, which seems to have been copied from Persia where it was used in a fairly developed form. The absence of semicircular arch extensively used in the west, from Mughal masonry bridges is thus very striking. It may be useful to compare the merits of the two forms, and their relationship with specific geographical conditions, if any. The

1 See Appendix 2.
semi-circular arch, so successfully used by the Romans, demands a high degree of precision in its execution, especially an accurate shaping of the voussoirs. The horizontal thrust at the abutments is least in this case and a greater exactness is needed in fixing the voussoirs for there is always a chance that even a small settlement in the joints between these voussoirs, may result in the collapse of the arch. On the contrary, the pointed arch is suited to situations of crude craftsmanship as the skills of a lesser degree may also perform the job. It also exerts less thrust on the abutments and is less susceptible to failure through subsidence of the crown. In the place of voussoirs, sometimes even loose stone rubble can be used, thus giving the pointed arch a greater flexibility in terms of the choice of building material.

The impact of the geographical conditions on the development of particular structural forms also deserves consideration. Smith cites the cases of Persia and China where the choice of particular arch formations was guided by the geography of the two regions. Wide deserts and rocky uplands devoid of almost all vegetation necessitated it

1 The grand scale viaducts of the Romans were sometimes as high as 48 m, and their arches of 45 m. span. This was due to their exploitation of the semi-circular arch. According to Shirley-Smith, the Roman 'arches were built with the intrados and extrados parallel, and stones of huge size and weight were used...Stones to be used as voussoirs were cut and fitted so perfectly that there was no need for mortar at the connections. Iron or bronze cramps were used between the stones of each ring, but not transversely' (Shirley-Smith, 15-6).
for Persian engineers to devise ways of using none or as little timber as possible. The scarcity was such that they were sometimes compelled to use only brick centering for their arches. Under such conditions they preferred to build in pointed arches, which for their shape exerted less load on the centering and a smaller thrust at the ends than a circular arch. Similarly, Chinese arch bridges present extraordinary features typified by the geography of that region. Owing to the impossibility of building rigid foundations in the plastic silt of the Yangtse delta, the Chinese developed their arches on the principle of resisting by yielding. The stone vaults of the arches were built of thin curved stone slabs joined end to end, curved with more stones placed crosswise, and loose rubble filling. The filling was contained by means of vertical side walls resting on the arch and bonded into the rubble. These bridges might thus be described as consisting of stone chains employed in compression.

This form of construction gave the arches amazing flexibility and they could easily adapt themselves to the rise and fall of the silt foundations and the weight of traffic.

1 Cf. Shirley-Smith, 24-7
2 Shirley-Smith, 31-2; Also see Andrew Boyd, Chinese Architecture & Town Planning, London, 1952, 153-54.
The pointed arches were quite useful for a medium span length because with a rise of at least one-fourth of the span, an economy could be effected in the foundations of the piers. In India, therefore, on rivers of average width, bridges with pointed arches were to prove very successful. The average width of an arch-span in the medieval bridges is 4.85 m. and the rise of the arch is roughly half of the span. The maximum width covered by an arch is 8.00 m. in the Chhaparghat bridge, which is incidentally the only case where the pier-width is half of the arch-span.

We have seen above that in the construction of pointed arches, the devices used for centering did not require the mathematical precision necessary in the raising of semi-circular arches. Thus instead of using wood scaffolding, the masons could as well do with brick centering. In fact, in countries such as Persia, where over large tracts of desert little if any timber was available, the architects were forced to use only brick centering for their stone arches. In the case of India, however, a dearth of information on the technique of raising arches in masonry, makes it very difficult to

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2 A detailed comment on this feature shall be found in the description of Chhaparghat bridge in B.
say anything on this point with confidence. At best we can derive that the Persian practice of brick centering might have been followed here with slight modifications. Since there was no scarcity of woodstock in India, it may be conjectured that in providing centering for an arch a combination of timber and brick was used. Probably the base was made of light timber works and it was then covered with concentric rings of brick work. An important point in this discussion is the nature and quality of mortar used for retaining the brickwork in the centering together. Smith says that in Persia 'the use of brick centering only would probably have been impracticable but for the discovery of gypsum mortar' which 'binds the bricks together mechanically'.¹ In India, however, the development of lime mortar, which forms a chemical bond with the bricks, would have been more advantageous.

An interesting feature in some of the Mughal bridges is the profile of a hump, which they gain from varying rise of the arches.² Mostly the central arch is higher than its flanks and there is a successive

1 Shirley-Smith, 25.

2 These are Nakodar, Sarai Pul, Wazirabad, Athpula, Barapula, Phutra Nala, Chaparghata, Hadaf & Atharuala described in Appendix 4.
decline in the rise of the arches on both sides of
the central arch. At least in one case the 'hump'
does not figure in the centre, but is located near
one end of the bridge. Curiously a corbelled bridge,
surviving from the pre-Turkish period, too exhibits
this feature. Apart from aesthetic considerations,
this profile had a great utility. It has been suggested
that these humps afforded 'additional strength to the
construction by reason of its effect in wedging the
structure between the banks and so strengthening the
whole against subsidence and the lateral force of the
stream'. In those places where the rivers were
navigable and boats used to ply, the central arch was
deliberately kept wider so as to facilitate traffic.
Such was the case with Bulalpur bridge.

Abutments: The abutments are structures at the end of the bridge, which bear the accumulated horizontal
thrust exerted by a series of arches in the bridge.
For the stability of the bridge, therefore, strong
abutments are necessary. But it seems in the medieval
bridges not much attention was given to the strengthening

1 This is Barapula in Delhi near Nizamuddin.
2 This is Athamala Bridge near Puri in Orissa.
3 Kuraishi, 219-20.
4 Cf. Lamb, 216-17.
of the abutments. The shape and length of the abutments were mostly determined by the conditions of site. Therefore, a universal code for the design dimensions of the abutments could not be applied in the building of bridges at this time. It has been suggested earlier that the piers of the Mughal arch-bridges were designed in such a way that they partly served the purpose of the abutments also. It seems probable that the pointed arches resting on thick piers obviated the necessity of paying great attention to the upkeep of strong abutments.
Appendix 2

Here we give the measurements of twenty masonry bridges in a tabular form. These structures were known to have been extant during the Mughal period. The measurements have been gleaned from the descriptions of these bridges surviving in the chronicles and in the various archaeological reports. The bridges have been arranged in a chronological order. The information relating to subsequent alterations or extensions in the structures of the bridges, wherever available, has been given in the table.
APPENDIX 3
CORRESPONDENCE REGARDING JAIIAU BRIDGE
Central Record Office, U.P., Allahabad

Serial No. 1, Old No.56
Name of the Office: C.O.V. (Varanasi)
Name of Group: C.O.A.1
Name & No. of Series: Miscellaneous
Identification No.85/Agra Division/Misc.

Letters received by the Commissioner relating to the City of Agra - its roads, bridges, gardens, nazul lands etc.: 1814-1857

To
A. Wright Esquire
E.W. Blunt Esquire
C. Macsween Esquire
Local Agents
Aghra

Gentleman,

I take the liberty of submitting to your consideration some observations on the present state of the Bridge at Jaujow. If they should be deemed worthy of your attention I should hold myself extremely fortunate in having made them.

I have etc.

(Signed/R.J. Seyer,
Lieut., 1st Bn., 6th Native Regt. doing duty with the Escort of the Resident Sindiah's Camp)

Gouliaor
January 20th, 1814
Observations on the present state of the Bridge at Jajaw - December 28th 1813

1st The town of Jajaw is situated in the northern bank of the river Ootunga, or Baungunga at the distance of nineteen miles from the city of Agrah, and on the high road from the place to the Dukhan, the opposite banks of the river were formally connected by a bridge. The bridge still exists - but the river has forsaken it for some years, having worn for itself a new course close under the wall of the town, which it has undermined and destroyed to a considerable extent.

2nd The bridge was constructed in the reign of the Emperor Aurangzeb, it is eight hundred and thirty two feet long, thirty four and half feet wide - and has twenty arches: the masonry appears to be very substantial. The road across it is paved with large flag-stones, a pavement, two hundred and one feet long, forms the approach from the northward - a similar pavement of three hundred and fifteen feet extends to the southward of the bridge.

3rd It is well known that with the rains the river is frequently unfordable; and indeed during the whole of that season the passage of it is rendered extremely difficult by the rapidity of the current. Under these circumstances it would be idle to enlarge upon the public advantages which would arise from restoring the bridge to the use for which it was built.

4th Having heard accidently that the project of turning the stream under the bridge was commonly talked of by the people of the country as a measure of no great difficulty, I had the curiosity to examine the ground in a cursory way whilst I was lately encamped near the town. The result of my examinations is exhibited in the accompanying sketch.
5th The dotted line c-d marks the line of level which I examined. This line commences at the centre of the third arch from the southern end of the Bridge A-B and was selected in preference to any other point because it was the lowest: there is channel under this arch formed by the water which runs from the high land into the antient course of the river.

6th All the arches of the bridge are much choked with sand and mud: but at the point from which the level commenced, there was a clear space about eight feet high, from the surface of the earth. The ground to the north of this front of the bridge rises considerably and is very irregular. On the eastern face of the bridge there are large mounds of sand and earth which in one or two places are small channels for the passage of the streams which flow during the rains.

7th It would appear that the differences of the level between the ground at the third arch of the bridge, at 'd' (choked as it is with mud) and the edge of the water in the river at 'c' is only six feet and a half. The total distance between the same points is 7670 feet, nearly one mile and a half.

8th If it should be deemed advisable to attempt to turn the course of the river, it might perhaps be affected by means of a Bund CD and the excavation of a sufficient channel in the antient bed of the river. Marked by the dotted line c-d, a causeway might be necessary at EF to facilitate the communication in the first instance between the town and the bridge. I had not time to prolong the level to the eastward of the bridge or to take a section of the river as I could have wished. But I saw enough to convince me that the ground presented no serious obstacle to the execution of the measure in question.

True Copy  
E.W. Blunt  

(Signed/ R.J. Seyer, Lieut.  
1st Bn 6th Native Regt.  
R. of Escort Sindia's Camp)
2. Identification No. 86/Agra/Division/Misc.
Letters addressed by the Commissioner relating to the City of Agra, its roads, bridges, gardens, nazul etc.: 1814-1837

Letter from Board of Commissioners, Farruckabad, dated 25 April 1815, addressed to N.B. Edmonston Esquire, Vice President in Council, Fort William:

"3rd With regard to the bridge at Jajow noticed in the concluding paragraph of the letter from the Local Agents in the annexed copy of a letter to their address from Lieut. Seyer, we have advised them to furnish us with a full report on the practicability of re-establishing it and on the probable expense. We must at the same time observe that in most instances which we have seen of bridges similarly circumstanced from the river having formed to itself a new channel, the cause is found to originate in some intrinsic defect in the construction of the bridge itself which for want of sufficient waterway forces the stream to take another course and that in such instances the expense of returning the water in its original bed may sometime be greater than that of building an entire new bridge."

3. Mainpuri Judicial 6/118
Letters despatched to Commissioner of Circuit Agra/114: 12.5.1841-31.12.1842
No. 51

To
R.M.C. Hamilton Esq.
Commissioner of Circuit
Agra Division

Sir,

Your communication as per margin, to this office, on the subject of the Jajow Bridge were lately made over by the Road Fund Committee to Lieutenant Abbererombic, Superintendent of the Bombay Road at
Dholpoor, requesting his assistance in furnishing them with information regarding the turning of the channel of the river. In reply that officer states that he will be able to do little unless an elephant be placed at his disposal. I have the honor to bring the proposal to your notice for such steps as you may think necessary to take in the matter and would suggest that an application be made to the officer commanding the situation to place an elephant at the disposal of Lieutenant Abberenotic.

I have the honor

Zillah Agra
Magistracy
The 6th August
1841

Sir,
Your most obedient servant

Magistrate

* No.376 dated 8th Oct. 1840.
No.144 dated 4th June 1841.
No. 80

To

P. B. Reid Esquire
Secy. to the Road Fund Committee
Agra

Agra and Bombay Road
Executive Engineer's Office
Camp Tehra, 22nd August 1841

Sir,

I have the honor to...informing your committee, that after examining the bridge and bed of the Gombhur at Jajow, I am of the opinion that the bridge itself has forced the stream from its former course, and that the river cannot be made to run permanently under it unless it is improved so as to give considerably more waterway.

2 This would probably occasion an expense much beyond the committee means, and one incommensurate with the advantages obtained, as the river is always fordable, except for a few hours in floods, two or three times in the rainy season.

3 The principal advantage gained probably would be the saving the public serae, the south-west of which, and half of the west wall, have been destroyed by the action of the river current.

4 I believe it be quite practicable to carry the river under an improved or enlarged bridge in the position of the present one, but am unwilling to offer any place of operation in estimate without having an
opportunity of making a survey of the river for some miles above the bridge, and taking some levels carefully during the dry weather; I disagree entirely with Major Drummond in his proposal to carry merely a portion of the stream under the bridge, the effect of which I believe would be to injure the inhabitants of the village by taking away some of their cultivation ground, and leave sufficient current to complete the destruction of the south-western portion of the serae.

I have the etc. etc.
Signed/w. Abbererombic
Executive Engineer

True Copy
P.B. Reid
Sec. R.Com.
SECTION B
Architecture and Planning: In the preceding sections we gave a detailed discussion on the nature of bridges extant during the Mughal period and attempted a general assessment of the various techniques employed in their construction. We also noted that in medieval India masonry bridges came to outnumber all other types of bridges. This was very largely due to the fact that masonry bridges incorporated the arch—the principal architectural advance of the times—in their designs, and hence established superiority over bridges built on other principles. Therefore for locating specific features of design development and for assessing the growth of new concepts in masonry bridges, a detailed study of some surviving structures becomes imperative.

We find that a large number of masonry bridges have survived from the Mughal period, and quite a few are in such a good state of preservation that they still carry vehicular traffic. These structures may, therefore, be treated quite legitimately as representative specimens of the architecture and planning of masonry bridges built during the medieval period. We have selected ten such structures which we are going to describe here in all the details of their designs and techniques. These are located at different places between Delhi and Sultanpur in Panjab, and Delhi and Ghatampur (via Agra) in Uttar Pradesh.  

Cf. Irfan Habib, 'Changes in Technology in Medieval India', Indian History Congress, 1979, Cyclo., 16.
Pradesh. Our list, also includes the description of a bridge situated in Orissa near Puri, which dates from the eleventh century. This is a fine specimen of pre-Turkish bridges and provides us valuable information on the techniques employed by architects in the construction of bridges before the introduction of true arches changed the very conception of masonry bridges in India. Wherever available, the literary information about these bridges has also been utilized. Some of the bridges surveyed by us were noticed by Cunningham and a few were described in some regional survey reports and district memoirs also. The measurements available from these sources have been checked and the cases of variance with our figures have been specified clearly. But before we begin with the descriptions a word of caution is warranted. The tale of medieval bridges is not all of success. In fact a count of surviving structures presents only one side of the picture. It does not include failures and disasters such as those that might have befallen the bridges attempted on major rivers. Evidence on them would unravel the causes behind the failures and help us fill some vital gaps when we trace the evolution. Unfortunately such evidence is very scarce and we have only the successful ventures to recount.
1. Atharnala Bridge: Atharnala stream is also known as Madhopur stream and 'was an important waterway some centuries ago' as it 'separated the mainland from the sandy ridges of Puri.'\(^1\) A masonry bridge is situated on this stream at a distance of about three kms. north-east from the town of Puri on the road leading to Bhubaneswar and now graded as state highway No.8\(^2\). This bridge, thus provides an important link between the mainland and the town of Puri. An early notice of this structure was taken by Fergusson\(^3\) and it was also described in a list of ancient monuments prepared by the Public Works Department of the Govt. of Bengal in 1896\(^4\). Both these accounts, however, state clearly that they reproduce a description of this structure as given by Stirling. Accordingly the building of this bridge has been ascribed to 'Raja Kabir Narsimha Dev, the successor of Langora Narsimha Dev, who completed the black pagoda'.\(^5\) The date of its construction, says Fergusson, would thus be about 1280.\(^6\) Hajendra Lal Mitra, however, differs on this issue; basing his views on the records belonging to

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1 Kuraishi, 297.
2 For its location see Habib, Atlas, Sheet 12 B, 1985.
5 Ibid.
6 Fergusson, op. cit., II, 113.
the temple of Puri, he pushes back this date by two centuries.\footnote{R.L. Mitra, Antiquities of Orissa, Delhi, n.d., II, 112.} He is supported by Kuraishi who writes: 'According to the "Palm Leaf record" Purushottam Chandrika, the bridge was built by Íśvara Matsya of the Kesari dynasty, who ruled between 1035-1050 A.D.'\footnote{Kuraishi, 297-8.}. It is, in any case, clear that this structure antedated the introduction and the development of true arch in Orissa.

Atharnala bridge is presently maintained by the Public Works Department and apparently till this day no major alteration has been made in its original structure. It stands north-south and the main road from Puri to Bhubaneswar passes over it. It consists of nineteen spans of the horizontal corbel construction resting on eighteen piers,\footnote{See Plate 12.} built of laterite and sandstone.\footnote{Ibid; Stirling says 'It was built of a ferruginous coloured stone probably the iron clay,..' (LAMF, 408).} There is a slight hump in the profile of this bridge because the height of the arches recede successively on both sides of the central arch even though only the central arch and the two arches flanking it on both sides are of a wider span than the rest. The
river flows from east to west, but is presently covered by a thick growth of hyacinth. Atop the arches is a plain cornice-band of slight projection, originally decorated at intervals with rude figures of lions and elephants, all of which except three on the east face have now disappeared.¹ The total length of the bridge between the abutments is 85.85 m. as measured by us and the width of the bridge is 10.80 m.²

The arches of the bridge are constructed on the principle of corbelling, whereby the stone blocks on a pier were laid in such a way that these blocks on two adjacent piers were projected slightly toward each other as the height increased. The two ends of these projecting stone blocks were then joined below roadway level by long stones placed across the gap. In Atharuala bridge corbelling begins at a height of 2.60 m. in the piers and five overlapping corbels reduce the span successfully till at the top it remains only 0.75 m. Here this space is covered by large stone slabs of laterite each of which measure, on an average, nearly 1.35 m. in length. However, in the central span, because of a greater width, the

¹ Kuraishi, 297-8.
² Kuraishi, 297-8, gives the length as '276 ft' and width of the piers as '38 4"', which are 86.86 m and 8.64 m. respectively.
corbelling begins at a lower height (nearly 2.30 m) in the two corresponding piers, and it has ten courses of overlapping corbels to reach the top. The abrupt increase in the size of the central span 'produces a somewhat awkward appearance in those on either side of it, owing to the lop sided effect of the unequal corbelling'. The width of the arches is 2.40 m. each till we reach the three middle ones which measure 4.05 m. for the central and 3.40 m. for the two flanking arches.

The piers of this bridge are 10.80 m. deep and 2.00 m. wide except the two piers on the middle on which rests the central arch. These are 2.30 m. wide. The piers are slightly curved on the eastern face. This feature is meant, probably, to reduce the thrust of the river water on the bridge. There are no cutwaters of the shape of a wedge. It seems the flow of river is so inconsiderable at this place because of the merger of the river into the sea a few kilometers away, that there is no necessity of making cut-waters in the piers; only a slight curve near the sharp edges of the piers suffices.

1 According to Kuraishi, 297-8, the corresponding measurements are: width of the arches 8', 10'5"(two), 14'5" (central) (2.44 m, 4.17 m, 4.39 m).
The abutments in this bridge are not formed properly. The two extremities of the bridge are lined with stone blocks only to prevent erosion at the banks. As we have noted earlier, the material used in the construction of this bridge is stone blocks of laterite and sandstone, of which the use of the latter has been made rather sparingly. These blocks measure 90 cms x 40 cms x 25 cms, though a few of smaller dimensions have also been used.

Corbelled bridges are a variation of beam bridges, where the weight of the superstructure is borne wholly by the piers. Atharnala bridge is a fine specimen of this type. The amazing stability of this structure may, however, be attributed to its location. The river carries only a trickle of the flow near the sea coast and therefore exert minimal force on the structure of the bridge. The only sizeable load, such bridges have to bear, is that of the traffic for which the laterite stone slabs are pretty strong. An interesting feature of this bridge is the 'hump' which it gains from the increased rise of three arches in the middle and a slightly tilted placement of stone slabs making for the covering of the corbels. These have been laid laterally conjoined to each other in which form they make an arch in the fashion of a chain. Partly, therefore, the thrust of the slabs is transferred on to the abutments.
The width of the central arch was perhaps increased to provide a passage to the boats from under it.

2. Wazirabad Bridge: Wazirabad is a locality in Delhi in the northern quarters, on the bank of the Yamuna, nearly 6 kms. from the Mall. About one km. south flows the Najafgarh drain or a branch of it, which falls into the Yamuna here. At this place stand some rubble built buildings and a masonry bridge which crosses over the drain. These buildings are said to be the tomb of Shah Alam, a saint from Firuz Tughluq's reign and are ascribed to the Sultan. The bridge lying close to this tomb, carrying the road northward across the drain, seems to be a structure contemporary with Shah Alam's tomb, and thus dating from the second half of the fourteenth century. The structure of the bridge and the tomb are in a fairly good state of preservation and are notified as protected monuments.

The bridge was described at No. 409 in the List of Muhammadan & Hindu Monuments of Delhi province prepared in 1919. Another notice of it was taken by Henry Sharp in his Delhi: Its Story and Buildings, published in 1928.


2 List of Monu. Delhi, II, 290.
northwards. As the fame of the saint was not sufficient to tempt the great ones of succeeding times to lay their bones at his shrine, the place is not overlaid with later structures and has preserved its unity of style and its original form.

...The bridge at this Largah is an impressive structure with its narrow arches and buttressed piers. Its style bespeaks its antiquity'.

This structure has been built entirely of loose stone rubble cemented with lime mortar. The quality of the mortar would have been really good since it has kept the stones intact over a period of six hundred years now. It was originally plastered all over, most of which, however, has peeled off now. The bridge runs north-south as it spans a drain flowing from west. The arches rise in height successively from both the ends so that in the centre the rise and width of the arch is maximum and the hump silhouette is quite marked. The width of the arches also increases in proportion to their rise.

The total length of the bridge between the abutments is 37.00 m, and the width of the vault of the bridge is 7.75 m. An interesting feature of this structure is that the vaults of this bridge have been covered on the two faces upto the point of springing of the arch, by a screen resting on a stone beam of

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thickness 0.50 m. which is laid across the width of the arch. This beam is supported on heavy stone brackets near the ends. There is an arched niche in the centre of the screen. Except for these screens on the facades of the vault, the rest of it is an open space. In the spandrels, at some places the geometrical designs cut in the plaster have survived.

The bridge consists of nine arches, of which the central arch is widest and also gains the maximum rise.\footnote{See Plate 13.} It is 3.70 m. wide and the rise of this arch is 2.40 m. Next two arches on the two flanks are 3.00 m. wide and their rise is 2.00 m. each. Further on the width of the two arches is 2.60 m. and the rise is 1.90 m. each; width is 2.40 m. and the rise is 1.80 m. each. The two end arches on the extremities of the bridge are 2.35 m. wide each, and their rise is 1.70 m. each. All the arches are pointed in shape and have been built of carefully sorted stones, which could be used as voussoirs. The key stone is not always clear and more often smaller stones have been filled in its place. The average thickness of the bare unplastered arch ring is 0.45 m.

The piers do not vary in width like the arches that they sustain except for the two piers supporting the central arch. The central piers have a width of
of 1.80 m. each, while the remaining piers are 1.50 m.
wide uniformly. All of these rise up to the base of
the parapet, and have cut-waters on both the upstream
and the downstream side of the bridge. These cut-
waters rise to the full height of the piers, and at the
top are capped by small domical constructions. Interest-
ingly cutwaters on the upstream side are wedge-shaped,
but on the downstream side these are rounded. On the
two piers supporting the central arch, the cutwaters
project 1.10 m. from the piers and the length of the
two wedges is 1.35 m. each, while on the rest of the
piers the projection is 1.00 m. and the wedges are
1.25 m. long each. These measurements are near the
point of springing of the arches. The cutwaters do not
rise in uniform width as they give a battering effect.
Actually these cutwaters serve as battered buttresses
lending additional support to the structure on both up
and down-stream sides of the bridge.

Near both the ends of the bridge there are strong
abutments which run for a considerable length. The
southern abutment is about 4.50 m. long. But the abutment
on the northern end runs for nearly 30 m., as it in
fact serves the purpose of a bund also. Thus on the
upstream side the bed of the stream stretches over a
vast area and in the flood-time the water in the stream
makes a pool of it. There is an interesting structure
at the northern end of this bund in the same alignment. It consists of a three arched chamber measuring 7.00 x 2.75 sq.m. The arches on the eastern and western faces of this chamber are covered with screens containing circular and ablong piercings. There are two staircases one each at the southern and northern sides of this chamber, which provide access to the chamber. It seems that the water pooled on the upstream side passed through this chamber. The purpose of this structure is not clear. According to a note in the List of Monu. Delhi,'This chamber has been variously described as a bathing place and a place for the catching of the fish, but it seems probable that it was simply intended to regulate or restrict the excessive back flow of the water from the Jamna when in flood; and that access to it was provided merely to permit the clearance of silt etc. that would be left in it after subsidence of the water'.

On top of the bridge, parapets run on both sides. However, the section of the parapet on the central arch and the two flanking arches on both sides is higher by 0.50 m. than its remaining portions. The average height of the parapet on the central section is 1.70 m. and of the rest of it is 1.20 m. The road over the bridge follows the humped profile of the structure as there is a gentle ascent in its central portion while near the ends it descends gradually. It must have been paved

1 List of Monu. Delhi, II, n. 290.
with stones originally as suggested by the peeling tar coat at some places.

This structure is an interesting specimen depicting bridge engineering of the pre-Mughal period. Construction in arch, as is evident, had acquired a developed form by the middle of the fourteenth century. But, perhaps it did not generate enough confidence in the architects to attempt bold constructions by raising arches on sleek piers, thereby reducing the obstruction caused by the piers in the passage for the flow of water. Additional measures for strengthening the bridge were taken by providing heavy stone beams below arches to sustain the weight of the superstructure and by raising buttresses in the form of cutwaters on both faces of the piers. The effect of thick piers is visible in that a heavy silting has occurred under most of the arches. The stream now runs under two or three arches only. Probably the scouring has not been caused due to the fact that the volume of water flowing in the stream for most of the time is not much, and in the flood times a considerable amount of water is trapped into the pool created by the bund.
3. **Jalalpur Bridge**: Jalalpur (25° 37' N, 82° 46' E) is a small town situated 20 kms. south of Jaunpur on the road leading to Banaras. It 'derives its name from Jalal Khan, a son of Sikandar Lodi', says District Gazetteer, 'who was appointed governor of Jaunpur after the expulsion of the Shargi kings and the destruction of their palaces'.¹ Jalal Khan, it is said, wished to transfer his capital here, 'but not a vestige remains of the city built by him'.² Only a bridge spanning the river Sai flowing on the northern outskirts of the town, stands today, and is attributed to Jalal Khan, who is said to have built it in 1510.³ It is also recorded in the District Gazetteer that 'In 1566, during the rebellion of Khan Zaman, his brother Bahadur Khan broke down two arches of the bridge in order to hinder the pursuit of the imperial forces while he was retreating to Benares'.⁴ The arches were restored by Munim Khan during his governorship of Jaunpur (1567-73).

The bridge connects the town, across Sai, to the road leading to Jaunpur and is the only passageway across

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¹ District Gazetteer Jaunpur, 230.
² Ibid.
⁴ District Gazetteer, Jaunpur, 231.
the river for land traffic. Of late two parallel railways have been laid across the river over two bridges standing close to each other but at some distance east of the masonry bridge. Since this masonry bridge carries the state highway connecting Jaunpur with Banaras, it is maintained by the P.W.D. The structure, however, is built so strong that not many repairs seem to have been done except for routine maintenance. ¹

Jalalpur bridge is a fine structure built of dressed sandstone. It exhibits a superior masonry work as the laying of the stone slabs and the finish of their mortar joints is very neat. It runs north-south and spans the river Sai flowing from west to east. The total length of the bridge between the abutments is 79.70 m. and the width of the vault is 7.60 m. It consists of nine pointed arches resting on eight piers and two abutments at the ends of the bridge.² Wing walls of the abutments on both sides is built of masonry and runs for some distance, protecting the banks of the river near the bridge.

¹ In the Gazeteer of 1908, there is mention of three major floods, in 1871, 1894 and 1903, which submerged the bridge. In the flood of 1903 some damage had been done to the northern abutment walls, which were repaired in the following year (District Gazeteer, Jaunpur, 230-31).

² See Plate 14.
The arches of this bridge are executed in stone beautifully. The voussoir stones are laid carefully and the keystone is marked distinctly. The thickness of the arch ring is uniformly 0.43 m. Curiously the arches are neither of uniform width nor do they follow any pattern, though of course the central arch is greatest in width. The rise of the arches, however, is uniform at 3.60 m. except the central arch for which the rise is 4.35 m. But in the case of the central arch the point of springing is 0.75 m. below the springing of other arches; thus at the crown it is at the same level as other arches. The bridge, therefore, does not acquire a humped profile and the road over the bridge runs flat. The width of the arches beginning from the southern end is 3.55 m., 4.40 m., 4.60 m., 5.55 m., 6.50 m., 5.80 m., 4.90 m., 4.60 m. and 4.60 m. The piers on which these arches rest are, however, of uniform width of 4.40 m., and have wedge shaped projections on both sides. In fact, these projections serve the purpose of cutwaters on both sides of the bridge and they rise up to the base of the parapet on both sides. The sides of the cutwaters measure 2.90 m. each as they project to a distance of 2.60 m. each on both faces. By rising up to the total height of the bridge, these projections serve the purpose of buttresses also. The parapets on both sides of the bridge are very low. Lately, however, railings have been
fitted on these. The triangular top of the cutwaters, near the base of the parapets has been converted into a semi-octagonal balcony with the help of cross beams supported on brackets. There are four niches carved in rectangular frames on each of the four wedges of the cutwaters.

The abutments of the bridge are well formed on both ends. They also have long masonry walls in the two wings, which protect the bridge from the danger of scouring by the river. The road over the bridge is laid with tar and makes it difficult to ascertain its original character.

Jalalpur bridge is an interesting structure in stone. As is evident from the shape of its arches and their execution in single stone voussoirs, this structure reflects a fairly advanced stage of construction in arches. The piers, however, like the Wazirabad bridge are very thick as they block only a little less than half of the total passage allowed to the flow of water under the bridge. The height of the bridge is low, and as recorded in the Gazeteer results in repeated submersion of the structure in floods. Probably the height of the bridge was deliberately kept low so as to allow flood waters to pass over the bridge without endangering its stability. Construction of full length cutwaters on
both sides of the piers was thus meant for protection of the bridge from fast currents of flood waters. A significant feature of this bridge is the varying widths of the arches. One would guess that in the piling of the piers of this bridge some attempt was made to excavate up to a depth where firm foundation was available. Perhaps an outcrop of sedimentary rock below the bed of the river would be used to lay the foundation. In such cases it would be difficult to keep a uniform or regular spacing between two contiguous piers, resulting in unequal width of the arches raised over these piers. A correct idea, however, could only be formed after test excavation of the foundations of any one or more piers. It is to be noted that in spite of the existence of thick piers, which block a considerably large waterway, the bridge has not been subverted by the river. We may attribute this to the low height of the bridge on account of which the flood waters would pass over the bridge submerging it fully. Moreover, the banks of the river are very steep and near the bridge, on both sides run masonry wing walls. It is, therefore, very difficult for the river water to scour past the banks. Despite the silting of the river bed, which has also partly blocked the arch at the northern end, the bridge has not been abandoned by the river.
4. **Sarai Pul Bridge:** Sarai Pul has been identified on the basis of the information given about it in Chahar Gulshan, as a place which stood on Nahr-i-Faiz, at a distance of about 5 km. south of Karnal.\(^1\) A stone bridge spanning the canal at this place was noted by Monserrate during his journey with Akbar on latter's march against Mirza Hakim in 1581. He writes, 'Leaving Panipatum and passing by the town of Camaris, we came to a tributary of the Jomanis. The infantry crossed this by a stone bridge, without any of the crowding or tumult which sometimes occurs in narrow places. The elephants, camels and cavalry, in accordance with the orders which had been given to them, crossed by a ford'.\(^2\) Monserrate's 'tributary of the Jomanis' is possibly Firuz Shah's hajivah,\(^3\) excavated and renamed by Akbar as Shekhuni,\(^4\) and depicted in the Indian Atlas sheet as Rajub canal.\(^5\) There also survives a farman (sanad) of Akbar dated AH 978, concerning the renovation of Finez Shah's canal, which records Akbar's orders for making

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1. Cf. Habib, Atlas, Sheet 8B, 29t, 76t & 12,b. He has cited CG. f. 138a for the location of this bridge.

2. Monserrate, 98.


4. Cf. Abha Singh, "Irrigating Haryana - The pre-Modern History of the Western Yamuna Canal", Aligarh Papers on Medieval Indian History, presented to the 43rd session of the Indian History Congress at Kurukshetra, 1982. This is a brilliant account recapitulating in the main, Akbar's efforts at excavating & reviving Finez's canal.

SARAIPUL

PLATE 15
the canal navigable and building bridges on it at different points. The bridge mentioned by Mousserrate was perhaps built thus; there is also reference to the existence of a similar masonry bridge on the canal at Safidon.²

The bridge stands on G.T. Road at a place called Madhuban in Haryana, at 27 kms. north of the town of Panipat and 5 kms. south of Karnal. Until a few years ago, the main road was carried over the bridge, but the construction of a new bridge, nearly 20 m. to the west of it, has now diverted the road over the latter. Older bridge now stands desolate. It is a three arched structure built in stone.³ The canal, which it spans, has dried up now, but the course of this canal near the bridge is well marked. The total length of the bridge between the abutments is 27.25 m. and the width of the vault is 2.80 m.

The central arch of the bridge is 6.45 m. wide and the two flanking arches on both sides are 5.90 m. each. The rise of the central arch is 4.20 m., while

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1 The farman (sanad) has been translated by Lt. Yule in "A Canal Act of the Emperor Akbar with some notes and remarks on the History of the Western Jumna Canal", JASB, 1846, AV, 213-23.


3 See Plate 15.
there is a drop of 0.40 m. in the rise of other two arches. The bridge has thus acquired a camel-back shape, which is also evident from the alignment of stone slabs forming the pavements over the bridge on both sides of the roadway. The two piers sustaining the arches are 4.50 m. thick and have prismatic projections of 2.25 m. on both, the up and down stream, sides. These projections are in fact integrated with the piers and are a part of the total structure of the piers, as they serve the purpose of cutwaters. They rise only upto the point of the springing of the arches. Above each of these cutwaters stand a turret extending upto the total height of the bridge. These have the form of a semi-octagon with regular sides, each of which is 0.67 m. long. The purpose of these turrets is only decorative as they break the monotony of an otherwise simple construction in stone.

The abutments of the bridge are not formed strongly. The parapets on both sides rise to a height of 0.80 m., and at the ends have four tapering minarets of height 2.35 m. These are octagonal in shape, each side of which measures 0.56 m., and are capped by solid domes of height 0.64 m. each. The road is laid with tar at present, with pavements on both
Sarai Pul is an interesting structure as it is built on a canal. There are two important features associated with canals: (a) the flow of water in the canal does not permit enough silting, and whatever little is done, is cleared periodically. There is, therefore, little possibility of the blockade of water-way forcing the stream to cut in a new channel for itself; and (b) the course of a canal is properly defined, so that the possibility of the erosion of its banks may be ruled out. The construction of a bridge over a canal, therefore, may not require as thick piers as needed in a river. It seems, however, that this fact was not accounted for by the Mughal architects; the piers are only marginally thinner than the arches. The waterway blocked is one third of the total. Clearly, the construction is uneconomical in terms of the cost of the bridge.

5. Chhaparghat Bridge: Chhaparghat is a small place situated 8 kms. east of Bhognipur on the road leading to Ghatampur. Incidentally, the old Mughal highway followed a similar course as shown by Irfan Habib in his Atlas.¹ Chhaparghat is famous for its

¹ Cf. Habib, Atlas, Sheet 8B.
fine sarai containing suites for the travellers. A small river Sengur flows close to the sarai at this place; about one km. to the south the river merges with Jamuna. Immediately to the east of sarai stands a stone bridge, which spans the river Sengur east-west. The road running along the outer wall of the sarai towards north, passes over this bridge. The course of the river is in badland here and the banks of the river are very steep. The earliest notice of the bridge was taken by Finch in 1611; subsequently Mundy and Tavernier also recorded the existence of a bridge at this place. Tavernier says, 'You cross this river Sengar by a stone bridge, and when you arrive from the Bengal side, to go to Sironj and Surat, if you wish to shorten the journey by ten days, when quitting the road to Agra you must come as far as this bridge, and cross the river Jumna by boats'. The author of Mirat-ul Haqaiq ascribes the bridge to Akbar.

2 Finch, Early Travels, 179
3 Mundy, II, 89.
4 Tavernier, I, 93.
5 Mirat-ul Haqaiq, f. 137 b. Also see Atkinson, Vol. VI, 405, n2, which says that the bridge and sarai were built by an officer of Aurangzeb.
Since the bridge carries the road from Bhogripur to Ghatampur which connects with Fatehpur via Kora Jahanabad and Bindki Khas, it has been kept in good repairs over these years. No major modification seems to have been made in this structure. Only the road and the parapets seem to have been relaid. The bridge thus retains its original plan and provides an interesting specimen of late sixteenth century bridges in India.

It is a seven arched bridge built in dressed stone. As this region is dominated by Jumna ravines the site at which this structure stands is marked by very steep banks of the river Sengur. The bridge, therefore, unlike other structures of this type, assumes a great height. There is hardly any possibility of the submersion of this bridge during the floods. The bridge, which stands east-west, is therefore built to withstand the pressure of the water even in the peak floods. The length of the bridge between the abutments is 80.00 m., and the width of its vault is 9.00 m. It stands on seven

1 See Plate 16.
pointed arches resting on six piers. The bridge has been built in slabs of grey stone, which are cemented with the lime mortar. It was originally plastered all over, some of which has peeled off now. In the spandrels of the central arch, where the plaster is intact, floral designs with words \textit{Allah} in the middle have been cut in the plaster. There is no other ornamentation in the structure, which is very simple in its looks.

The most important part in this bridge is the foundation of piers, which have fortunately been raised up to the bed of the river. The foundations are 5.80 m. wide and have wedge shaped projections both up and down stream sides. The piers are raised above these foundations. The unusual height which this bridge attains due to its peculiar location perhaps necessitates additional projections against floods. High foundations have been devised to meet this demand. Moreover, as we have noted in the preceding section, the foundations have been spread over a large area to offset the deficiency caused in the strength of the bridge, presumably due to the inability of the architects to lay the foundations on a firm base below the bed of the river.
The bridge stands on seven arches, each measuring 8.00 m. in width. The central arch is higher by nearly 25 cms. than the rest - the rise being 3.90 m. for six arches and 4.15 m. for the central arch. However, the width of the central arch does not change. There is a slight hump in the centre of the bridge. But it does not become noticeable due to a great length of the bridge. The surface of the road on the bridge appears flat. The arches have been elaborately designed and the keystones are quite prominent. But the width of the arches are not in proportion with the height of the bridge. Therefore, they give the looks of narrow arches in comparison to the height of the bridge.

The piers of the bridge are solidly built and have 4.00 m. width for each. Both the ends of the piers are wedge-shaped and project 2.35 m. on each side. These projections rise upto the point of springing of the arches. The foundations are nearly 2.00 m. wider than the piers, and provide a strong base for building high piers.

The abutments of the bridge are formed properly and extend on both sides of the bridge. At the eastern end the abutments run upto a distance of 5.90 m. and are almost in line with the last arch.

Chhaparghat bridge is a unique example of Mughal masonry bridges. It seems to contain a number of
features that distinguish it from the general run of Mughal bridges. Possibly the innovations found in this bridge were dictated by the peculiar topographical setting in which it was placed. The most remarkable feature of this structure is that the thickness of the piers is only half of the arch spans. The waterway allowed under the bridge is thus more than two-thirds of the total span. The thickness of the piers in this structure, it seems, was reduced purposely. The location of the bridge is such that there are steep banks on both sides; the height of the bridge, therefore, can not be reduced to prevent the chances of erosion during the floods by letting excess water submerge the bridge and flow past it. Necessarily then the architects had to resort to reducing the width of the piers to permit a larger waterway under the bridge. An additional measure of strength envisaged by them was of course the widening of the foundation and raising it up to the level of the river-bed. Interestingly, however, this improvement does not seem to have been incorporated in the structures built subsequently, most of which continued to be plagued with the problem of scouring due to a constricted waterway.
6. Athpula: 'The tomb of Sikandar Lodi is situated in what is known as Lodi gardens today. Originally the site inhabited village Khairpur, part of which was made into a large beautiful garden during the British period. Close to the tomb of Sikandar Lodi, flows a stream, which is probably a branch of the Jumna. About 100 m. east of the tomb, over this stream stands a masonry bridge called Athpula,¹ which is of very similar construction to the Barapula on the Muthra road'.² According to a local tradition, the bridge is said to have been built by one Nawab Bahadur who had been at Kabul in the time of Akbar.³ It is, however, difficult to ascertain the precise date of its construction. Presently this structure stands in the precincts of the Lodi gardens immediately to the south of its gate No. 4.

In fact access to the garden from this gate is provided across this bridge. Since this structure was enclosed within the garden and was thus saved from the pressures of rapidly growing vehicular traffic, it has retained most of its features in their original form without

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¹ Cf. Sharp, op. cit., 117 n. 1, which says: 'The Ath Pulah at Sikandar Lodi's tomb has seven arches, the Barah Pulah has eleven. So the numbers of the names do not correspond with the number of arches. They probably indicate the piers or else the pairs of small columns'.
² Ibid, 65; Carr Stephen, 170.
ATHPULA

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PLATE 17
much mutilation or modification. Of late, the stream flowing from west to each has been closed near the eastern end of the garden, some 50 m. from the bridge, and the course of the stream in the garden has been paved with stones on both the banks. A pool of water has thus come to form near the bridge, which is used as a source from where the water is pumped in the garden for irrigation.

Athpula is a seven arched structure running north south over the stream which flows from west to east.\(^1\) The total length of the bridge between the abutments is 40.80 m. and the width of the vault is 9.50 m. There is a gentle ascent in the profile of the bridge from both ends till the centre, which is the highest point. The bridge has thus acquired the shape of camel's back. Curiously, the material used in the construction of this bridge is both, the loose stone rubble and dressed slabs of grey stone, perhaps quarried locally. The stone rubble has been used only in the vaults, which were originally plastered. The rest of it is a construction in stone slabs which are of an average thickness of 0.35 m. The length of these slabs, however, varies from 1.00 m. to 0.35 m. These stones have been arranged in irregular course as they do not follow any particular pattern.

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\(^1\) See Plate 17.
As we have noted above, the bridge has seven arches which decline successively in width as well as in rise on both sides of the central arch. The width of the central arch stands at 3.80 m., of the next two on either side at 3.50 m., next 3.20 m., and of the arches near the end at 2.80 m.\(^1\) The rise of the central arch is 1.90 m., which drops successively to 1.80 m., 1.70 m., and 1.50 m. It would seem that the arches in Athpula are flatter than other bridges. In fact there are four central arches and are constructed in a very bold fashion within the rectangular recesses provided between the piers. They spring distinctly over the piers with voussoirs of depth 0.50 m., laid very carefully along side each other to prevent any settlement between them. Only a very thin layer of the mortar seems to have been used between the voussoirs to join them. The key stone is also very well marked. But unlike the usual form of keystones fitted at the crown over the entire width of the arch ring, in the arches of this bridge, the voussoirs adjacent to the keystone are shaped in a manner that at the soffit they cover the final space. Thus the keystone is a smaller stone than the voussoirs, which fits closely into the wedges at the crown. Presumably, in the formation the pressure

\(^1\) The corresponding measurements given by Cunningham and quoted in the *List of Monu. Delhi, II*, 38-9 are as follows: Middle arch: 12' 4"; two next arches: 11' 4\(\frac{1}{2}\)"; two next arches: 10' 4"; Two outer arches: 9' 1\(\frac{1}{2}\)"
exerted by the keystone, besides dividing the horizontal pressure, brought the adjacent voussoirs closer.

Athpula has eight piers, two of which, at the ends, serve the purpose of abutments. The width of all these is 2.25 m. each. Each pier has wedge-shaped projections on both sides, which extend to a length of 0.75 m. The wedges are 1.25 m. long, and act as cutwaters. These cutwaters extend up to the springing line of the arches. At the top of the cutwaters, the space between the two arches is filled by a circular fluted and engaged pilaster formerly topped by an octagonal finial.\(^1\) The vaults rising over the piers are built in loose stone rubble and were originally plastered, which has peeled off at places.

Above the crown of the arches runs a moulded string course which follows the curve of the bridge, while below this is a pinjra cresting.\(^2\) The parapet of the bridge rises some 1.10 m. above the level of the roadway. The top width of the parapet is 0.60 m., and it was 'formerly crowned with a moulded coping'.\(^3\) The roadway is paved with irregular slabs of grey stone.

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1 List of Monu. Delhi, II, 39.
2 Ibid.
3 Ibid.
The design and lay-out of Athpula resemble the Barapula near Nizamuddin. It may, therefore, be presumed that Athpula was built at almost the same time either at the close of Akbar's reign or the beginning of Jagangir's reign. Since the bridge was built on a small stream, the abutments have not been made very strong as there was little danger of the stream swaying past the bridge by cutting at the banks.

7. Dakhni: This place derives its name from a Mughal sarai called 'Dakhni Sarai'. It is located in village Jahangir at 8 kms. west of Nakodar on the road leading to Sultanpur in Panjab. A river 'Dhauli-veni' or White Bein flows on the northern side of the village. An old ruined bridge stands on this river at 400 m. from the sarai towards east and 200 m. from the village towards north. Presently the river flows further west of the bridge as it lies abandoned. On his return from Lahore in 1607, Jahangir halted at this place. Besides other things he also noted that his father had granted some money to Abul Fazl for the construction of a bridge here. Jahangir had given orders for the construction of a building and laying out a garden on

1 Habib, Atlas, 12,a.
the side of this bridge. The building perhaps alludes to the sarai, while the neighbouring village called Jahangir may indicate the site of the garden. Cunningham has noted this bridge and gives a brief description in the following words: 'There is another Badshahi bridge of similar construction (as the two at Sultanpur) which once spanned the Dhauli-Veni river at Dakhini Sarai. Only five of the arches now remain, the stream having swept away the other half of the bridge'.

The structure of the bridge extends east-west as its total length between the abutments is 41.75 m. It is built of 'lakhauri bricks cemented with lime mortar. The arches have been executed with great care and are all pointed in shape. The structure was originally plastered but now only a few traces have survived. The bridge is devoid of all ornamentation. There has been considerable silting below the arches and the river has completely deserted its former course under the bridge.

Two massive abutments stand on both ends of the bridge, but have been destroyed partly.

1 T J., 64.

2 Arch. Survey Reports, AIV, 57. Cunningham is not correct in suggesting that half of the bridge was swept away by the river. In fact both the abutments at the two ends are still existing, and the five arches extending between them complete the structure. If Cunningham has to be believed, we should imagine that the bridge was built in two parts, one of which has survived the ravages of the river.
The bridge stands on five arches of width 4.75 m. each.¹ These arches rest on four piers and two end abutments. The design of the arches and the workmanship is of a superior quality. The bricks have been systematically arranged as voussoirs and the keystones. The central arch is higher than the others as there is a decline of 0.20 m. in the rise of arches successively on both sides of the central arch. As a result of this variation, the profile of the bridge has become curved.

The piers of the bridge are simple in design. Each has a width of 4.50 m., and two wedge-shaped projections at both up and down stream side to act as cut-waters. The length of the projections is 2.25 m. each. These projections rise upto the point of the springing of the arches.

The road over the bridge is 9.50 m. wide and is paved with lakhairi bricks arranged vertically. Thus the thickness of the surface of the road becomes 0.20 m. The road is enclosed on both sides by 1.00 m. high parapets.

This structure provides an interesting illustration of the limitation of the general design of medieval arch bridges. As is evident from measurements,

¹ See Plate 18.
the piers of this bridge are almost as wide as the arch-spans. Thus out of an overall waterway of 41.75 m., the passage blocked by piers is 18.00 m., which is only slightly less than half. This resulted in the deposit of silt below the arches and ultimately the river adopted a new course by cutting through the east bank. Some idea of the scouring action can be had from the fact that the western abutment, which was spared by the river, measures nearly 13.00 m. after partial destruction. The river might have cut almost the same length, if not more, before beginning to flow in a different channel.

8. Sultanpur: Sultanpur is a small town situated 30 kms. west of Nakodar in Panjab on the Mughal route to Lahore. A river called Bein flows on the northern side of the town. Two old masonry bridges, spanning the stream in its original course stand at two different places, nearly 400 m. apart. These structures date back to different periods because in 1615 when Richard Steel and John Crowther, two English travellers, passed through this place they mentioned only one bridge 'with Sixe Arches' lying across the river. It was in 1878-9

1 See Habib, Atlas, Sheet 4B, 31°, 75 E.

2 Richard Steel & John Crowther in Purchas His Pilgrimes, Glasgow, 1907, IV, 268-9.
that Cunningham recorded two bridges at this place, and gave the following description: 'To the north of the Serai there are the remains of two different bridges which once spanned the Kalwa or Kali-Veni River. They were both built on well foundations; but as the piers have the same thickness as the span of the arches, one half of the waterway was obstructed, and the river, like Virgil's pontem indignatus Araxes, soon made a way for itself by cutting away the bank at one end of the bridge. The upper bridge is said to have been built by Jahangir, which is no doubt true, as it stands on the old high road to Lahore, which is still marked by a kosminar closeby. The other bridge is attributed to Aurangzeb'. Clearly the bridge ascribed to Jahangir is the same as mentioned by Steel and Crowther in 1615. Cunningham has also given a site plan of Sultanpur depicting the location of both the bridges and the course of the river in his time. It is evident from this plan that the river has shifted further north.

1 Arch. Survey reports, IV, 57

2 See Plate 19. Cunningham has faltered in the dating of these bridges and has reversed the order. For, the presence of arched piercing over the piers in the so-called Jahangiri bridge is a feature found in the bridges built during the latter half of the seventeenth century. See Arch. Survey Reports, II, 325-7.
from the time when it flowed under the bridge, and both these are standing abandoned now.

The location of these bridges in such close vicinity to each other is a curious feature. In fact both these bridges together present an interesting case of the meandering of the river due to the faulty designing of the bridges. It would appear from the site plan that at different points of time at least three attempts were made to provide a bridge across the river but in each case the river subverted the bridge. We give below a description of the structures of these bridges and follow it with a comment on the behaviour of the river. For the convenience of description we have denoted the sites of these bridges as 'A' and 'B' in the site plan.

The structure standing at 'A' seems to have originally consisted of three parts, of which only two at the southern and northern banks respectively survive now, the one in between having been washed away completely in an early flood as it has not been depicted by Cunningham in the site plan. From the design and dimensions of the piers and the arches in

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1 This is evident from the position of the two abutments, one standing at the northern end of the first part and the other at the southern end of the third part.
both the surviving parts it can be suggested that they were built at different points of time.

The first part of the bridge stands at the southern bank of the river and extends north-south between two massive abutments. The total length of the bridge between the abutments is 51.20 m. as measured by us, while the width of the vault is 8.70 m. It has seven pointed arches resting on thick piers numbering six. The span of the three arches in the centre is 4.00 m. each and of the next four arches, two on each side, is 3.80 m. each. The width of piers, however, is uniformly at 4.00 m. Towards east the pier length is projected by 2.00 m. and the ends are wedge-shaped. Thus it acts like a cutwater. This wedge-shaped projection rises only up to the point of springing of the arch. There are no such cutwaters on the western side, probably due to the flow of river being east to west.

This part of the bridge was built of finely cut small bricks (lakhauri) cemented with lime mortar. The entire structure of the bridge was originally plastered. But presently most of the

1 See Plate 20.
plaster has peeled off. Only on top of the projections survive inverted lotus motif cut in the plaster.

The abutments of the bridge survive at both ends but only the southern abutment is intact, the northern one being destroyed partly. The width of the southern abutment is 4.40 m. and there are steps in its eastern face to reach the road.

The other surviving part is located at the northern bank of the river. The discontinuity between these two may have been occupied by another part of the bridge, which does not exist now. This part is a smaller structure as it consists of only three arches resting on end abutments and two piers. The width of each arch is 2.55 m. and of each pier is 2.50 m. On the eastern side the piers project 1.25 m. and their ends are in a wedge-shaped form. These projections are decorated with the design of a kalash capped with inverted lotus. To the west, however, the piers project in the shape of a semi-hexagon.

The length of the bridge between the abutments is 12.65 m. and the width of its vault is 9.40 m. It is thus wider by 0.70 m. from the first part. The width of the road on the bridge is 9.00 m. Of the two abutments, the one on the southern side is ruined.
partly under the effect of water corrosion. The river at present flows from under this part, having shifted from its original course near the southern bank.

The second bridge located at 'B' consists of five arches of width 3.50 m. each, sustained by four piers and abutments. The width of each pier is 3.30 m. and it is projected at both ends in the form of a prism. However, as the piers have been largely buried under earth deposit now, we could not measure the projections. An interesting feature deserving notice in this bridge is that the upper part of each pier is pierced by a small vault of 1.00 m. span. This is probably an additional passage for the flow of water during floods. Similar piercings, it may be noted, were recorded by Cunningham in the Narwar bridge.

This bridge is also built of small bricks cemented with lime mortar, and like the neighbouring structure was plastered originally. The total length of the bridge between the abutments is 30.70 m. and the width of the vault is 7.10 m. The width of the

1 See Plate 20.
2 Arch. Survey Reports, lIV, 325-27.
abutment on the southern side is 2.85 m. The road over the bridge is 6.90 m. wide. As has been noted earlier and also shown in the site plan, it is lying abandoned now - the river has drifted further north of its original course.

These two bridges together present a very interesting specimen for the defective designing of masonry bridges where excessively thick piers cause the river to drift away from the bridge. A close look at the plan of the site enables us to reformulate the entire process of the shifting of river channel in different courses at different point of time. It seems that originally the river flowed along the southern bank, where the bridge at 'A' was built during Jahangir's time. But the design of the piers in this structure was such that nearly half of the total space available for the flow of water below the bridge was occupied by the piers. The river, therefore, cut through the northern bank and put the bridge to disuse. At this stage two options were available to meet this problem. One was to build a new bridge at some convenient place upstream side, because the river had not drifted from its original course there. The other option was to extend the existing bridge towards north and span the
new channel. It is difficult to say with certainty as to which course was eventually adopted. The possibility, however, remains that the first option was chosen and a new bridge was erected at site 'B'. Even in this structure the pier width was not reduced to any effective limit, though of course an additional feature in the piercings was introduced. This was, in any case, a measure protecting the bridge from the thrust of the flood-waters. It did not solve the problem of silting at the heavy piers. The river, therefore, straightened its course by subverting the bridge towards north. At this stage perhaps recourse was taken by providing an extension towards north in the first bridge at 'A'. But this extension also seemed to have met with the same fate. Ultimately another extension below which the river flows at present, was provided. But one may suspect that in some floods the first extension was completely washed away, thus rendering the second extension too out of use.

9. **Phutra Nala Pul:** On the road leading from Shikohabad to Etawa, at about 15 kms. north of Etawa is a village BistenKa Nagla. It is situated at a distance of nearly 50 m. towards the east of road. The Tunda-Kanpur section of railway line runs parallel
to the road close to the village on its western side. Between the railway line and the road also runs the course of a river Sirsa called locally as Phutra Nala. The river crosses the road 2 kms. further ahead of this point towards south. An old bridge stands on Sirsa to the north-east of the village Bishan Ka Nagla at about 150 m. This bridge is locally called Phutra Nala Pul, and has not been mentioned in our sources. A visual inspection of the bridge, however, makes it clear that it is a medieval structure built of lakhauvi bricks cemented together by lime mortar. Some traces of road running on both sides of the bridge can still be seen. Since the alignment of the old Mughal highway was not much different from the present road, it may be presumed that this bridge carried the old route across Sirsa at this point. There are the ruins of a tank, 50 m. east of the bridge. The side walls of the tank, built of lakhauvi, have survived at few places. This seems to support our presumption about the date of this bridge. Presently the bridge stands amidst fields, which are cultivated. Since the channel of the river is deep, it does not become visible till one reaches very close; the bridge seems to grow out of the ground from some distance. When the crops stand in the field, only the heads of turrets standing at the
two ends are visible from a distance. The channel is still active and carries some water all round the year; the banks on both sides are very steep. Fortunately the bridge has not suffered any considerable damage. It seems the old road was abandoned pretty early and the bridge has since been used by the neighbouring villagers only. Not many repairs, too, seem to have been carried, and so the effect of weathering is quite visual. Barring a patch of about 51 m. of the old paved road, on both sides of the bridge, the rest has been totally obliterated.

The bridge extends north-south and its length between abutments stands at 14.29 m. The width of the vault of the bridge is 5.48 m., but the road on the bridge is only 4.57 m. wide. The material used in the construction of bridge is lakhauvi bricks, which are cemented with the help of lime mortar. The bridge has three arches raised on two piers and two abutments at the ends. There are two pairs of domed burjis at ends. Atop the domes are inverted lotus motifs as finials. The entire structure was originally plastered, but most of it has peeled off now. The river flows from west to each and over the

1 See Plate 21.
years has silted the southernmost arch.

As noted above the bridge has three arches of four-centered pointed shape. The central arch measures 2.81 m. in width and the two flanking arches on both sides measure 2.00 m. each. Central arch has a larger rise also as it measures 1.67 m., while the other two have a rise of 1.47 m. each. As a result of the bridge has adopted a slightly curved profile. The arches are executed nicely and are built in lakhauḍi bricks. There was, however, some difficulty at the crown in fixing the keystone. Thus instead of making keystone by weding the bricks, three blocks of kankar stone have been used in their place to form the keystone. In fact kankar stones have also been used to form the top layer in the piers over which the arches take a spring, and also in the arches at the two points of compression as shown in this figure:

![Diagram](image)

The thickness of the arch rings are: central arch - 0.76 m. the other two side arches - 0.60 m. each. Incidentally, the proportion in which the central arch is wider than the two flanking arches, it is not in the same proportion higher than these, so that the central arch looks flatter.

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1 The ratio in the rise is 1.136:1, but in the width is 1:1.405.
than the rest and the curve in the profile of the bridge is not so prominent.

The two piers of the bridge are 1.87 m. wide each. The abutments of the bridge are also similar in design and measurements to the piers. Thus in effect there are four piers of 1.87 m. width each, sustaining the three arches. Interestingly, on both ends of a pier are cutwaters projected in a rounded shape which rise upto the total height of the bridge. The projections of these cutwaters are 1.60 m. in thickness. Four of these cutwaters on each face of the bridge, actually serve the purpose of buttresses also, providing additional strength to the structure. Perhaps for this reason, despite the erosion of the cutwaters near the bottom by the river water, the bridge has not caved in.

The parapets of 0.55 m. width and 0.71 m. height run on both sides of the bridge. Some plaster on parapets has been retained even today. The road running over the bridge is paved with kankar blocks of width 0.54 m. and length 1.14 m. But the portion of the approach roads near the two ends of the bridge are metalled.

In the local tradition the bridge is ascribed to Lakhi Banjara, who retained the flock of hundred thousands cattle. Sometimes the bridge is also associated to an old woman who cheated and strangulated
travellers passing over this bridge, with the help of her two sons. The design of the bridge, however, suggests that it was built sometimes in the first two decades of the seventeenth century. Beautifully built arches and the burjis makes it resemble with the Barapula bridge in Delhi.

This structure is an interesting case for the study of the behaviour of the river in a given topographical setting. As is evident, the piers are almost as wide as the arches, so that the ratio between the total waterway under the bridge and the waterway blocked by the piers is 1.91:1. The river should, therefore, in the normal circumstances have eroded through a bank and diverted past the bridge. But as noted earlier, the banks of the river are very steep, and despite the fact that the river carries water all round the year, and a considerable silting has occurred near the southern arch, the banks have not been cut. An additional factor, perhaps is that the approach roads here serve as embankments, containing the spread of the river.
APPENDIX 4

Extant Masonry Bridges of the Mughal Period

As stated earlier the information on masonry bridges outgrows similar information on all other types. The masonry bridges therefore form the core of the specimen selected for our study. There are frequent references in the chronicles to the existence of masonry bridges during the Mughal period. Most of these also find a notice in various archaeological reports. Some have even been described at length in the reports of the Archaeological Survey of India. The available information on the specific measurements of some of these bridges has been given in a tabular form in appendix 2. This table, as we have seen, can be a very useful guide for discerning the changes in the standard designs of the Mughal bridges over a longer period.

Moreover, we can have an approximate idea of the economic and strategic significance of the Mughal bridges only if we are aware of their geographical distribution. For this it is important to know the locations of the individual bridges in terms of the rivers or water channels they span and the highways on which they are located.

To make available information on the above aspects and also to collect all the scattered pieces on medieval bridges for ready reference, it has been considered useful to furnish a catalogue of all the bridges known to have existed during the Mughal period. Here the arran-
gement follows a regional classification which conforms to the pattern adopted in the Atlas of the Mughal Empire for various sheets. For making this catalogue comprehensive I have also included in it brief references to the ten bridges surveyed and described at length in this thesis elsewhere. Wherever available, the measurements of the bridges have also been noted. It may be pointed out here that the exact year of the construction of the individual bridges could be ascertained only in a few cases. But on the basis of the designing and techniques used in these bridges, it has been possible to ascribe them to different periods. In this catalogue the individual bridges are identified either by their popular names or by the names of the localities where these stand, or sometimes also by the rivers or streams which they span. It goes without saying that a considerable part of evidence particularly that coming from Persian manuscripts is borrowed by me indirectly from Irfan Habib's Atlas of the Mughal Empire.
1. **SURKHAB**: Surkhab is a town located on the route from Kabul to Khyber pass which was the main line of communication between Kabul and Lahore during the Mughal period.\(^1\) Interestingly this route is intersected all along its length, but especially between Khyber pass and Kabul, by numerous streams, yet it did not possess any masonry bridge on this portion of the route till as late as Shahjahan's reign. Probably most of these streams were seasonal rivulets and could be easily crossed at fords over a major portion of the year. The construction of a masonry bridge on this route is attributed to Ali Mardan Khan in 1646.\(^2\)

The bridge is located at a place called Surkhpul, nearly 90 kms. east of Kabul; river Surkhab flowing 'along the south of Adinapur',\(^3\) crosses our route at this place. The completion of this bridge on Surkh in 1646 must then have improved the position in the Kabul region of the Mughals considerably from the point of view of logistics. It is significant especially in the context of Mughal invasion of Balkh and Padakhshah in the reign of Shahjahan.

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\(^1\) Cf. AN, III, tr., 528-31. \(^2\) Cf. Mohan Lal, 339-40.

\(^3\) Kabib, Atlas, Sheet 1A-B, 34+, 69+

\(^4\) BN, 1, 209; Also Moorcroft & Trebeck, II, 487.
The description of this bridge survives in the journal of an officer of East India Company, kept during a journey to Turkestan across Hindu Kush, to select a batch of suitable stallions to improve the breed of horses in the military stud of the company. This expedition was undertaken in the first quarter of the nineteenth century and his notes etc. were since published in 1837. A similar notice of this bridge was available in another travel account written only a quarter of a century later. Incidentally, the latter also recorded the translation of an inscription 'engraved on a black stone of the rock by the bridge'. It reads: 'In the reign of the impartial Shahjahan, the founder of this bridge was Ali Mardan Khan. I asked Wisdom the date of its erection; it answered, "the builder of the bridge is Ali Mardan Khan". The date computed on the abjad powers of the chronogram and commuted into Christian calendar comes out to be 1646. According to Moorcroft & Trebeck the structure of the bridge was repaired around 1815 by one Akram Khan, possibly a local chieftain.

1 Moorcroft & Trebeck, II, 487.
2 Mohan Lal, 339-40.
3 Ibid.
We have two different set of measurements for this bridge, the two varying only slightly. According to Moorcroft & Trebeck, 'The bridge was one hundred and seventy yards long, and eighteen feet broad, with a single arch: it was flat at top, with a low parapet on each side'. ¹ In the other description, Mohan Lal too refers to the existence of only one arch, but the length and breadth of the bridge have been given as 200 yards and 8 yards respectively. ² This discrepancy in the figures for the measurements of the bridge may, possibly, be explained by the fact that some repairs in the structure were carried out by Akram Khan around 1815. Thus in 1846, when Mohan Lal recorded the measurements, these were probably for the repaired structure.

2. Gandamak: Gandamak is a town located nearly 100 kms. east of Kabul on the route to Khyber pass. ³ It is situated immediately to the west of Nimla pass and must have been an important stop on this route during medieval times, by virtue of its strategic location. This region was also famous for its wheat

1 Moorcroft & Trebeck, II, 487.
2 Mohan Lal, 339.
crop. At Gandamak a 'rivulet of some size' crossed the route; but it was not provided with a bridge till the second quarter of the seventeenth century. Perhaps for the same reason as the river Surkhab was bridged by Ali Mardan Khan in 1646, Gandamak was also provided with a bridge on this rivulet during Shahjahan's reign.

The first notice of this structure was taken by Moorcroft & Trebeck: 'Beyond Nimba we entered the district of Gandamuk, which is famous for its wheat, and crossed a rivulet of some size by a bridge of two arches, erected, as an inscription on it records, in the reign of the Emperor Shah Jehan'. Nearly twenty-five years later, the same structure probably had given an awesome impression to Mohan Lal as he recorded that he 'crossed a very large and dangerous bridge on the road.' In both these notices, we do not have any reference to any measurement except that the bridge has two arches.

3. **Peshawar**: The route between Peshawar and Attock passed through Sarai Daultabad, Sarai Bara and Khairabad.

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1 Cf. Moorcroft & Trebeck, II, 486.
2 Ibid.
3 Mohan Lal, 65.
4 Cf. Tj, I, tr., 101-2.
Between Chirawara and Attock it almost ran parallel to the course of the river Kabul. Thus after crossing the Indus at Nilab no major river was encountered till, near Peshawar, river Bura crossed this route. A bridge was constructed on this river in the eastern outskirts of the town during Shahjahan's reign. According to an inscription placed on the bridge originally, it was built 'by Abdul Latif Khan under the supervision of Daud bin Abu Muhammad Quraishi in 1039 A.H.*(1629 A.C.)* i.e. in the third year of Emperor Shah Jahan's reign.' The bridge is no longer in existence but the inscription has been preserved in the Peshawar Museum.

1 Cf. habio, Atlas, Sheet 1A-B.
3 S.M. Jaffar, op. cit., 114-15. The English translation of the inscription as given by him is reproduced here: 'Emperor Shah Jahan, the Champion of the Faith. Praise be to Allah by whose grace foundations of great charitable institutions have been laid by that lover of the largehearted, Abdul Latif, the like of whom the world has seldom produced. He founded a bridge in Peshawar. May it endure as long as the world subsists. To record the date of its completion the arithmation said: "May this charitable work perpetuate and prosper". In the reign of His Majesty, the Shadow of God, the second Lord of the auspicious planetary conjunction (Shah Jahan) and in the days of the rule of Nawab (Lashkar Khan) under the supervision of the slave of the loving God, Daud bin Abu Muhammad Quraishi it received the honour of completion.'
HASAN ABDAL: The imperial Mughal route from Lahore to Attock passed mainly through Shahdara, Laminabad, Gujrat, Khawaspur, Rawalpindi and Hasan Abdal. It has been described time and again and some idea of its importance can be had from a remark by Baron Charles Hugel that 'The great imperial route formerly leading from Hindusthan to Kabul passes from Hussein Abdal to Lahor, and Serais were built along it at intervals of every six kos from each other'.¹ Starting northwards from Lahore, this route crosses three major rivers of the Indus system viz. Ravi, Chenab and Bihat, besides numerous smaller rivers and rivulets. We do not find any mention in our sources, of the existence of a masonry bridge on any one of these major rivers. However, there are references to the existence of as many as four masonry bridges on smaller rivers at different places (Hasan Abdal, Gujrat, north of Shahdara and Shadara).

Beginning from north-west the first of these bridges was located at Hasan Abdal. The road between Hasan Abdal and Rawalpindi ran through a difficult rocky profile and at the pass of Margala, nearly 15 kms. south of Hasan Abdal, the hills were cut to provide a paved roadway under the orders of in 1672.²

¹ Hugel, 226-7.
² Cf. Moorcroft & Trebeck, II, 455; Eurnes, II, 60; Hugel, 226-7. Also see Indian Antiquary, III, 203 for an inscription placed there.
At a distance of about one km. to the north - after crossing this pass - ran a small river known as Kalapani. It was provided with a 'substantial bridge'\(^1\), built possibly at the same time as the paved roadway was cut in the rocks across Margala pass. According to Alexander Burnes, 'The defiles continue for about a mile; when a bridge across a rivulet conducts the traveller to the next caravansary. A bridge, a caravansary, and a road cut through a hill, within a distance of two miles, bespeak a different rule from that of the Punjab in modern times'.\(^2\)

Clearly the paved roadway, the construction of a bridge over Kalapani river and that of a sarai near the bridge were public works planned by\(\text{Aurangzib}\) to facilitate road communication between Lahore and Attock. Incidentally within five years of the notice of this bridge by Burnes in 1831, Hugel, while travelling in the same region, lamented the ruined state of this bridge, so that 'the traveller is now left to find his way through the ravines and the stream as he best can'.\(^3\) Apparently

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1 Moorcroft & Trebeck, II, 455. For the location of the bridge see Habib, Atlas, sheet 4B, 33\(^v\), 72\(^v\).
2 Burnes, II, 60.
3 Hugel, 226-7.
the structure of this bridge had fallen in a state of neglect and disrepair over a long period and definitely by 1835, when Hugel saw it, had become obliterated beyond use.

5. GUJRAT: The site occupied by the city of Gujrat is identified by Elliott as the battle-field of Alexander and King Puru. \(^1\) But the present city was founded by Akbar around 1580, \(^2\) on the bank of the river Chenab. It was also the point at which the route to Kashmir deviated from the Lahore-Kabul highway, and took its course through Bhamber and Drarmula to Srinagar. \(^3\) Gujrat has been closely associated with a religious personage, Shah Daulah, who is said to have settled here during the reign of Shah Jahan. \(^4\) Interestingly the building of a number of public edifices in the region of central Panjab, particularly Mughal masonry bridges, have been ascribed to Shah Daula (d. 1673-4). \(^5\)

\(^1\) Chronicles of Gujrat, 10-4.
\(^2\) AN, III, tr. 1081; Also see Chronicles of Gujrat, 76-8.
\(^3\) Habib, Atlas, sheet 4B, 324, 744, 2334, 744.
\(^4\) Chronicles of Gujrat, 18.
\(^5\) Habib, Atlas, 12, a.
According to Elliott, in the earlier days 'river Chenab flowed by the city, and not six miles away as now. This is partly confirmed by the existing arches of the Shah Laulah bridge, which is over half a mile long, and goes to show that if the Chenab did not then flow near, some very considerable branch of it, or else some nala, did flow by the city.'¹ In the Imperial Gazeteer this stream has been identified as a mere 'torrent bed' close to the town and the bridge of Shah Laulah has been noted to be 'in good state of preservation'.² Sujan hai while referring to the construction of this bridge records that it was built on river Chenab (زور پناب).³ Possibly then Elliott's contention that the stream which flowed by the city, was certainly a considerable branch of Chenab, if not the river Chenab itself, holds ground.

No other measurements, except that the bridge spanned a sizeable width of nearly half a mile, become

¹ Chronicles of Gujrat, 19; For the location of the bridge see Habib, Atlas, Sheet 4B, 32 t., 74 t.
² Imperial Gazeteer, xii, 373.
available to us in the description of this bridge in our sources. One would, however, presume that the building of this bridge must have enhanced the importance of the city of Gujrat by making it accessible from the south, more so when Gujrat had become a strategic junction of the Kashmir route with Lahore-Kabul highway.

6. **SIALKOT**: The town of Sialkot did not lie on any of the trunk routes passing through Panjab during the Mughal period, yet it was an important place as the headquarter of the **pargana** of the same name was located there. Sialkot has also been associated with Shah Daula's name. In the early years of his life Shah Daula is reported to have stayed at Sialkot which was the abode of his teacher Shah Saidan Sarmast. After the death of his teacher Shah Daula moved out of the town and finally took up residence in Gujrat in 1612.¹ 'During the ten years he lived there' Shah Daula showed munificence to the town of Sialkot also, where 'he built many mosques, tanks etc., the most notable being the bridge over the Aik nala'.² This bridge was noticed by Cunningham during his tour of the Panjab in 1878-79;

¹ **Chronicles of Gujrat**, 56.
² **Ibid.**; See Habib, Atlas, Sheet 43, 32+, 74+ for the location of this bridge.
he surveyed it and also gave some of the measurements of its structure in his report. The account of this bridge, as given in his report runs as follows: 'The Ayak river is 150 feet broad with steep banks. The bridge was originally built by Shah Jaulah of Gujarat with seven small pointed arches of $9\frac{1}{2}$ feet span, and with piers nearly as many feet thick. At the time of the British occupation it was much dilapidated, and the engineer, when repairing it, took the opportunity of increasing the waterway by removing three of the piers, and throwing three large elliptical arches of 27 feet 3 inches span over the openings. The old waterway was only $66\frac{1}{2}$ feet; it is now $91\frac{1}{2}$ feet'.

7. **ON BAGH BACHHA RIVER:** At a distance of nearly 80 kms. north of Lahore and 25 kms. north of Shahdara the Mughal highway was intersected by the river Bagh Bachha, tributary of Ldeg and obviously not a considerable stream. The only mention of the existence of a masonry bridge at this point has been found in Waris.

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1 Arch. Survey Reports, AIV, 45.
2 Cf. Habib, Atlas, Sheet 4B.
8. **SHAHDARA:** Another bridge on Lahore-Kabul highway was located at a distance of nearly 20 kms. from Lahore and 10 kms. from Shahdara towards north.\(^1\) It spanned the river Deg which emanated from the Siwaliks and after flowing a considerable distance south-west joined with havi near Sadghara.\(^2\) Sujan Rai locates this bridge at 5 kurohs from Lahore, towards Aminabad on the imperial highway (\(\text{سہمنگہ} \))\(^3\).

Alliott has recorded an interesting anecdote relating to the building of this bridge. He writes: 'To build the bridge a **bund** had to be made to keep back the river. One Buta, a zamindar, who earned a livelihood by carrying travellers over the river, objected to the bridge, and to drown the workers he cut the **bund** in flood time. But Daulah guessing his intention, had had another **bund** built below the first, and so his object was frustrated'.\(^4\) It is thus evident that the device used for keeping back the water of the river from the site of

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2. Habib, Atlas, Sheet 4B.
3. Sujan Rai, op. cit., 74. Waris, op. cit., 194 has also noted this bridge.
construction consisted of raising a bund which would divert the river into an alternative channel. In a subsequent description, too, we notice the use of a similar device for keeping the work-area dry. ¹

The reference to the cutting of the bund by the local zamindar who was operating a ferry service, suggests that the building of bridges on routes traversed by regular traffic were likely to be resisted sometimes by the local magnates who would be earning riches by controlling all means of conveyance across the river at such places. Though this act would be frowned upon by the central authority, they would naturally resist and try to thwart any attempt at providing the facility of a bridge over the rivers at such points.

9. SULTANPUR: Sultanpur is located nearly 90 kms. south-east of Lahore. A small river called 'Kali Veni' or Black Bein flows past the town on its northern outskirts. We have Steel & Crowther, the two English travellers passing through this region, notice a 'bridge with sixe arches' on this river in 1615. ² Cunningham, during his tour of Panjab in 1878-9,

¹ See the description of Jaunpur bridge.

noticed the remains of two different bridges spanning the Kali Veni river at Sultanpur. One of these is ascribed, in the local tradition, to Jahangir and Cunningham argues that 'as it stands on the old high road to Lahore, which is still marked by a Kosminar close by', it may safely be identified as the one built by Jahangir. This structure has been depicted as at 'A' in the plan of the site of these bridges appended with the description of this bridge in above.

This structure too, like many other Mughal bridges, suffers from the intrinsic engineering defect of extra thick piers. Thus 'as the piers have the same thickness as the span of the arches, one half of the waterway was obstructed, and the river, like Virgil's ponter indignatus Araxes, soon made a way for itself by cutting away the bank at one end of the bridge'. Possibly at this stage the river was bridged at another site, nearly 500 m. east of the earlier one. This effort is attributed to Aurangzeb in the local tradition. But this too did not serve its purpose for long as the river once again meandered away from the bridge by eroding the bank.

1 *Arch. Survey Reports*, XIV, 57.
10. **SULTANPUR:** The other bridge at Sultanpur spanning Black Bein river finds only a passing notice as Cunningham records that in the local tradition it was ascribed to Aurangzeb. An interesting feature in this bridge is the existence of small arched passages provided in the spandrels. Possibly by this time the architects had become aware of the defect in the designing of the piers. They, therefore, made an attempt to provide additional passage to the water by piercing the spandrels.

11. **NAKODAR:** Nearly 10 kms. south of Sultanpur, the highway was again intersected by a river called 'Dhauli Veni' or White Bein. Jahangir records in his memoirs that the region lying between these two places viz. Sultanpur and Nakodar was very pleasant; his father Akbar had given Shaikh Abul 'azl a grant to construct a bridge on this river and beautify the region. This bridge was located in front of Sarai Lakhni, and in effect provided a passage to the sarai across the river. Cunningham takes note of this bridge in his reports: 'There is another Badshahi

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1 Arch. Survey Reports, AIV, 57.
2 T J, 64.
3 Cf. habib, Atlas, Sheet 45, 31+, 75+.
bridge of similar construction which once spanned the Dhauli-Veni river at Dakhini Sarai. Only five of the arches now remain, the stream having swept away the other half of the bridge'.

12. TANDA: The existence of two Mughal bridges on Black Bein at Sultanpur have just been noted. These bridges were located on the Mughal highway passing through this place. But the District Gazeteer of Hoshiarpur records the existence of another 'imperial bridge' on west (Black) Bein river at a place called 'landa nearly 35 kms. north of Jalandhar, which does not fall on any highway running through this region. The construction of a bridge like this at such remote site is suggestive of the munificence or localized interest of the zamindar of the place.

13. SAhAI PUL: 'Saraipul' has been identified in Chahar Gulshan as a place which stood on Nahr-i Laiz, immediately to the south of Karnal. Monserrate on his journey with Akbar during latter's march against Mirza Hakim noted the existence of a bridge at this place. He writes: 'Leaving Panipatum and

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1 Arch. Survey Reports, LIV, 57.
2 Hoshiarpur District Gazeteer, 1904, 'A' vol. 17.
3 C_G, f. 138a; habib, Atlas, 12a.
passing by the town of Camaris (Karnal), we came to a tributary of the Jomanis. The infantry crossed this by a stone bridge, without any of the crowding or tumult which sometimes occurs in narrow places. The elephants, camels and cavalry, in accordance with the orders which had been given to them, crossed by a ford. Possibly by a "a tributary of the Jomanis" Mouserrate alludes to Firuz Shah's canal, excavated and redesignated by Akbar as Shekhuni. Here it would be noteworthy to refer to a farman of Akbar dated A.H. 978 (1570 A.D.) concerning the renovation of Firuz Shah's canal. The information important for us in this farman relates to Akbar's orders for the construction of bridges at different points on this canal and making the canal navigable. Perhaps this 'stone bridge' mentioned by Mouserrate was constructed on this canal under this order of Akbar. There is also mention of another masonry bridge on this canal at Safidon; this makes it clear that Akbar's orders

1 Mouserrate, 98
2 Cf. Abha Singh, op. cit.
3 Cf. Lieut. Yule, op. cit., 213-23
4 Cf. Sanderson, op. cit. Also see Abha Singh, op. cit who contends that "the Safidon bridge must also belong to his (Akbar's) time, since Shahjahan's Nahr-i-Bihisht did not run past Safidon" (47-8)
were implemented and in the re-excavated course of this canal was a perennial run of water necessitating permanent masonry bridges for the flow of traffic across the canal.

That in the building of at least the Karnal bridge, navigability of this canal was kept in sight, is evident from the 'humped' design of this three-arch bridge. The width of the central arch is 6.45 m. while that of the adjoining ones on both flanks, is 5.90 m. each. The rise of the central arch is 4.20 m. while there is drop of 0.40 m. each in the rise of the two flanking arches. It is thus clear that in this structure care was taken to provide sufficient passage under the central arch for the boats.

14. SAFEDON: Safedon is a small town situated nearly 30 kms. west of Panipat. The Rajabwah branch of Firuz Shah's canal flowed past this town. About the year 1560 Akbar ordered a renovation of the Rajabwah and redesignated it 'Shahabnahr', which ran from Yamuna to Safedon.

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1 There are more specimens of the 'humped' bridges from the Mughal period. But it has not been possible to ascertain with certainty that in each case the consideration was the same.


3 Cf. Abha Singh, op. cit., 45.
Sanderson records the existence of a masonry bridge on Western Yamuna canal at Safedon. As has already been suggested, this bridge should also belong to Akbar's time, built at his order contained in his firman of 978 A.H.

15. CHITTOR: Chittor is a well known place. A river called Gambhir flows at the foot of the hill on which is located the famous Rajput stronghold. At present a massive masonry bridge stands on Gambhir below the fort. It is attributed to Alauddin Khalji who is said to have built this bridge in commemoration of his victory over Chittor and named it after his

1 Sanderson, op. cit., 40 n.

son Khizr Khan. Percy Brown, while taking note of minor buildings of the Khalji period in his Indian Architecture (Islamic Period), laments that the bridge's chief architectural features, the gateways and towers raised over the abutments at each end have disappeared, but then massive arches of grey lime-stone still exist to show that competent engineers as well as accomplished architects were engaged to carry out such projects.  

16. DELHI :ON NAHR-I BHIIST: We have already referred to two bridges built during Akbar's time on Shekhuni to facilitate traffic across the canal. A similar bridge is reported in Miratu-1 Alam as existing in Nahr-i Bihist of Jahanghan; it is attributed to Bakhtawar Khan, a senior noble of Aurangzeb. On entering the confines of Delhi in the western side,

2 Percy Brown, op. cit., 19.  
3 See supra, Nos. 13 & 14.  
4 Shaikh Muhammad Baqar Baqa, Miratu-1 Alam, MS, M.A. Library, Dept. of History, Aligarth Muslim University, Abdu-s Salam Collection 84/314, f. 253 a; Habib, Atlas, sheet 8B, 28+, 77+. 
Shahjahan's canal was carried in the 'Poolchaddar aqueduct' over the Najafgarh jhil drain. This bridge was located 'to the east of the Pulchaddar' and consisted of a 'single arch' only. The canal was abundantly supplied with water so that at times it even flooded over its banks. It was to overcome this difficulty of crossing the canal on such occasions that Bakhtawar Khan built this bridge over it.

17. **WAZIRABAD:** Nearly 6 kms. from the Mall in Delhi, 'just where the end of the ridge (northern) dips down into the Jumna and disappears', stands a rubble built bridge which spans the Najafgarh drain. Close to the bridge are a couple of buildings said to be the tomb and mosque of a saint Shah Alam who lived during the reign of Firuz Lughluq. The bridge and the adjoining structures are contemporaneous.

The bridge is 'an impressive structure with its narrow arches and buttressed piers'. It is built

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2 *List of Monu. Delhi*, II, 264
3 Miratu-1 Alam, *op. cit.*, f. 253 a
5 Cf. *List of Monu. Delhi*, II, 290
6 Sharp, *op. cit.*, 117
of 'rubble masonry with features of dressed stone' and consists of nine arches with an overall length of '156' from north to south. This bridge is an interesting specimen from the pre-Mughal period.

18. ATHPULA: The Khairpur in Delhi is located at 'about two miles to the south-west of the Purana Qila and just to the east of Safdar Jung's tomb'. The tomb of Sikandar Lodi stands in the midst of Lodi Gardens here and a small stream, possibly an offshoot from Jumna flows past this tomb. 'About 150 yards to the east of the tomb' stands a masonry bridge of 'seven arches' which spans this stream. It is a 'beautiful bridge of very similar construction to the Barah Pulah on the Muttra road' and is 'said to have been built by Nawab Bahadur, who had been at Katul in the time of Akbar'.

The measurements of this bridge have been given by Cunningham. He writes: 'The middle arch, as

1 List of Monu. Delhi, II, 290
2 Sharp, op. cit., 65.
3 Arch. Survey Reports, XX, 159.
4 Sharp, op. cit., 65; Carr Stephen, 170
5 Arch. Survey Reports, XX, 159.
usual, is the largest, the other arches decreasing in span from the middle. The piers are 7 feet 4 inches thick, and the whole length of the bridge is as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Ft.</th>
<th>In.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle Arch</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Two next arches, at 11 ft. 4½ in.</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>Two next arches, at 10 ft. 4 in.</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Two outer arches, at 9 ft. 1½ in.</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>Waterway</td>
<td>74</td>
<td>0</td>
</tr>
<tr>
<td>Six piers, at 7 ft. 4 in.</td>
<td>44</td>
<td>0</td>
</tr>
<tr>
<td>Two abutments, at 7 ft. 4 in.</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total length</strong></td>
<td><strong>132</strong></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>

19. **Nizamuddin**: In Delhi: Its Story & Buildings, Henry Sharp records the existence of three bridges on a small offshoot of Jumna flowing past Sikandar Lodi's tomb. 2 While two of these viz. Athpulah close to Sikandar Lodi's tomb, and Sarah Pulah on Mathura road are well known structures, the third located near Nizamuddin seems to have been a little known structure. As is clear from its notice in the *List of Monu. Delhi*,

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1 *Arch. Survey Reports*, XX, 159.
2 Sharp, *op. cit.*., 117.
his structure measured '70' by 39' and consisted of '3 arches' only, built in 'rubble masonry'. Already by 1919 the bridge was in a state of decay and two pairs of bastions, which stood at each end, had broken down. Presently, however, no trace of this structure is available at this site.

According to Sharp all the three bridges probably belonged to Akbar's time and while Athpula 'possibly carried the road from Kirozabad to Old Delhi', one near Nizamuddin 'may have led to Jahanpanah'. The only architectural feature mentioned is that 'these bridges were 'ornamented with columns rising from the buttresses'.

2. SALIMGARH: The fort of Salimgarh was situated on what was originally an island in Jamuna, on the eastern side of the Red Fort in Delhi. It was built by Salim Shah, son of Sher Shah in the year 1546. After Red Fort was built it was linked with Salimgarh through a bridge. This arrangement is testified by Manucci. He writes: 'This fortress ( Red Fort, Delhi ) is encircled by walls of larger redstones, and it has a bridge of

1 List of Monu. Delhi, II, 180
2 Ibid.
3 Sharp, op. cit., 117
4 Ibid.
5 Ibid, 85; Carr Steph., 195.
some twelve arches, by which access is obtained to the fortress of Sellamgver (Salimgarh), situated on an island made by the river Jamnah.\(^1\)

This bridge also possessed two inscribed slabs,\(^2\) which have been preserved in the Delhi Fort Museum,\(^3\) and tell us that the bridge was built during Jahangir's reign. English translation of both these inscriptions has been given by Carr Stephen.\(^4\) It reads:

\textbf{(1st Inscription)}

"God is great!

(This bridge) was built by the command of Shah Nuruddin Jahangir, the Great.

The year and the date of its building (are to be found in the words):

The auspicious, straight and firm road. Year 1031 (Hijri)"

\textbf{(2nd Inscription)}

"(God is great) By the command of the King of the Seven Worlds. (Great may be his glory,)

(Of the) Emperor, just, equitable and politic.

1 Manucci, I, 178; Carr Stephen, 195 says that the bridge had only five arches.

2 Carr Stephen, 195-6.

3 Sanderson, op. cit., 67.

4 Carr Stephen, 195-6.
The year 17th) When this bridge was built in Delhi
(Of the reign)
The praise of this bridge should not to be written
(Of Jahangir.)
(Under the superintendence.) Thought gave the date
of its completion. (Of Hosain Halbi.)
The Bridge of the Emperor of Delhi, Jahangir.
(A glorious inscription.)

According to the chronogram the date of the
construction of this bridge is 1031 A.H/1621 A.D. A
description of the arches of this bridge survives in
Reglar's report on Delhi based on a survey conducted
in 1871. He writes, 'the arch sheeting is formed
of rubble and mortar, and springs flush from the face
of the abutments. It is strengthened by a series of
arched ribs springing from corbels that project from
the faces of the abutments, which give great appearance
of lightness, with great strength. As it is the
bridge cannot, from the immense size of its piers,
appear light, but were the piers well proportioned,
the effect would be very pleasing. 1

The bridge was demolished sometimes in the early decades of the present century or in the last decade of the preceding century. This was deemed necessary to provide for the laying of the railway line - a railway bridge presently stands at the site occupied by Jahangir's bridge. 2

2. **BARAH PULA**: Barah Pula is located nearly 100 m. south-west of Wazamuddin railway station in Delhi. 3 A large channel, probably a previous arm of the Jumna, 4 intersects the road coming from Mathura at this point. This bridge spans the channel here over eleven arches. The earliest notice of barah Pula survives in the account of Finch and relates to the year 1611: 'A little short (of Delhi) is a stone bridge of eleven arches, over a branch of Gemini (the Jumna). 5 There was, however, an inscription

1. *Arch. Survey Reports*, IV, 72.
2 Carr Stephen, 126-7.
3 For its location see Habib, *Atlas*, Sheet 85, 284, 774.
4 Finch, *Early Travels*, 155-6; Also see Habib, *Atlas*, 316.
5 Ibid.; Also see Manucci, I, 119, where he calls it 'a long bridge of 12 arches', obviously mistaking arches for piers.
placed on the bridge which gave the data of its
construction as 1021 A.H. or 1612 A.D. The
english translation of this inscription has been
given by Carr Stephen and is reproduced here:
" God is great,
(It was) Owing to Jahangir Shah, the son of
Akbarshah,
Whose justice is (like unto) the wind and
mankind (like unto) flowers;
To his friends he is a crested chief like the
Hoopoo,
To him enemies he is ringed like a dove;
Hind in his reign,
Was addressed by Istambol as (I am) your servant;
Hazrath Lehli is a garoen,
Which has taken a sweet odours from flowers and
colours from wine;
In the seventh year of his reign
Which was such (a time) that the Nightingale
did not complain of the cruelties of the flowers,
Miharou Agha, his special servant,
Chief of the King's seraglio (who) has knowledge
of all (its) secrets,

1 Carr Stephen, 209-10 2 n.
Built this bridge out of a kindly feeling (to others),
that it might be of service to him on that bridge
(in the day of judgement.)
I asked for the date of this (building) from the
firmament,
The face (of the firmament) looked like a full
blown flower with joy.
It said: 'Take up your pen and write
(he) built this bridge out of kindness (Miharbau)'.

There is clearly a discrepancy in the date of
the construction of this bridge as given in the
inscription and as deduced from the notice of this
bridge by Finch in 1611. Cunningham says: 'There is
probably a mistake of one year in this date, which,
I think, should be A.H. 1020, or A.D. 1611, or
properly 1612, according to our present reckoning'.

Carr Stephen gives a detailed account of
this structure: 'The bridge is 361 feet long, 46 feet
wide and has a maximum height of 29 feet. 'The sides
of the bridge are protected by heavy masonry walls;
the walls over the arches are flanked by minars,
about 10 feet high, one on either side of every arch.

1 Arch. Survey Reports, I, 222 n.
On the second northern arch, the highest point of the bridge, stands a red stone wall, about eight feet high and five feet wide, containing an inscription,... The road on the middle of the bridge is covered with masonry and on either side of it is a foot path of sandstone. As already stated, the second arch on the north is the highest arch of the bridge, and from here the arches decline in height till they reach the road on the opposite side.' 1 He also tells us that the arch over which the inscribed slab was located, got damaged in the heavy rains of 1875 and the inscription fell into the river. 2 We do not know for certain whether it was recovered from the bed of the river later or was lost forever.

An interesting feature in this bridge is that the width of its arches successively diminishes, but the piers throughout retain the same width. Thus more than half - which is a substantial measure - of the passage of this channel was blocked by the piers. The stream, however, has not subverted the bridge.

1 Carr Stephen, 209-10
2 Ibid.
Possibly a lesser volume and slower flow of water in the river prevented the scouring.

22. SOUTH OF BADARPUR: The Delhi-Agra imperial highway ran along Jamuna on its right bank and some of the important places through which it passed were Badarpur, Faridabad, Ballabgarh, Palwal, Hodal, Kosi and Mathura. Only two masonry bridges are known to have existed on this route viz. Barah Pula which has been and a bridge to the north of Faridabad. This latter bridge was located at a distance of nearly 25 kms. from Delhi southwards, between Badarpur and Faridabad over a nullah. According to the author of Miratu-l Alam, this bridge was built by Bakhtawar Khan. A brief notice of this bridge is also available in the List of Monu. Delhi which says that 'The bridge constructed of rubble masonry contains three arched openings and is paved with rubble stone. It measures some 91' long by 26' broad'.

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1 Habib, Atlas, Sheet 85, 274, 777, 224, 774.
2 Habib, Atlas, Sheet 8B, 234, 774.
3 Miratu-l Alam, op. cit., f. 252.
4 List of Monu. Delhi, IV, 14.
23. Hapur: The route passed through Ghaziuddin Nagar, Dasna, Hapur and Baksar. To the east of Hapur it was intersected by two rivers Kali & Choiya at a short distance apart. Mukhlis in Safarnama records the existence of a bridge on Kali river here. This bridge has also been mentioned in Chahar Gulshan. According to Irfan Habib the manuscript available in Aligarh Library, Habibganj Collection (32/157) lacks the note found in other manuscripts of the same work, wherein this bridge has been attributed to Dargahi, a saint belonging to the Nanak panth.

24. Hapur: Further east of Hapur on the same route, was located a bridge on river Choiya. The distance from the earlier bridge was nearly 10 kms. It was also mentioned in Chahar Gulshan and attributed to the same person i.e. Dargahi.

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1 Habib, Atlas, Sheet 8B, 284, 774, 284, 784.
3 CG, f. 141 a.
4 Habib, Atlas, 31 C.
5 Habib, Atlas, Sheet 8B, 284, 774.
6 CG, f. 141 a.
25. **CHHALERA:** The Delhi-Kol route was intersected by river Hindan at about 10 kms. south-east of Chhalera.¹ A masonry bridge on the river at this spot has been mentioned in *Chahar Gulshan.*² More details about this bridge are not available.

26. **JAJAU KA PUL:** The Agra-Burhampur imperial highway was an important route as it passed through places like Bholpur, Gwalior, Narwar etc.³ Since this route crossed a number of small and big rivers we have references to the existence of several masonry bridges at various places along this route, particularly between Agra and Narwar. The first of these, beginning from Agra southwards, is the famous bridge at Jajau spanning the river Utanga. It was mentioned by Mundy in 1630-31. He wrote: 'In the way hither (saya (Saiyan, Sainya), 11 course) wee passed over a faire large stone bridge, comparable to that of hochenster. It had 20 greate Arches, 2 Piramides att either end, with prettie Cupalaes etts. in the middle, where of this countrey

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¹ Habib, *Atlas*, Sheet 8 B.
² CG, f. 141 t.
³ Habib, *Atlas*, 31, C.
uses much about their Tombes, messitts, saraes etc.'

In 1661 Tavernier also crossed Utangan here 'by a very long bridge built of cut stone'. At this time, interestingly, this bridge was also used as a checkpoint where duty was realized on the merchandise coming from Bushanpur. Possibly the 'Piramides' with 'prettie Cupalaes' mentioned by Mundy as located at the two ends of the bridge, were used as checkpoints. Jajau, in view of this fact, must have assumed great importance during the latter half of the 17th century.

27. SOUTH EAST OF DHOLPUR: Between Dholpur and Gwalior, the imperial highway crossed one large river i.e. Chambal and three smaller rivers. Chambal, it seems, was too large a river to be bridged, given the level of technological advancement in Mughal India. But on the other three rivers, we find bridges existing at least from the reign of Aurangzeb. The first of these bridges was located on this route midway between Dholpur and Nurabad and spanned the river Kunwari. It contained 'six large arches' as reported by Tavernier

1 Mundy, II, 64-5; Habib, Atlas, Sheet 8B, 26‡, 77‡
2 Tavernier, I, 64-5.
3 Ibid.
4 Cf. Habib, Atlas, Sheet 8B, 26‡, 77‡ & 85‡, 73‡.
in 1661 who also calls this place as 'Quariqui-sera' i.e. Kunwari-ki-sarai.¹ It has, however, not been possible to identify any place of this name near the site of the bridge.

29. NORTH OF IVURABAD: Another bridge, further south, spanned the river Asan. It was located at about 5 kms. north of Nurabad.² It has been listed at No. 929 in the Ancient Monuments in Madhya Bharat and identified as a Mughal bridge.³ It is probably the same structure as 'Oilman's Bridge' of James Tod across the river Asin. During his travels in Western India Tod had recorded this bridge (in 1819) as he wrote: 'The Taili-ca-Pool, or "Oilman's bridge", at Moorabad, i.e., however, a magnificent memorial of the trade, and deserves preservation,"⁴ Anc. Monu. in Madhya Bharat has placed this structure at Maharajpura in the Gird district.⁵

29. NURABAD: The last of the three bridges between Dholpur and Nurabad is located in the Nurabad town

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¹ Tavernier, I, 64.
² Habib, Atlas, sheet 85, 264, 784.
³ The Descriptive and Classified List of Ancient Monu. in Madhya Bharat, Gwalior, 1952, 75.
⁴ Tod, I, 621.
⁵ Anc. Monu. in Madhya Bharat, op. cit., 75.
itself on the river bank which flows past the town.\footnote{\textit{Arch. Survey Reports}, 11, 397}

Iliurabad is a small town situated on the imperial highway at 25 kms. to the north of Uwaliar. Cunningham has given an account of the town and its buildings in his reports for the years 1862-65.\footnote{Ibid. There is, however, no categorical reference to the inscription in the report.} He also describes the bridge and possibly on the basis of an inscription attributes it to Aurangzeb, in A.H. 1072/A.D. 1661.\footnote{Ibid.}

The bridge consists of 'seven arches' all of which are pointed. These are 18 feet 10 inches in span, resting on piers 16 feet 9 inches thick, and 21\frac{1}{2} feet high to the spring. The roadway of the bridge between the abutments is 260 feet in length and 32 feet 9 inches in breadth, and the walled roadway of the approaches is 48 feet in breadth. The long lines of parapet are broken with square-headed trefoil openings, and are ornamented with four pairs of small octagonal minarets on the central piers and abutments.\footnote{Ibid.}

As is evident from the measurements of arch-spans and pier widths, this structure also suffered from the usual defect of thick piers. Cunningham

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1 Habib, \textit{Atlas}, Sheet $8B$, 264, 784.

2 \textit{Arch. Survey Reports}, 11, 397

3 Ibid. There is, however, no categorical reference to the inscription in the report.

4 Ibid.
in comparing this bridge to the two similar structures at Narwar wrote that 'in the Nurabad bridge the thickness of the piers is exactly one-ninth less than the span of the arches', but 'this difference was, however, much too small to save the bridge from being turned by the stream'. Thus in 1850 when he first saw this bridge, he found 'an open gap of 100 feet in length at the northern end.'

30. WAHBAH: From Uwaileyor, the imperial highway ran south-west past Autri and Palaichha to Narwar and further south-west to Longri, Shivpuri, Kolaras & Kachnari to Sironj. Near Narwar, the river Sind formed a loop intersecting this route at two points viz. immediately to the north of Narwar and at Longri. Till about 1664 this river was not bridged at both these places, as Tavernier lamented 'that it were easy to facilitate the passage by making a bridge, since there is no lack of either wood or stone.' Ultimately as Manucci tells us, Shaista Khan constructed at Narwar 'a large bridge as his memorial.'

1 Arch. Survey Reports, II, 397.
2 Habib, Atlas, Sheet 8B, 26t, 78t, 25t, 78t, & 25t, 77t.
3 Ibid.
4 Tavernier, I, 60
5 Manucci, II, 322; Habib, Atlas, sheet 8B, 25t, 77t.
Cunningham gives us a detailed account of the structure and its measurements since these two bridges viz. at Narwar and Dongri were surveyed by him in minute details to establish the defect of thick piers common in all Mughal bridges. I reproduce his account of this bridge below:

'The northern bridge (at Narwar) is situated three miles to the north-east of the fort, where the bed of the Sindh river is partly firm rock and partly loose boulders. From the remains of a large pier or abutment near the north end I infer that the original bridge must have consisted of 22 arches like that at the Patti-Ghati (Dongri), each having a span of 19 feet 5 inches, with piers of the same thickness. The central pier was ornamental with two square open cupolas. The whole length of the original bridge including two massive abutments, of which one is still standing, was 1000 feet...The main piers and arches of this northern bridge are similar to those of the southern bridge at Patti-Ghati, and need not, therefore, be described. The piers have the same curved projections up and down stream, and the same small arches above. The masonry of the central portion of the arches, however, must have been very inferior, as many of the arches have
fallen down, although the roadway above is still intact, owing to the strong adhesion of the splenaid mortar grouting of which it is formed. The roadway is 32 feet 7 inches wide, which is increased to 110 feet at the ends by the splay of the abutments'.

Since the arch-span and the pier-width in this bridge were equal, the river was allowed a passage only half of the original resulting in the washing away of three arches at the northern end. This necessitated an extension. Consequently, 'a new bridge of 10 small arches, each 11 feet 4 inches span, with piers of 13 feet 4 inches, was added at that end; but this also having been turned by the stream, a second addition of 3 arches, each of 11 feet span with piers of 13 feet 8 inches, was made at the same end, which has since shared the fate of its predecessor'.

31. **DONGRI**: The other bridge on Sind at Dongri is also attributed to Aurangzeb. As there is a lot of similarity in the designs of the two bridges at Dongri and Warwar, one would agree that both these structures are contemporaneous. Like the

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1. *Arch. Survey Reports, II, 325-7.*

bridge at Niarwar, Cunningham has subjected this structure too, to a detailed survey and I give his description here:

The south bridge is situated in the midst of the hills at a place called Patti-Ghati, near the small village of Ulongri, 10 miles to the south-west of Narwar. At this point the bed of the river is rocky throughout, and offers every advantage for the construction of a permanent bridge. But the fatal mistake of making the thickness of the piers equal to the span of the arches, which is common to all the Muhammadan bridges of this period, has filled half the channel with solid masses of masonry which 'the indignant stream' has resented by working its way round each end of the bridge. From the position of two square turrets on one of the mid-channel piers, as well as from the general direction of both banks, I infer that the original bridge consisted of 22 arches, each of 19 feet 7 inches span, resting on solid piers 20 feet in thickness. The roadway was 20 feet in breadth and horizontal. As the bridge at present stands it consists of 26 of these arches, and of five smaller arches of 13 feet 9 inches span, resting on piers 16 feet 2 inches in thickness. The latter are at the northern end
of the bridge, and as they are still unbroken, I conclude with some probability, that the Sindh River must have carried away the abutment at this end soon after it was built. But as these small arches afforded an additional waterway of only 68 feet 9 inches, the amount of relief was too small to be of any real use. The bridge was accordingly cut away at the southern end, where the bank now forms a deep bay, which extends no less than 180 feet beyond the 22nd and last arch of the original bridge. This increased channel was then bridged by four new arches of the same span as those of the first design, but they have again been swept away by the stream, and only the foundations of the piers are now traceable. The height of the piers to the spring of the arches is 15 3/2 feet and the height of the arches is 10 4/2 feet, and their thickness 3 feet. Up to the spring of the arches the piers have curved ends projecting 7 feet both up and down the stream. The upper part of each pier is pierced by a small arch of 4 feet span, or one fifth of the thickness. As it at present stands the whole bridge is 1204 feet in length, with 31 arches, of which 26 are large and 5 are small. Altogether the waterway amounts to only 577 feet 11 inches, while that of
the solid mass of piers is no less than 592 feet 5 inches, or somewhat more than one-half of the actual breadth of the channel. The bridge is substantially and honestly built with large stones and excellent mortar, and the long stones of the parapet are carefully dovetailed together. But the original defect of blocking up one-half of the channel with a row of massive piers was fatal to the permanent stability of the bridge, which has been turned by the stream at least three times in 200 years, and which is now standing quite useless in the rainy season, and only accessible in the dry season by a ladder at one end.'

32. PHUTHA NALA PUL: The Etawa-Firozabad road marked as the National highway No. 2 crosses a small river Sirsa at about 15 kms. north-west from Etawa. Further north from Etawa on this road, one observes a three-arched masonry bridge standing in partly ruined condition and located to the west of the road, nearly 100 metres away as an isolated structure amidst the cultivated fields. A conspicuous feature

1 Arch. Survey Reports, II, 325-6
of this bridge is the existence of four turret
like structures rising in pairs at both ends of the
bridge. This bridge has not been reported in our
sources, though from its location it can be easily
ascertained that the old Mughal road must have
passed over it. I have surveyed the bridge and recorded
important measurements.¹

33. CHHAPARGHAT: The Mughal route from Lutawa
to Allahabad passed through Sikandra, Bhognipur,
Kora and Kara.² Nearly 15 kms. east of Bhognipur
the route was intersected by the river Bengar, a
tributary of Jamuna, at a place called Chhaparghat.³
Finch in 1611 reported the existence of a 'faire large'
bridge and a sarai called by him as 'one of the fairest
saraiies in India' at Chhaparghat.⁴ According to Miratu-
Haqiq both these structures were built by Akbar.⁵
In 1632 and again in 1665 the bridge was noticed by
Mundy and Tavernier respectively.⁶ It has also been
described by Atkinson as consisting of five pointed
arches.⁷

¹ See the description of this bridge in 6 above.
² Habib, Atlas, Sheet BB
³ Cf. Mundy, II, 89; Habib Atlas, 31 C.
⁴ Finch, Early Travels, 179; Habib, Atlas, Sheet BB,
⁵ Miratu-Haqiq, f. 137 b.
⁶ Mundy, II, 89; Tavernier, 1, 93. He gives the name
of the river as Sengar, but does not mention the
sarai.
⁷ Atkinson, Vol. 6, 206. He ascribes the bridge and
the sarai to an officer of Aurangzeb.
KORA: Kora was a sarkar headquarter in the suba of Allahabad during Akbar's reign. The Mughal highway from Agra to Allahabad passed through Kora and was intersected near the eastern end of the town by a small river Rind, which was a tributary of Jumna. Mundy (1632) wrote about Kora in the most commendable terms: 'This place (Corrura (Kora Khas), 7 Course) is the biggest and best furnished of any wee sawe since our comeinge out of Agra. Heere is... a prettie river (the kind) with stone bridge,...' The bridge mentioned by him on Kind was again recorded by Itimad Ali Khan, the author of Miratu-l Haqaiq in 1130 A.H. (1717 A.D.). Soon afterwards, however, this bridge seems to have been abandoned by the river, so that by the middle of the 19th century it had 'earthed up to above the crown of the arches' and had 'cultivated fields on both sides of it, the river having completely deserted its former course'. Since Kora was an important place and this route was a Mughal highway, there was an urgent need for another bridge. This came up

1 Ain, II, tr., 178; Habib, Atlas, 29, b.
2 Mundy, II, 91; Habib, Atlas, Sheet 88, 26+, 80+.
3 Miratu-l Haqaiq, f. 137 b.
4 Fuhrer, 163.
somewhere around the close of the 18th century, almost on a similar design as the older Mughal bridge and has survived to this date. The older Mughal bridge lies half buried below the Kora fort, about a km. to the west of the present structure.

35. **AKBARPUR**: During the early years of Akbar's reign, till the final subjugation of Afghans in Bihar and annexation of Bengal, the region of Jaunpur remained an important command receiving utmost attention in military matters and attracting appointment of some very senior nobles here. Thus after the suppression of the Uzbek rebellion Akbar appointed Munim Khan to the charge of Jaunpur (June 1567), one of his principal duties being the containment of the surgent Afghans in Bihar and Bengal.³

During his tenure at Jaunpur (1567-74) Munim Khan contributed in a large measure to the improvement of Mughal positions, from the point of view of logistics, by constructing several masonry bridges spanning different rivers and water-courses in this region.²

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2. Fuhrer, 163
3. Cf. Iqtidar Alam Khan, *op. cit.*, 101
4. Ibid., 120-1, where lists five major bridges built during Munim Khan's governorship of Jaunpur.
The first bridge of this series was located at Akbarpur town, nearly 50 kms. south-east of Awaah (Fyzabad).\(^1\) It spanned the river Tons, which intersected the Agra-Jaunpur route at this place. According to an inscription on the north face of the bridge\(^2\) it was built in 976 A.H./1568 A.L. by Mohsin Khan\(^3\), who was the darogha of Jaunpur under Munim Khan.\(^4\)

A description of this bridge is available in the District Gazetteer, Fyzabad: 'The bridge in its original form was entirely of masonry and beyond it on the right bank is a large embankment partly of masonry, which extends for some hundreds of feet eastwards. Of late years some of the piers have been removed and the arches replaced by girders.'\(^5\)

36. **SURHARPUR**: Further south-east of Akbarpur at a distance of 25 kms. this route is again intersected by river Majhoi at a place called Surharpur.\(^6\) Here

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\(^1\) Habib, Atlas, Sheet 8B, 26+, 82+  
\(^2\) Distt. Gaz. Fyzabad, 186.  
\(^3\) Ruhrer. 300  
\(^4\) Cf. Iqtidar Alam, op. cit., 120.  
\(^6\) Habib, Atlas, Sheet 8B, 26+, 82+.
stands a masonry bridge, said to date from the time of Akbar. More details of this bridge are not available in our sources.

37. JAUNPUR: The bridge over Gomti at Jaunpur is one of the best specimen of medieval bridges in India. As is evident from six inscriptions placed on the bridge, it was completed in 1568-9 during Munim Khan's governorship of Jaunpur. However, the construction of this bridge had begun in 1564 under Ali Quti Khan, who apparently 'could not proceed with the work in the following years owing to his conflict with the central authority. It was then completed by Munim Khan after he became governor of Jaunpur'. According to Cunningham, 'In the time of the Sharki Kings a bridge-of-boats had been kept up for the greater part of the year (on Gomti); but when their kingdom came to an end, the boat-bridge went with it, and for nearly a century the crossing was made by ferry'. In 1564, during

2 Habib, Atlas, Sheet 8B, 25+, 82+.
3 For the texts and the translations of these inscriptions see Fuhrer, The Sharqi Architecture of Jaunpur, Calcutta, 1889, 17-20.
4 Iqtidar Alam Khan, op. cit., 120 ascribes the beginning of this bridge to 972 A.H. on the basis of a chronogram baisharat on the top of third kiosk towards the northern end of the bridge.
5 Arch. Survey Reports, XI, 120
solid stone parapet of 2 feet 3 inches on each side. The whole length of the bridge, according to my measurements, is 654 feet 3 inches. The main bridge to the north consists of ten pointed arches of 18 feet 3 inches span resting on piers of 17 feet with abutments of half the thickness. The smaller bridge to the south has only five arches of the same span as the others, and with similar piers and abutments. The island between the two is 125 feet 6 inches broad. The whole length is, therefore, made up as follows:

<table>
<thead>
<tr>
<th></th>
<th>Feet</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern bridge</td>
<td>352</td>
<td>6</td>
</tr>
<tr>
<td>Island</td>
<td>125</td>
<td>6</td>
</tr>
<tr>
<td>Southern bridge</td>
<td>176</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>654</strong></td>
<td><strong>3</strong></td>
</tr>
</tbody>
</table>

It is evident that this bridge too suffers from the same defect which is common to a number of other Mughal bridges. But in this case the river has neither subverted the bridge because of an additional waterway made available to it under the southern part of the structure. Yet to prevent damage during floods the height of the bridge has been deliberately kept at a level at which the river submerges the structure.

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1 Arch. Survey Reports, A1, 120-3. Also see Fuhrer, 184 who has copied Cunningham's description.
Akbar's visit to Jaunpur, an order for the construction of a bridge over Gomti was issued, the compliance of which was made immediately and in four years time the bridge was completed.

A detailed description of this bridge has been given in Cunningham's report for the years 1875-76 and 1877-78: 'The bridge (on Gomti) consists of two distinct portions separated by an island. When the position was selected, there was only one stream deep and unfordable; but the architect having diverted the river into another channel, which he had dug a short distance to the south, found himself unable to close it, when the bridge over the river was finished. He was, therefore, obliged to build a second bridge over the diversion channel, a lucky accident which has most probably been the means of the permanent safety of the whole structure, as the waterway has been increased by upwards of 90 feet.

The Jaunpur bridge is certainly one of the most picturesque in India. Its long line of arches and piers, all of the same size, is relieved by the light pillared rooms which crown the ends of the piers on both sides, and form a handsome street of detached shops.\(^1\) The roadway is 26 feet in clear width with a

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\(^1\) Cf. *Vincent, Early Travels*, 176 who has so conspicuously noted that this bridge is 'seated on a small river' and is 'with houses like London Bridge, but nothing so good'.
and flows over it. Cunningham recounts a similar instance in 1774 floods when a fleet of boats was plying clear over the bridge.¹

38. **SIKRARA**: Sīkarara is a small village situated at about 15 kms. south-west of Jaunpur on road to Pratapgarh. River Sai flows past this village and crosses this road. A stone bridge called 'Pulguzar' spans Sai at Sīkrara.² It is attributed to Munim Khan and is said to have been built in A.H. 979/ A.D. 1569.³ According to Fuhrer, 'Originally it consisted of eight 18 feet arches with piers of somewhat greater breadth; one or two arches had more than once been blown up by floods and repaired; but when a pier was broken down in the rains of 1847 arrangements were made for remodelling the whole. Two arches were in each case thrown into one to the great increase of beauty of the bridge and improvement in every way.'⁴

39. **JALALPUR**: Jalalpur is a small town 20 kms. south-east of Jaunpur, situated on the road leading

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¹ Arch. Survey Reports, XII, 120-3.
² Habib, Atlas, Sheet 8B, 254, 82+.
³ Fuhrer, 185.
⁴ Fuhrer, 185. Also see Listt. Gaz. Jaunpur, 321.
to Banaras. Jalal Khan, a son of Sikandar Lodi is said to have transferred his capital here in early 16th century. "But not a vestige remains of the city built by him, and it is said that his palace and other edifices were razed to the ground by Humayun." ¹ Sai flows to the north of the town and possesses a bridge attributed to Jalal Khan in 1510. ²

It has nine pointed arches and a roadway of 245 feet breadth passes over the bridge. ³ According to the District Gaz. Jaunpur, "In 1566, during the rebellion of Khan Zaman, his brother, Bahadur Khan, broke down two arches of the bridge in order to hinder the pursuit of the imperial forces while he was retreating to Benares. They were restored by Munim Khan, Khan Khanan,..." ⁴ During the survey of this bridge, we noted that the arch-spans varied from 3.55 m. to 6.50 m., but the pier-width remained uniform at 4.40 m. ⁵

² Fuhrer, 178; Dist. Gaz. Jaunpur, 230. For the location of the bridge see Habib, Atlas, Sheet 8B, 25†, 82‡.
³ Cf. Fuhrer, 185.
⁵ See Appendix 2.
Thus the passage blocked by piers is only slightly less than half of the total passage. There is, however, not noticeable any subversion by the river, and the structure of the bridge serves a heavy vehicular traffic even to this date. One might seek an explanation for this in the terrain in which the bridge is located. Incidentally the banks of the river on both sides are very steep and therefore not subject to erosion, as rapidly as in other cases. Moreover, the bridge is low, making the flood water pass over it without much difficulty. These seem to be the two major reasons for the survival of this structure without any scouring of the banks.

40. BHITRI: Bhitri is a small village situated 70 kms. south-east of Jaunpur on the Mughal highway to Patna. According to Cunningham, 'The Ganges river, which surrounds the village on three sides, is crossed by an old stone bridge of early Muhammadan style. The oldest bridge consisted only two small arches, to which two others have since been added at different times'.

1 Arch. Survey Reports, I, 96; Fuhrer, 229. For the location of this bridge, see Habib, Atlas, Sheet 3B, 25, 83.
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41. **GHAZIPUR:** Bayazid records a bridge near Ghazipur on 'Siyah Ab' built by Talibi Sultan.\(^1\) According to Iqtidar Alam, Talibi Sultan held Jagir in Ghazipur and this bridge was built by him on river Besu linking Ghazipur with Muhammadabad and Ballia.\(^2\) He suggests that the site of this bridge was somewhere near Khalispur, where an old masonry bridge was in use until a short time ago.\(^3\)

42. **KHURRAMABAD:** It is a small town situated 100 kms. south-east of Banaras on the Mughal highway to Patna. According to an inscription found at Khurramabad, it was a prosperous township during Jahangir's reign.\(^5\) The same inscription also records the construction of a bridge by Ali Akbar, 'who was either a close relative or the chief-officer of Nawab Safdar Khan, the powerful jagirdar of Bihar (1605-1612)'. The date of its construction is given as 102 A.H./1612-13 A.D. and it spanned the river Kudra flowing through the town. This bridge was also

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2. Iqtidar Alam, *op. cit.*, 121.


5. Q. Ahmad, *Corpus of Arabic & Persian Inscriptions of Bihar*, Patna, 1973, 208. He writes: 'The inscription is historically important and unique in some respects. It not only records the construction of the mosque to which it belongs, but also that of a number of other, secular structures - a palace, a bridge, an inn and a bath. In fact it is a unique record of the founding of a complete township in the early 17th century'.
noted by Mundy & Tavernier in 1632 & 1661 respectively\(^1\) and according to Q. Ahmad this massive five arched masonry bridge\(^1\) survives even to this date, in the south-western part of the town near the sarai.\(^2\)

43. **SADALPUR:** Sadalpur is a small village situated 20 kms. north of Dhar.\(^3\) Jahangir mentions this place as the one where he stayed on his return from Dhar in 1617.\(^4\) He also took note of certain buildings and a bridge built by Nasiruddin Khalji (1500-1511) over a stream flowing through this place.\(^5\) These buildings, identified as 'Jal Mahal' in Anc. Monu. in Madhya bharat, were built 'across bed of a stream'.\(^6\) Possibly, the bridge recorded by Jahangir served the purpose of a causeway across the stream for reaching these buildings. The stream has been identified by Irfan Habib as a branch of Chambal and he seems to be correct in his suspicion that this bridge was not meant for public use, but was used as a passage to reach royal palace.\(^7\)

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\(^1\) Mundy, II, 127; Tavernier, I, 120.
\(^2\) Q. Ahmad, op. cit., 208.
\(^3\) Habib, Atlas, sheet 9B, 22t, 75t.
\(^4\) TJ, I, tr., 409.
\(^5\) Ibid.
\(^6\) Anc. Monu. in Madhya Bharat, op. cit., 118, no. 1433
\(^7\) Habib, Atlas, 38, b.
FATAWA: Fatawa is a small township situated on the banks of Punpur, 15 kms south-east of Patna. During Said Khan's governorship of Bihar, under Akbar, it is said that one of his enuchs Ikhtiyar Khan built bridges and sarais in Patna and Bihar. There was a bridge at Fatawa on Punpur ascribed to Ikhtiyar Khan. It was noticed by Marshall in 1670 as a 'stone bridge', but Buchanan says it was built of bricks. Originally the bridge seemed to have had several arches, but when the English took possession, these had fallen. One the same piers then a wooden bridge was raised but that too did not survive for long.

Buchanan writes in Patna Gaya Report: 'The only antiquities (of this place) are two bridges of brick said to have been built by an Ikhtiyar Khan...'

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1 Habib, Atlas, Sheet 10B, 25f, 85f.
2 Maathir-ul Umra, II, tr. 682.
3 F. Buchanan, An Account of the Districts of Bihar & Patna in 1811-12 (Patna-Gaya Report), Patna, Not dated, 76.
4 Marshall, 77
5 Patna-Gaya Report, op. cit., 76.
6 Ibid.
7 Ibid.
We have already described one of these bridges which was a bigger structure. But the other bridge, seemingly close to the earlier one, 'over the little Punpun is a trifling work still entire'.

46. **TELHARA:** Telhara is a small village situated nearly 50 kms. south of Patna. The 'ruins of a fine bridge of five arches' are surviving there across a 'now nearly dried up course of the Sund nadi'. No more details about this bridge have been available.

47. **DHAKRA NALA:** The Patna-Hajmahal highway crosses a small stream known as Bhkranala, nearly 5 kms. south of the town of Monghyr. Here stands a bridge, attributed to Shah Shuja during his governorship in Bihar (1639-59). A detailed note on this bridge has been given by Oldham, the editor of Buchanan's *Bhagalpur Journal*, in the form of an appendix. It reads: 'The ruins still standing of the old bridge

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3 LAMB, 270
over the Lakra nala, in spite of Buchanan's somewhat
disparaging comment, present one of the most
picturesque sights in the district. As they have
been the subject of some misconceptions (going by
Buchanan's record) it seems desirable to record the
following details. The bridge was built entirely
of bricks laid in a tenacious mortar, and not of
stone, as has sometimes been supposed.

By whom this fine old bridge was originally
built, we have no record to show. Judging from the
kind of bricks used and the peculiarly strong mortar
employed, both of which recall the fabric of the old
Damdama Kothi in the fort (where the collector's house
now stands) I am inclined to the view that it dates
from the time of Shah ʾHuja's vice-royalty (1639-59).

KALYANPUR: It is a small village situated on
Patna-Kajmahal highway, about 25 kms. south-east of
Monghyr. Marshall passed through this place in 1671
and recorded 'a stone bridge of 3 arches' over a
ditch near the village. He also noticed 'a little
watch house' on 'every corner of the bridge'.

1 Habib, Atlas, Sheet 10B, 25+. 2 Marshall, 123.
3 Ibid.
seems the 'watch-houses' of Marshall were in fact cupolas placed at the four corners of the bridge. The mention of a 'ditch' near this place suggests that it was in the rainy season only that small streams would become active. When dry during summers and winters such streams would look like ditches.

49. GHORGHAT: A short distance east of Kalyanpur lies the town of Ghorghat. An off-shoot of Ganga passes through the town southwards. Marshall describes a bridge located at this place: "This town has a stone bridge with 7 arches, which is about 40 yards long, 15 or 20 high, and 6 or 7 broad. About 1/2 course south of this town is a little hill with a Muskeet or white stone house upon it. I suppose said bridge is for the water in rain time to run under in the Ditch, which probably may come from the Hills, which now is dry."³

50. GARHI: Garhi is situated 60 kms. east of Bhagalpur on the Patna-Raj Mahal highway. A short distance to the west of the town flows a small stream,

1 Habib, Atlas, Sheet 10E, 25. 86.
2 Habib, Atlas, sheet 10E
3 Marshall, 74
4 Habib, Atlas, Sheet 10E, 25. 87.
possibly an off-shoot of Ganga, which gets activated during the rains. In 1671 when Marshall passed through this place, he noticed a bridge on this stream under construction. This stream has been identified as 'Kunderpol Nala' in Aennell's Bengal Atlas.

51. **HADAF**: About 5 kms. to the west of Raj Mahal stands a bridge called Hadaf bridge. According to Kuraishi this bridge is situated '800 yards' to the north-west of Jami Masjid on the road leading to Sahibganj. It seems that this bridge, like several others in this region, spanned a seasonal stream to provide access to the town of Raj Mahal. According to the District Gazetteer, Santal Pargana, the bridge is contemporaneous with the Jami Mosque of Haja Man Singh (C.1580-1600). But Kuraishi argues that 'the style of its architecture points to a later date, and it is probable that it may have been constructed during the viceroyalty of Sultan Shuja, second son of the Emperor Shah Jahan, about 1650 A.D.' Kuraishi has also given detailed description of the structure of this

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1 Marshall, 120
2 J. Rennell, A Bengal Atlas, containing maps of the theatre of war & commerce on that side of Hindostan (London), 1781, XV.
3 Kuraishi, 219; Habib, Atlas, Sheet 10E, 254, 874.
4 Distt. Gaz. Santal Parganas, 277 as quoted by Kuraishi, 220.
5 Kuraishi, 220.
bridge: 'The Hadaf bridge is an interesting structure of six arches, each 11 feet in span. It is 236 feet long and 24 feet broad at the top, and at each end of it are two circular bastions of stone masonry, one on either side of the roadway. The bastions taper upwards as they rise, and are about 32 feet in diameter at the top, which is flat and is approached by steps. The piers supporting the arches of the bridges are 28 feet 5 inches deep, and 17 feet wide, and each pier is further extended to form a cut-water at both ends running some 16 feet into the stream. Both the piers and cut-waters are faced with stone masonry up to the springing of the arches, which like the upper walls and parapets are built of small finely rubbed bricks. Half cut-waters are also added at the inner faces of the bastions. The addition of small finials at the tops of the cut-waters and simple ornament framing the arches and appearing at the cornice below the parapets, lends interest to the structure. Like the Hindu bridges in Orissa, this bridge also rises in the middle, where the arches are higher than at the ends - a characteristic which, besides being of aesthetic value in lending grace to the outline, affords additional strength to the construction by reason of its effect in wedging the
structure between the banks and so strengthening the whole against subsidence and the lateral force of the stream. The total height of the bridge including the parapets (which are 3 ft. 9 ins. high) varies from 21 feet to 25 feet above the bed of the stream.

The stone used in the masonry of the bastions and piers etc. is locally known as the Tetia. It appears to be limestone.¹

52. SOUTH OF DUGACHHI: Lugachhi is a small town situated 25 kms. south of Khaj Mahal on Mughal highway to Makhsusabad.² Marshall had noted 'a great steep stone bridge' here 'over a dry ditch which suppose is filled in the rains times by the water which comes from the hills'.³ Since Ganga was only 'about 1/2 course' from this place, one would assume that this bridge was located on a flood channel.⁴

53. DUNAPUR: Dunapur is a small township situated 40 kms. south of Khaj Mahal on the Mughal highway to Makhsusabad.⁵ An arm of the river Ganga flows past

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1 Kuraishi, 219-20. Also see LAMB, 460-2.
2 Habib, Atlas, Sheet 11B, 24r, 87r.
3 Marshall, 115; Habib, Atlas, 48, b.locates the bridge south of Lugachhi.
4 Habib, Atlas, 48, b.
5 Habib, Atlas, Sheet 11B, 24r, 87r.
the town\(^1\) in south-easterly direction. The author of *Alamgir Nama*, records the existence of two masonry bridges on this arm of the Ganga and adds that the one at Lunapur was destroyed by Shuja during his flight from Bengal against Aurangzeb.\(^2\) Both the bridges Lunapur are attributed to Muazzam Khan, who built these bridges to improve his position against Shuja after the treachery of Prince Sultan Khan.\(^3\)

54. **WEST OF DUNAPUR:** Of the two bridges noted above, one was situated/about 500 m. west of Dunapur on the same stream.\(^4\) While the destruction of the earlier one i.e. at Dunapur, had been recorded in Alamgir Nama, we do not have any other information on the fate of the second bridge.

55. **TUNGI:** Tungi is a small village situated at a distance of 20 kms. from Dacca on Dacca-Mymensingh road.\(^5\) A masonry bridge is reported here on a stream flowing past the town, and has been attributed to

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1. *Alamgir N.* 529.
4. *LMB*, 204.
5. *Ibid* 204-5.
Mir Jumla. During the mutiny the bridge was demolished and presently only the remains are standing.\(^1\)

56. **PAGLA**: At 5 kms. from Bacca towards east, the highway is crossed by a river called Pagla.\(^2\) Mir Jumla is reported to have constructed a 'fine brick bridge' over this river.\(^3\) It is in a dilapidated condition now though 'the turrets which flanked it still stand on the banks'.\(^4\)

57. **KADAMTALI**: A little west of the bridge at Pagla, there was another brick bridge on the river 'Cadamtali'.\(^5\) Tavernier had noted the distance between Pagla river and Kadamtali river as only 'half a coss'.\(^6\)

58. **DULALPUR**: Immediately to the south of the city of Sonargaon lies the ancient city of Painam.\(^7\) There also stands a bridge over the ditch surrounding the city of Painam 'which leads directly into the main street of the town'.\(^8\)

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1. Lamb, 204-5
4. Lamb, 204-5; Also see C.J.C. Davidson, *Diary of Travels and Adventures in Upper India*, London, 1843, II, 121.
6. Tavernier, I, 128
7. Habib, Atlas, 48, b
8. Arch. Survey Reports, XV, 143.
'This is a fine Muhammadan bridge' and has 'three arches, the middle arch is higher than those at the sides and is intended for the passage of boats'. At the time of its notice in 1896 in the List of Ancient Monuments in Bengal this bridge was in a state of disrepair.  

69. MIRKADIM: West of Sripur (in Bengal), stands a masonry bridge of three arches. It spans the 'Mirkadim Khal' which is located in thana Munshiganj. In the local tradition the bridge is ascribed to Raja Vallal Sen, who ruled Bengal before its conquest by the Muhammadan invaders in the twelfth century. The bridge has been noted and described in the List of Ancient Monuments in Bengal: 'It consists of a centre Gothic arch 14 feet span and 28 feet in height above the bed of the Khal, with two side arches of 7 feet 3 inches span each, and 17 feet high. It is a fine bridge.

The piers are 6 feet thick, the wings are straight back, and the whole length of the bridge is 173 feet. The abutments, piers, and arches and the two north wings are entire.

The two south wings have fallen down, and the cut-waters are cracked. The whole structure is overgrown

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1 LAMB, 216-7.
2 Ibid.
3 Habib, Atlas, 48, b & Sheet 11B, 23, 90.
with large trees which have taken root in the masonry'.

This state of the bridge was recorded in 1896 when the List was compiled. Since no later description of the structure has become available, it is difficult to state if the bridge survives today.

It is interesting to note that the ratio of pier-width to arch-span in this bridge is maximum. Therefore the waterway blocked by the piers is less than even one-third of the total. Only Chhaparghat bridge (No. 35) corresponds in these dimensions with the Mirkadim bridge.

60. TALTALA: Further west of Mirkadim bridge, there stands another masonry structure spanning the 'Taltollah Khal' in thana Jrinagar. 2 It is also said to have been built by Kaja Vallal Sen. It has been recorded in the List of Ancient Monuments in Bengal that 'the capital of the Hindu Kajas was at Rampal about 2 miles to the east of Munshiganj. Both this and the Mirkadim bridge stand in a direct line westward from the capital, over two parallel khals, and it is said that they stood on a line of road running from the capital westward to the bank of the Padma river.


2 Habib, Atlas, 48, b & Sheet 11B, 234, 904.
It consisted of three arches of masonry, of which 2 were of 15 feet opening each and the other of 30 feet. The larger arch was blown up by gunpowder during the first years of the English rule, so as to secure direct communication between Calcutta & Dacca, for large boats for the conveyance of troops etc. to the eastern frontier and for the Burmese wars'.

GAUR: Gaur was the old capital of Bengal and was also known as Lakhnauti. During the reign of the Sultans considerable architectural activity had taken place here. But after the Mughal conquest, the city began to decline and by seventeenth century most of the buildings had been ruined. In the latter half of the nineteenth century Cunningham surveyed the city and its ruins and found an inscription dated 862 A.H/1475 A.D., which belonged to a bridge located 'between the Lattan Masjid and the Kotwali Gate.' The translation of this inscription as done by Blochmann is given below:

'The building of this bridge took place in the time of the just Sultan Nasiruddnyawaddin Abul Muzaffar Mahmud Shah, the Sultan on the 5th day of Safar. May

1 L A M B, 220-1.
2 Cf. Manrique, II, 123-34.
3 Arch. Survey Reports, XIV, 57.
Allah allow the month to pass with success and victory! A.H. 862.'

The bridge has been described by Cunningham and its measurements also given. It 'consists of five pointed arches, the middle one being 11 feet 6 inches span, the next one on each side 10 feet 3½ inches, and the end arches 9 feet 1 inch. The piers also lessen in the same manner, the two middle one being 10 feet 6 inches thick, and the other two only 9 feet 3 inches. 'The roadway is 27½ feet broad and 275 feet long.' This bridge was 'built over a rivulet which constituted the main drain and means of access to the interior of the town'.

62. GAUR: According to Cunningham, several more bridges of the same kind as the one located between Lattan Masjid and Kotwali Gate, were to be found in the city of Gaur. At least one more bridge of this type was located by Abid Ali Khan 'to the south of Gunmant Mosque'. No other description, however, of this bridge is available.

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1 This translation has been given in M. Abid Ali Khan, Memoirs of Gaur and Pandua, ed. & rev. H.E. Stapleton, Calcutta, 1921, 75.
2 Arch. Survey Reports, XV, 57.
3 Abidine Ali Khan, op. cit., 75.
4 Arch. Survey Reports, XV, 57.
5 Abid Ali Khan, op. cit., 75.
63. Naraingarh: In the pre-Mughal period Naraingarh had a fort, probably controlled by a native ruler. Marshall had visited the place in 1669 and he recorded the existence of a bridge at the entrance to the town. It seems the bridge spanned some small river which was activated during the rains only.

64. Jajpur: Jajpur is nearly 65 kms. north-east of Cuttack and is located on the Mugh highway running between Balasore and Cuttack. A river called Mandagni flowed near the town towards north. An old bridge spanning the river has been noted and described in the List of Ancient Monuments in Bengal. It is one of the several pre-Turkish bridges surviving in Orissa, and is built on the principle of corbelling. It is known as Tentulimal bridge and is located south-west of the Chandesvara village, about two kms. from the Inspection Bungalow, Dist. Cuttack. Another notice of this structure was taken by Kuraishi in 1931 and he modified some of the measurements of this bridge as given in the List of Anc. Monu. in Bengal. We reproduce here the description given in LAMB:

1 Habib, Atlas, 50, a.
2 Marshall, 63. For the location of the bridge see Habib, Atlas, Sheet 12B, 22+, 87+.
3 LAMB, 478-80; Habib Atlas, Sheet 12B, 20+, 86+.
4 Kuraishi, 228-9.
'It is a very peculiar 11-arched bridge not far from Jajpur. It is similar to the one called the Atharnala bridge near Puri, the arches being formed entirely by corbelling or making each successive layer of masonry overlap by five or six inches the layer below, until the two piers come at the top to within a foot of each other. On this space a long narrow block of stone is laid as a sort of keystone. Over the keystone transversely enormous blocks of stone, some of them 4½ feet long and half that in breadth, are laid apparently with the view of making the upper layer of the piers on each side grip the keystone. Each of the layers is formed of stone about a foot thick. The lower half of these stones at the openings or arches is bevelled off for about six inches, the upper half being perpendicular. In this way each side of the arch resembles an inverted stair with the edges of the steps worn off. The whole bridge is about 10 or 12 feet wide. The arches or openings are small near each end of the bridge, and become larger in the middle. The height of the central opening is about 9 feet, and the width is about 10 at the bottom. The smallest openings are five feet high and six feet wide at the bottom. The abutments at each end are of laterite;
in the centre the masonry is of coarse red granite. In the highest arch there are about 12 tiers of masonry above ground. It is clear from this description that the bridge was very strongly built even on corbelled arches. Some repair, says Kuraishi, was undertaken in the bridge at some point of time, in which the remains of an old ruined temple were used in the bridge. By 1931, the openings had considerably silted up and the river "andagni had dried up.

The date of the construction of this bridge has remained uncertain. But the design suggests that it was built in the period before the Mughal conquest of Orissa.

GengaTī: An old corbelled bridge is located about 1.5 kms. south-east of Bhuvaneshwar. It spans the river GengaTī. It has been attributed to the Kesari Kings of Orissa. The bridge has been ruined considerably and most of the dressed stone from this structure has been used in paving the road by Distt. Board.

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1. LAMB, 478-80
3. Ibid.
4. Habib, Atlas, Sheet 12B, 20f, 85f. 5. LAMB, 532
6. Ibid.
ATHARNALA PUL: North-east of the town of Puri flows a stream called Atharnala. A masonry bridge built on the principle of corbelling spans the stream at a distance of three kms. from the town and carries over it the road leading to Bhubaneswar. This structure has been described by Kuraishi, who places it, on the basis of "Palm Leaf record" Purushottam Chandrika, in the years 1035-50. The description given by Kuraishi is reproduced below:

The bridge is constructed of laterite and sandstone and traverses about 276 feet of waterway by means of 19 spans of the horizontal corbel construction characteristic of Hindu work. The piers of the arches are 34 ft. 4 ins. deep, 6 ft. 8 ins. wide (except the two central ones which are a little over 8 ft. in width and about 8½ ft. high to the lowest corbelling, where the span is 8 ft. 3 ins. wide. Five overlapping corbels intervene to reduce the span, which at the top course measures some 2½ feet. This space is covered by large laterite slabs each about 4½ feet long. The bridge gradually rises from the sides towards the middle, where the 9th and

1 Habib, Atlas, Sheet 125, 195, 254.
2 Kuraishi, 297.
and 10th piers have overlapping courses on the inner side, necessitated by the greater width of the central span, which measures 14 ft. 5 ins. wide and 18 ft. 2 ins. high. The abrupt increase in the size of this bay, however, produces a somewhat awkward appearance in those on either side of it, owing to the lop-sided effect of the unequal corbelling. The spans on each side of the central opening are also wider than the others flanking them and measures 10 ft. 5 ins. across.

Above the openings is a plain cornice-band of slight projection, originally decorated at intervals with rude figures of lions and elephants, all of which except three on the east face have now disappeared. The brick parapet on either side of the road over the bridge is apparently a modern addition.

The abutments at the ends of the bridge are rounded on both sides, the curve being carried back to a distance of about 20 feet, the more effectively to resist water action. The corners at the base of the piers have also been rounded off on the east face, from which, it would appear that the stream used to flow from east to west.'

1 Kuraishi, 297-8; Also see L A M B, 488-9; Ferguson, op. cit, II, 112-14.
67. **BALASORE**: Balasore was an important port town on the eastern coast during the Mughal period. It also produced silk. The notice of a stone bridge has been taken in the *List of Ancient Monuments in Bengal* as lying 'on the second mile of the Gopinath Mandir road'.

It was curiously called the 'Mahratta bridge', though it was 'believed to have been erected by the lion kings of Orissa'. Irfan Habib has depicted this bridge in his *Atlas*, but it seems, by an oversight, he has not given any references for it in the notes.

68. **NALDRUG**: Naldrug was the head-quarter of the sarkar of the same name in Sinba Bijapur. It had a well known fort. Irfan Habib has depicted a bridge and a dam as located on river Eori at Naldrug.

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1. L A M B, 482
5  Habib has cited ref. for this bridge from
   (i) Bhimsen, ff. 886-89a
   (ii) Shafiq, 164-5.
   (iii) Thakur Lal, f. 102 b.
   (iv) Fashiruddin Ahmad, *Waqiat-i Mumlikat-i Bijapur*, III, 589, for a modern description.
69. **KAMTHANA:** About 8 kms. west of Bidar lies the famous Kamthana tank and dam¹, which supplied water to the town of Bidar through a canal. According to Yazdani, 'walking from the embankment of the tank towards the reservoir, the visitor will notice on the way the remains of an old bridge. It was supported by arches, two of which are still intact.'²

70. **HYDERABAD:** Hyderabad is known to have had two bridges in the beginning of the seventeenth century.³ These have been variously described by the European travellers visiting Hyderabad. From these descriptions it becomes clear that the two bridges were located on Musi and Nerua rivers respectively. The one on Musi has been described by Peter Moris, who visited Hyderabad in 1606. He says, 'Twoo stone bridges which go over the river, the one of 19 and the other of 15 arches, as artificially (i.e. skilfully) made as the lyke my judgement att leaste 3 faddem high above water, these were 2 hasta

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(i.e. cubits), being 3 foote underwater; whereof, of the bridge of 19 arches, 6 arches were washed awaye. If anybody should have tolde mee this 7 yeares ago I should have hardly have believed it, for then I was uppon this bridge and behelde it with admiration, and might very wel be compared to the bridge of Rochester'. Tavernier writing nearly six decades later compared it to Pont Neuf at Paris which was built in the year 1578-1604. The notice of a bridge of twenty two arches at this place has been taken by Bilgrami. He has also given the inscription suggesting that the old bridge was built in 1578 and consisted of twenty-two arches. It seems that all these three descriptions relate to the same bridge. It was damaged in floods several times, but was perhaps repaired soon; the last such repair has been inscribed on the bridge and relates to the year 1820.

4. Ibid.
71. **HYDERABAD:** Of the two bridges described by Peter Floris, one is known to have had 15 arches only.\(^1\) No other description of this bridge, however, becomes available.

72. **HYDERABAD:** It seems there were several smaller bridges besides the two large structures described above. One such bridge had been noted by Thevenot in 1666 during his visit to the city of Hyderabad. He writes, 'we past the bridge, which is only three Arches over. It is about three Fathom broad, and is paved with large flat stones: The River of Nerva runs under the bridge, which then seemed to be but a Brook, though in time of the Rains, it be as broad as the Seine'.\(^2\)

73. **GOA:** Fryer records the existence of a bridge and a two mile long causeway at Goa.\(^3\)

74. **MANGALORE:** della Valle records the existence of a stone bridge on the outskirts of Mangalore, which may have provided access to this port town through the land

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1 Peter Floris, *op. cit.*, 128-9.
2 Thevenot, 131-2.
route. He writes, 'A musket-shot without Mangalor, on that side, is a small river which is pass'd over by a ruinous stone bridge and may likewise be forded'.


2 Ibid.