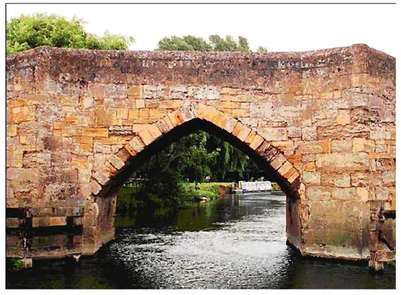
Strengthening Methods for Arch Bridges Found to be Inappropriate for Newbridge

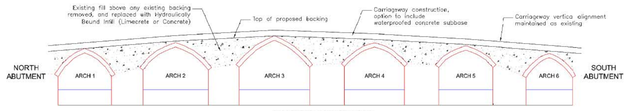
Strengthening of Arches

Method	Description	Reasons for Rejection
Increased Backing level	After removal of the road surface the bridge fill material would be completely removed down to the top of the stone arches and tops of the piers and completely replaced with concrete.	1. The bridge fill forms part of the historic original fabric of the structure. Its removal would therefore be damaging to the conservation of the structure and the loss of original fill would be irreversible 2. It would be difficult to remove or replace the concrete without causing some damage to the remainder of the structure. 3. Newbridge would be exposed to increased risk of damage/collapse during construction. 4. This technique would change the structural action of the existing bridge which could prove detrimental to the remaining original fabric of Newbridge in the longer term.
Saddling	As above except only a layer of structural concrete would be placed above the stone arches and the tops of the piers. Granular fill or weak concrete would be used above this up to the underside of the new road surface.	Points 1, 2, 3 and 4 above apply.
Over Slabbing	Removal of carriageway surfacing, part of the arch fill and all fill above the tops of piers. The level of piers would then be extended with concrete and reinforced concrete slabs constructed over the arches.	Points 1, 3 and 4 above apply.
Cintec's Archtech System	Holes would be cored from the road surface through the arch stonework and stainless steel reinforcing bars inserted and then grouted.	Point 4 above applies. In addition this technique would irreversibly damage the stones forming the arches, and the reinforcement bars would be impractical to inspect, remove or replace.
Masonry Arch Reinforcement Strengthening (MARS)/ Bersche-Rolt System	Drilling or cutting channels on the underside of the arches and fixing reinforcement.	Point 4 above applies. This technique would irreversibly damage the stones forming the arches, and the reinforcement bars would be difficult to inspect or replace. This technique would also leave visible traces of the strengthening on the underside of the arches.
Structural Lining to underside of arches	Casting concrete to underside of arches.	Points 2 and 4 apply above, but technique would be very visible and would also reduce clearance under the arches which would be detrimental to water flow capacity and navigation.

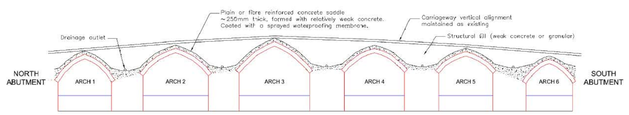


West Elevation of Arch 3

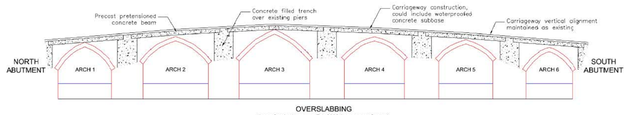
View Looking North Across Bridge



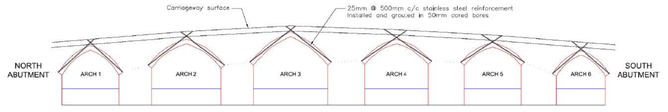
INCREASED BACKING LEVEL
(Long Section based on Feb 2000 Assessment Survey)



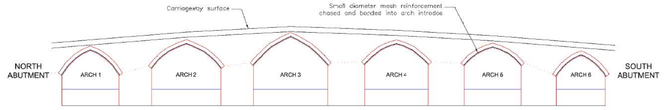
SADDLING
(Long Section based on Feb 2000 Assessment Survey)



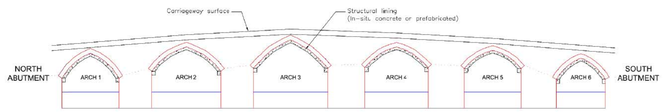
OVERSLABBING
(Long Section based on Feb 2000 Assessment Survey)



CINTEC'S 'ARTECH'
INTERNAL REINFORCEMENT SYSTEM
(Long Section based on Feb 2000 Assessment Survey)



MASONRY ARCH REPAIR & STRENGTHENING (MARS)
EXTERNAL REINFORCEMENT SYSTEM
(Long Section based on Feb 2000 Assessment Survey)



STRUCTURAL LINING
(Long Section based on Feb 2000 Assessment Survey)

Strengthening of Parapets

No doubt numerous sections of Newbridge's parapets have been knocked down and reconstructed throughout its lifetime so the historic importance of the existing parapets could be regarded as less important than other undisturbed parts of Newbridge.

Strengthening of the parapets to provide an adequate level of vehicle containment for cars travelling up to 30mph has been considered. The layout of the existing parapets does not enable them to be brought fully up to modern safety standards with just the strengthening methods below. It would also require all the existing pedestrian refuges in the west parapet to be infilled to provide a smooth traffic face and for safety fences to be provided at the four corners of the bridge. The lack of a smooth traffic face or protection to the ends of the bridge currently could result in vehicles being brought to an abrupt stop, causing serious injury to vehicle occupants. The strengthened parapets should however stop a car/light vehicle from falling into the river. The infilling of the pedestrian refuges though would obviously put pedestrians using the bridge to cross the river at more risk.

Method	Description	Reasons for Rejection
Re-construct to same shape/profile	The stonework to the parapets would be taken down and re-built re-using the original stones but with a high strength mortar.	1. The high strength mortar would be detremental to the durability of the weaker stone and the damage this caused to the stone would be irreversible. Depending on the strength of the existing stone and the point of impact the parapets may still not be able to contain cars travelling at just 30mph. 2. Any improvement in parapet strength obtained would serve to extend the extent of any damage so could affect a longer length of parapet and increase the potential for impact damage to extend down to the supporting structure/arches below.
Reinforce the existing parapets with stainless steel	Holes would be cored through the parapet stonework and grouted stainless steel reinforcing bars installed.	Coring holes would damage the historic fabric of the structure and would be irreversible. With the reinforced bars installed through the stones, repairs to any subsequent impact damage would be much more difficult to undertake and would make reuse of some/all existing stones impractical. Point 2 above also applies.
Construct unreinforced stone parapets to a greater width	The stonework would be taken down and reconstructed using new stonework and high strength mortar.	The existing parapets are a single block of stone wide, so in order to widen the parapet the stonework would need to be replaced, removing historic fabric from the structure. The shaped coping stones on the top of the existing parapets would also have to be replaced. If the parapets were widened on the carriageway side this would reduce the space for pedestrians further and potentially increase the frequency of impacts. If they were widened on the external face then it would have a significant impact on the appearance of the structure. Point 2 above also applies.