



ADAIN YMGYNGHOROL CONSULTANCY DIVISION



BOMB STORE AT GLYN RHONWY, LLANBERIS

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Bomb Store at Glyn Rhonwy, Llanberis

Structural Report

Introduction

The building is a reinforced concrete structure constructed around the time of the second world war to store ammunition. Ammunition was still stored in the building well after the war, and it is believed that it was not until the early 1970's that the building was fully emptied of its contents.

The building came into the ownership of the Local Authority in 1983 and the Highways Consultancy of the Highways and Engineering Department of Gwynedd Council have prepared this report for the Planning Department, to assist them in deciding on a future use for the building.

All the galleries, apart from the railway gallery have been given identification letters, which are painted on the gallery walls. These starts with A at the ground floor north side and J at the 1st floor north side and running through to H and S respectively on the south side. The letters I and O are not used.

The galleries have been further divided by identification numbers, with each length of gallery between any pair of interconnecting doorways being given a bay number from 6 to 10, starting at the front of the building. Bays 1 to 4 have been demolished and Bay 5 is now outside the building.

The floor level in A11 and B11 has been raised some 1.5 metres above the adjacent floors with concrete steps leading up to this raised area.

There are the remains of two large lifts connecting C9 to M9 and C6 to M6. These lifts are roughly square on plan and occupy most of the gallery width. The openings in the first floor slab for these lifts have been trimmed by large reinforced concrete downstand beams spanning the width of the galleries.

The only means of access to the first floor area at the present time is a small reinforced concrete staircase some 900 mm wide located at C11 and consisting of two flights with a small half landing.

There is a tunnel running into the building at D11 from an adjacent quarry to the south. There is also running water present in this tunnel which is then piped under the building.

Access to the site is by means of a footpath down a slate waste embankment at the North west end of the site.

When the building was in use, access would have been through two tunnels under the A4086 road adjacent to the site. Both these accesses have since been blocked off.

Condition

The building is structurally in a generally good condition.

The main defect found in the structural concrete was spalling of concrete to expose reinforcing bars. This is considered to be due to carbonation of the concrete rather than from the result of loading. Steel in concrete is protected by an oxide layer which effectively inhibits corrosion. This passive layer is stable under the alkaline conditions that exist in concrete under normal conditions. Carbon Dioxide from the atmosphere diffuses into the concrete, resulting in a reduction of this alkalinity, and corrosion of the reinforcement can then take place. Corrosion of the reinforcement results in an increase in its volume which results in the reinforcement forcing off its concrete cover.

This is a very slow process and does not penetrate more than 30 to 40 mm into good quality concrete. It is therefore usual to associate this problem with older reinforced concrete structures or where the concrete cover to the reinforcement is very small.

The concrete cover to the reinforcement where spalling had occurred in this structure was in many places as little as 6 to 12 mm.

There were some minor cracks at various locations within the building, many of which had been monitored in the past and had marks with what were believed perhaps to be dates e.g. /42.

These marks certainly predate the Council becoming the owners and there did not appear to have been any appreciable movement of these cracks. These cracks would not therefore be the cause of any great concern although it would not amount to a major expense to seal these cracks and monitor them to confirm that there is no movement.

The first floor slab has a 50mm sand/cement screed. This screed has broken up over a fairly large area of floor in the general vicinity of Q9, R9. This is considered to be possibly due to the spillage of some substance onto the screed at some time in the past, or possibly, though less likely, a defective batch or contamination when the screed was laid.

There is standing water on the upper floor at around Q6. This is considered to have entered the building from the front, where the wall has been constructed to seal the remaining building when the part demolition was carried out. Because of the cool unvented conditions within the building, this water will take a considerable time to dry up.

The part of the building outside the partition wall at the front (Bay 5) is in a generally poor condition and showing severe signs of weathering.

Both the ground and first floor areas in this region, are perfectly flat and undrained, so that any material washed down from the fill above the building is deposited as a thick wet sludge on both floors. There are large areas of exposed and corroded reinforcement in this area.

Site Investigation

As much information as possible was obtained regarding the size and spacing of reinforcement from the areas of exposed reinforcement in the heavily weathered areas at the front of the building as well as elsewhere where there had been spalling of the concrete.

An indication of the strength of the concrete was obtained by drilling cores out of the building and carrying out compressive test on these cores.

Because of the difficulty of bringing coring equipment etc. to the site and the limitations of the budget, only three cores were taken. These consisted of one horizontal core from the wall between E6 and F6, one vertical core from the floor at M10 and one vertical core from the floor at M11.

Analysis

It is difficult to predict exactly how a building such as this behaves structurally without having access to all the information regarding its construction.

Codes of practice on the structural use of concrete have changed considerably since this building was constructed.

In the absence of a more detailed investigation it is therefore necessary to err on the side of caution when assessing the load carrying capacity of the structure.

The building has been subdivided into the following component parts.

1. 6.5 metre roof arch.
2. 8.1 metre roof arch.
3. 210 mm deep floor slab.
4. 590 mm deep floor slab.
5. Downstand beam supporting floor slab.
6. Columns.
7. Walls.

When analysing complicated structures without any movement joints, these structures are said to be highly indeterminate for analysis purposes. With this type of structure the limiting load case is often the loads generated within the structure from thermal movements rather than any applied external force.

In this building, because of the fill covering the roof, there are not expected to be significant temperature variations throughout the year, and the temperature load case has therefore not been carried out. This would need to be considered if any future use of the building involved heating.

1. and 2. Since the roof arches are only carrying a uniformly distributed load, primarily the dead load from the fill, there will only be direct compressive stress in the arch, and no significant bending. The concrete in the arch will be capable of carrying this load, with the reinforcement only serving to limit any cracking of the concrete.
3. The 210 mm deep 1st floor slab is capable of supporting a live load of 8 KN / m² of floor area.
4. The 590 mm deep 1st floor slab is capable of supporting a live load of 5 KN / m² of floor area. This reduced loading being due to the greater span and self weight of this slab.
5. The downstand beam is capable of supporting the 210 mm deep slab when the slab is loaded at 8 KN / m².
6. The columns are capable of supporting the downstand beams when the 210 mm floor slab is loaded at 8 KN / m².
7. The walls are capable of supporting the arched roof and the floors loaded to 5 KN / m² and 8 KN / m² respectively. The compressive stresses in the walls are quite high since the wall is supporting the fill above the building, the weight of the building itself as well as any 1st floor line loads. It would be beneficial if the height of the fill over the building would be reduced.

Recommendations

Repair the areas of spalled concrete. Larger areas could be repaired by thoroughly cleaning down the affected area to provide a clean sound surface and then guniting the area. Smaller areas could be repaired using hand applied repair mortars.

The part of the building exposed to the elements as a result of the past demolition, and the wall constructed to close off the remaining building, should be made weatherproof and some form of drainage system introduced to stop water standing in this area and entering the building.

Consideration could be given to removing some, but not all, of the slate waste fill from above the building.

Repair damage to 1st floor screed around areas Q8, R9.

Repair any minor cracks and introduce a system of monitoring.

Any further work would be dependent on what use was to be made of the building.

Storfa Bomiau Glyn Rhonwy

Prif Wrthrych

Caniatau a hwyluso mynediad ddiogel ar droed i'r storfa bomiau, y twll chwarel, a'r twnnel rhyngddynyt.

Gwaith Angenrheidiol

1. Clirio'r deunydd a'r tyfiant o'r lle agored o flaen y storfa. ✓
2. Clirio'r deunydd o'r hen hafn rheilffordd i alluogi i'r dwr ddraenio ohonni. ✓
3. Gosod draen i gario'r dwr o'r hafn i'r system draenio bresennol. X
4. Dymchwel y waliau briciau yn y cyn-agoriadau i adrannau'r storfa.
5. Clirio deunydd a ffitiadau rhydd oddi mewn y storfa.
6. Gosod caeadau clo ar y manols yn y storfa a'r twnnel.
7. Gosod system draenio'r dwr arwynebedd oddi ar y lle agored o flaen y storfa.
8. Gosod cwteri i gario'r dwr daear a glaw oddi ar y toau bwa a lloriau allanol y llawr cyntaf, a'i drosglwyddo i'r system draenio uchod(7).
9. Atgyweirio'r waliau a'r lloriau concriid allanol y llawr cyntaf i'w gwneud yn ddiogel, ac i wrthsefyll ymosodiad dwr yn y dyfodol. Y lloriau concriid i'w gwynebu i sianelu'r dwr arwynebedd i'r cwteri uchod(8).
10. Atgyweirio'r waliau a'r toau/lloriau mewnol i'w gwneud yn ddiogel.
11. Clirio'r deunydd o'r agoriad mewnol(pen y twll chwarel) y twnnel rhwng y storfa a'r twll chwarel.
12. Creu llwybr troed rhwng yr agoriadau mewnol ac allanol y twnnel uchod(11), pen y twll chwarel.
13. Gwneud sianel yn gyfochrog i'r llwybr uchod(12) i gario'r dwr o agoriad allanol y twnnel i'r sianel bresennol o fewn yr agoriad mewnol.
14. Clirio'r tyfiant a'r gwastraff llechi o ganol y twll chwarel i greu man agored addas ar gyfer cerdded arno. Bydd angen mewnfario deunydd ar gyfer y gwyneb.
15. Gosod pibell i gario'r dwr o agoriad y twnnel rhwng y ddau dwll chwarel i'r sianel uchod(13) yn agoriad allanol y twnnel.

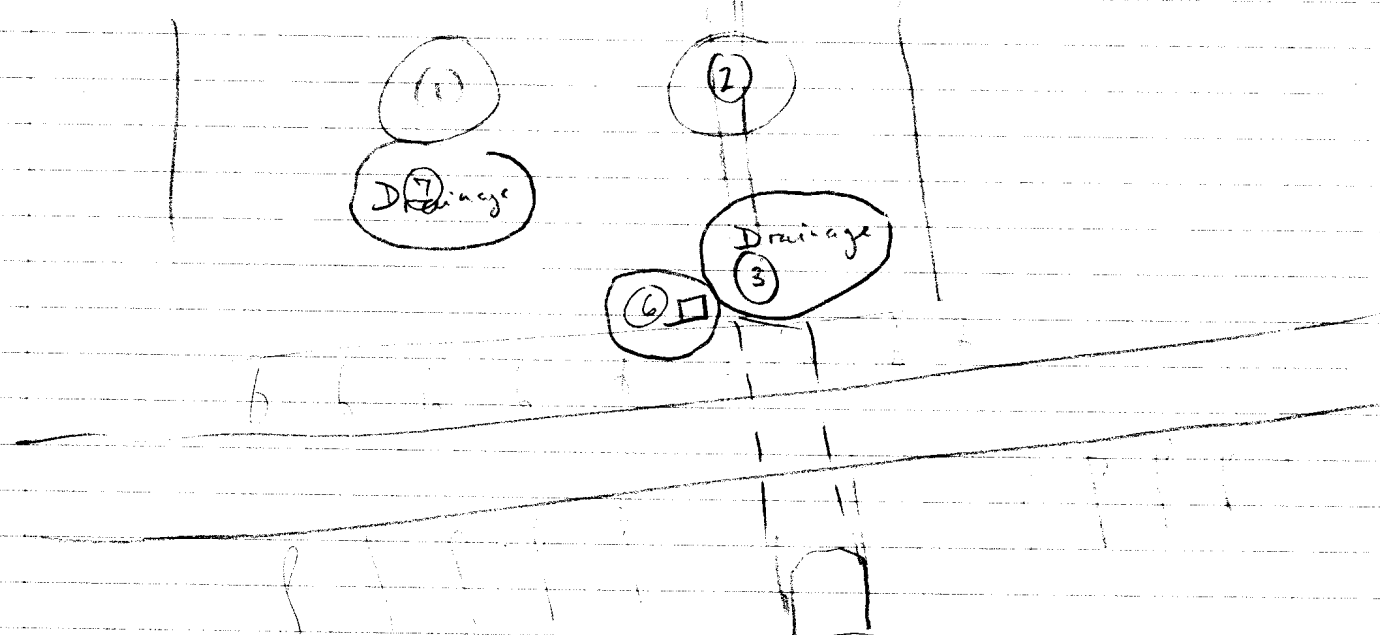
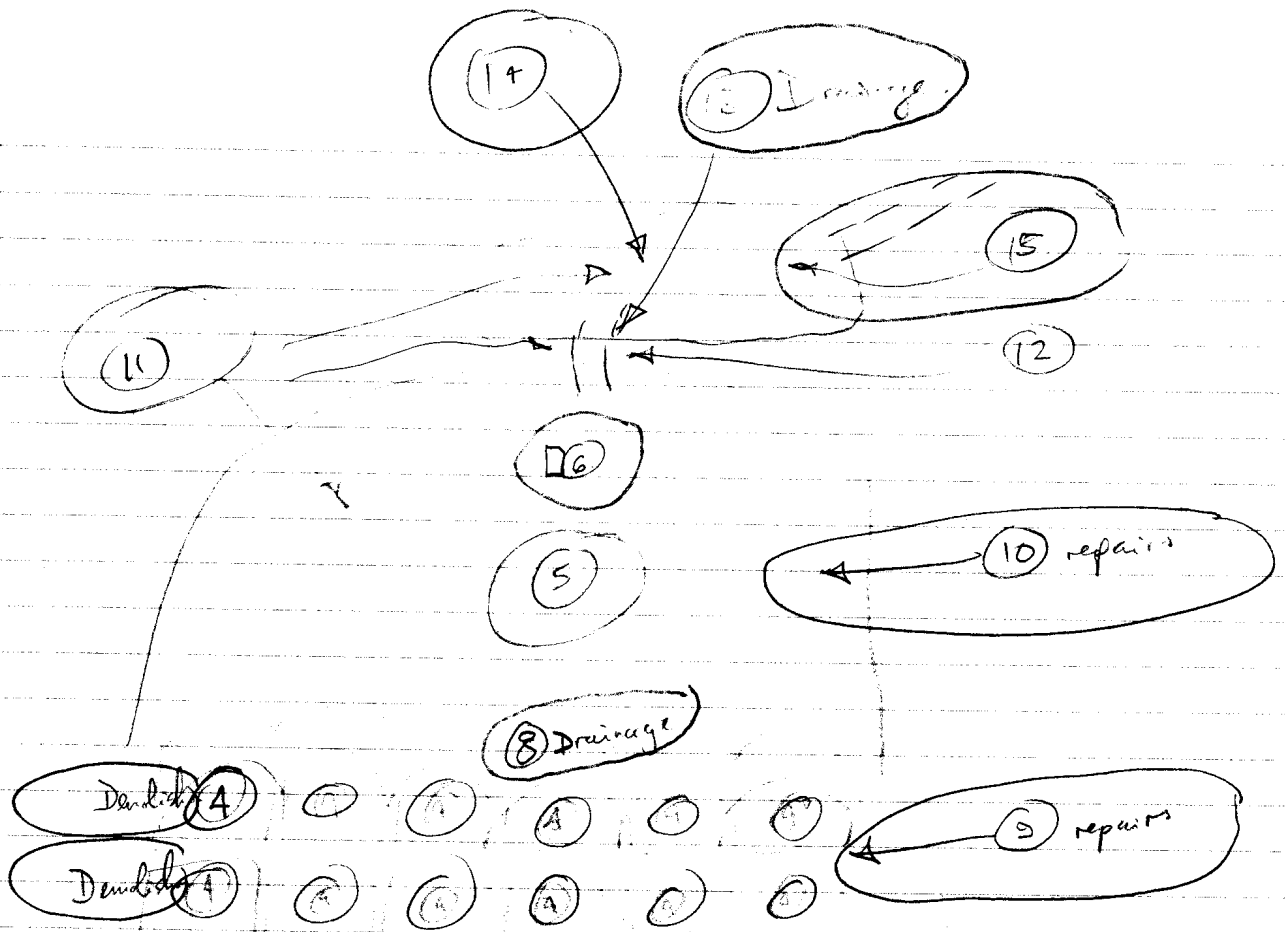
Gwaith Ymchwil

Er mwyn ceisio sicrhau y gall y systemau draenio presennol gymeryd y dwr ychwanegol a fydd o bosib yn cael ei sianelu iddynt fel canlyniad i'r gwaith arfaethedig, bydd angen ymgymryd a'r gwaith ymchwil canlynol. Gall hyn hefyd arwain at ei bod yn ofynnol i ymgymryd a gwaith ychwanegol i'r hyn sydd wedi'i restru eisioes:-

1. Archwilio'r sytem draenio bresennol sydd yn cario'r dwr o'r twll chwarel oddi tan y storfa bomiau, gan gynnwys yr elfennau canlynol:-
 - (i) Ffynhonellau'r dwr sydd yn cronni oddi fewn mynedfa'r twnnel rhwng y ddau dwll chwarel
 - (ii) Ffynhonellau'r dwr sydd yn cronni oddi mewn i fynedfa allanol (pen y twll chwarel) y twnnel rhwng y storfa a'r twll chwarel. Rhagdybir mai'r dwr cronni (i) sydd yn llifo ar draws y twll chwarel i'r fan hon.
 - (iii) Effaith clirio'r twll chwarel ar lif y dwr i'r system draenio bresennol, h.y. a fuasai'n ychwanegu at y llif ac a fuasai'r system yn gallu cymeryd y dwr ychwanegol heb achosi i'r dwr sefyll ar y wyneb yn y twll chwarel?
 - (iv) I ble mae'r draen sydd yn rhedeg oddi tan y storfa bomiau yn draenio iddo?
 - (v) A fydd modd cysylltu'r system draenio dwr arwynebedd oddi ar y lle agored(7) i'r system draenio bresennol? Os buasai, a fyddai'r system hon yn gallu cymeryd y dwr ychwanegol heb achosi problem dwr yn sefyll un ai yn y twll chwarel neu'r lle agored?
2. Darganfod system ddraenio'r hafn rheilffordd er mwyn cysylltu'r draen newydd (3) iddi.
3. O fewn y twnnel rhwng y storfa a'r twll chwarel mae twnnel arall yn arwain ac sydd a'i fynedfa wedi'i chau i fyny. Bydd eisiau agor y fynedfa i archwilio'r twnnel i nodi ei faint, hyd ac i ble mae'n arwain, ac adrodd ar yr archwiliad.

Gwasanaethau Ymgynghorol ynghlwm a'r cynllun

1. Dyletswyddau ynghlwm a'r gwaith ymchwil uchod gan gynnwys trefnu a goruchwylio unrhyw waith ffisegol megis dymchwel, agor tyllau archwilio, ymgymryd ac arolwg CCTV etc.
2. Paratoi adroddiad ar y gwaith ymchwil fel bo angen a gwneud argymhellion ynglyn a'r gwaith i'w ymgymryd.
3. Trefnu unrhyw arolygon neu brofion angenrheidiol i asesu'r gwaith fydd angen ei ymgymryd, a'r meintiau i'w cynnwys yn y Rhestr Feintiau.
4. Paratoi lluniadau ar gyfer cyflwyno cais cynllunio a rhoi amcangyfrif bras o gostau'r cynllun, gan gynnwys ffioedd.
5. Dylunio manwl, paratoi dogfennau contract ac amcangyfrif manwl o'r costau, a gwahodd tendrau.
6. Ymgymryd a dyletswyddau'r Goruchwiliwr Cynllunio o dan reolau CDM.
7. Adrodd ar y tendrau a gosod y contract.
8. Goruchwylio'r contract i'w therfyn, ardystio taliadau i'r ymgymerydd, setlo'r cyfrif terfynol, a pharatoi adroddiad archwilio ar y cyfrif terfynol.
9. Ymgymryd a dyletswyddau goruchwylio'r contract ar y safle, fel bo angen.



REPAIRS.
 DEMOLITION.
 DRAINAGE.
 CLIRIO.

Risk Area
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