Spire Research Project


Work on the cathedral started in 1220 and it was completed by 1258 though the crossing was then topped by a small lantern tower and spire. The form of the spire is unknown but it is likely to have been a simple structure. The tower and spire that exist today were erected in the early fourteenth century. The tower is 33 ft square and the walls are over 6 feet in thickness. This great weight was placed on the original lower tower section which was never designed to carry such a load. The large crossing arches below were reconditioned and extra stone arches inserted. Flying buttresses were also added. Over many centuries iron reinforcing bands have been added to both the tower and spire, and with time these have rusted and provided further structural challenges. The additional structure forced the four main columns (under the crossing inside the cathedral) into the ground and distorted them. The masonry in the walls of 13th century tower deteriorated, with joints opening up or splitting.

It is not just the weight of the tower and spire that has caused problems - the constant battering by the wind and rain has also had a damaging effect. The wind tends to cause the structure to lean away from the vertical while the rain erodes the stonework, especially on the south and western sides. In January 1930 there was a great gale with winds of 100 mph. This had an inevitable impact on the structure and especially the weak spots. The stone newels in the staircases started to crack and the north-west angle of the tower was also shaken.

Over many centuries the tower and spire have been the subject of major restoration schemes. Rusting ironwork has been replaced by copper, concrete supports have been added and the stonework has been cleaned regularly, repointed and in parts replaced.

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During the twentieth century the tower and spire have been the subject of regular architect led inspections. A comprehensive description of the problems and what had happened pre the 1980s was produced by Alan Taylor and appeared in1986 in the Association for Studies in the Conservation of Historic Buildings Transactions (Vol 12), viz

The lantern, or short original tower, was open to the cathedral floor until about 1480. Tower and spire weigh almost 5,000 tons. Walls of tower were pierced by lancets until 1939. Inside condition of stone is satisfactory but outside it has suffered from the effects of weather – ‘causes no undue concern for the stability of the structure’, yet ‘much of the decorated stone is in a very dangerous condition’.

The tower up to 8-doors will be encased in scaffolding from end 1988 or early 1989. This must not place any additional strain (weight) on the columns and its design will be a major structural challenge. The whole structure will then be closely inspected and photographed as a preliminary to replacement of damaged stone.

The spire rises 185 ft and imposes a vertical load of 600 tons. The walls are generally of Chilmark stone, though the top section was rebuilt in the 1950s with Doulting stone. A timber frame scaffold is connected to the capstone via a bronze bar and adjusted with a turnbuckle. It was suggested that it be replaced by a steel structure in 1937 but the proposal was not implemented.

Pressure at the junction of the tower and spire caused considerable outward pressure on the squinch arches. The original tie bar became corroded and failed. It was removed in 1968-9 and replaced by a stainless steel bar with turnbuckle screws in the squinch openings. A concrete ring beam was formed in the floor of the gutter and was extended around the tower.
It was also suggested that a twin bronze tie be inserted around the octagon but only a single one was inserted across the arch opening. Other tensioning was inserted above this. Three bands of lattice decoration exist and the stone thickness at these levels is reduced to 5 ins and has suffered from severe erosion, especially the joints. The three bands are in a ‘parlous state (approaching the perilous)’. Steel space frames have been inserted behind these decorative bands to enable stones to be replaced. The frames were fixed in March 1987. They enable the stones to be ‘lifted’ so as to reduce the vertical pressure and so enable damaged stones to be removed and replaced. The loading can be checked by striking the struts and listening to the note produced – an eighth indicates an acceptable load.

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The various architect’s reports which have been produced are summarized below.

1922  Report stated that the structure ‘stands in an uncertain condition’.
1926  Four large raking oak struts were replaced below main beams of the spire floor.
1926  Weight placed on the four main columns at the crossing is probably twice that planned by the original builders despite the elaborate system on flying buttresses which have been installed. The weakest part is the C13th lantern (ie the bottom part of the tower which terminates level with the roof ridges of the nave, transepts etc Wren had added iron bands to reinforce the structure in 1668. The iron hoop around the base of the spire is badly corroded. Doubts that much work had been done between Wren and Scott.
1927  Lightening conductor inspected and repaired
1931  Iron tie bars at level of C13th tower were replaced. (see 5:F27)
1935  Spire reported to be in good condition but some minor works required.
      Water accumulation behind the gables and pinnacles above the parapets and some pinnacles had become faulty, especially on the south side. Also the stair turrets were causing concern.
      Rusting ironwork, especially on the south and west, needed to be replaced by copper.
      Lead gutter behind the south parapet was faulty and needed to be replaced. Floor below scaffolding needed some attention.
      Masonry in C13th tower in a poor condition because of wind pressure especially caused by great gale in 1930 with winds of 100 mph.
1937  Freeman suggested that the timber scaffold be replaced by a steel one - not implemented.
1938-40 Staircases and wells causing concern. Staircases filled with cross brick walls and 8 lancets were filled in to create blind arcades. All this was done in 1939.
      Extra work carried out at base of n/e staircase.
      An oak staircase was erected to provide access to the balcony.
      The main problem is rusting ironwork which had been installed to stabilise the structure as this was damaging the masonry. A Delta metal tie bar was inserted at the squinch level to resist any sudden thrust should ironwork above fail.
      Some repair work to the wooden scaffold which had been affected by beetle and rain.
      Work cost £2,885.
1950  Top section of the spire was rebuilt in Doulting stone (see 1986 report).
1967  30 years since the structure was last surveyed and suggests this be rectified. There was concern over the state of the s/e stair turret. Also concern over the effects of supersonic flights, and any risk to the cathedral structure.
      First priority repairs to cathedral estimated at £23,750 of which £8,000 was for tower top.
      Report on condition of the tower top said that the iron bands below the parapet level were heavily corroded and damaging the masonry.
      Another iron band which had been inserted by Wren needed to be replaced by a ring-beam or girdle – cost £8,000.
Another bar close to the squinch is also corroded. Much masonry repairs required to
the parapet. Replace ironwork on stair turret spires.

1968-9
Iron bar at squinch arches level removed and replaced by a stainless steel bar (see

1971
Stone shell of spire is sound. There were cracks in the tower but they were not
considered important.
The effect of wind on the structure was estimated and a design wind speed calculated
at 115 mph i.e. the building was not designed to withstand wind speeds above 115
mph.

1974
Aircraft warning lights replaced

1977-8
Corroded ironwork was removed

1978
First aid repairs carried out and many crockets replaced.

1979

1980
Measurements checked annually since 1979.

1986
Paper on history of structure
Tower to 8-doors encased in scaffolding 1988-9 so that a full inspection could be
made.
Pressure of spire was causing outward movement at squinch arches.
Stone erosion at the decorative bands was poor as the masonry was only 5” thick at
those points.

1987
Steel frames inserted behind the decorative bands.

In case they were needed there is a more detailed summary of the various architects reports. It
follows:

1922 Report on the Tower and spire by William Forsyth
He concludes that no satisfactory conclusion can be made without measured drawings but his general
conclusion was that the structure ‘stands in an uncertain condition’, though as long as the
reinforcement iron remains he feels that there will be no serious problems.

1926 Sir Charles Nicholson Report
Examined the tower and spire in September 1926 with Mr Forsyth (architect) and Mr Messenger
(Clerk of Works).
Weight on 4 main columns most probably twice that intended by medieval builders of cathedral
despite an elaborate system of flying buttresses. All have settled and steeple tilts to south-west.
Columns also buckle inwards, a common thing in such buildings, and most probably happened when
tower and spire built. The weakest part of the structure is the lantern.
Wren added iron banding in 1668. The horizontal hoops on the exterior are still here but the iron tie
splints on the inside which should have secured them are largely missing. The iron hoop around the
base of the spire is badly rusted.
He concludes by saying that ‘Taking everything into consideration I am of opinion that at the present
time the steeple is in a safe condition and I believe your architect Mr Forsyth shares this opinion’.

1935 Report on Structural condition by W A Forsyth
Spire In good external condition and with no change in deflection in recent years.
However, here was water accumulation behind the gable and pinnacles above the doorways onto the
tower parapets and some of the pinnacles were faulty, especially on the south side including the
staircase turrets.
Most problems were caused by rusting of the wrought iron ties which had been inserted to stabilise
the structure. The problem is worst on the south and west sides. Policy has been to replace with
copper and this should continue.
The lead gutter behind the south parapet is faulty and needs to be replaced.
Scaffolding and windlass in good condition. Floor and base of scaffold needs some attention.
Ventilation needed at the weather door level to prevent beetle problems

1967 Lawrence Bond. Notes on tower etc
Letter to Dean 29 July 1967 outlining work to be done:
- Immediate work to the tower-top.
- Setting up of a system of regular inspection and recording.

It is 30 years since the building was surveyed and a new survey is needed. Concern over recent movement in south-east stair turret.
Recommended Ministry of Technology be asked to bar supersonic flights over the cathedral as effects were unknown.
Letter from John Stonehouse the Minister of Technology dated 27 July 1967 saying supersonic test have just ended and Salisbury Cathedral was not affected. Ministers will keep the situation under review.
More papers on sonic booms and letter from Michael Hamilton at House of Commons letter paper.
Report on the condition of the tower-top October 1967. Iron bands just below the parapet level were heavily corroded and causing damage to the masonry. Also another iron band a bit lower which was inserted at time of Wren. Iron bands must be replaced by a ring-beam or girdle. Cost about £8,000.
Also another bar found at base of spire close to squinch arches was also corroded, and especially so in one area. Much masonry repairs to parapets. Stair turret spires to be examined and all visible iron work removed.

1968-9 Work to top of spire  J W Gray & Son Ltd
March 1969 to July 1976
Replacement of aircraft warning lamps in 1974.
Reinforcing beam and removal of medieval ironwork at top of tower 1968-9

1971 Report on Tower and Spire E.W.Gifford and Peter Taylor
Condition of tower and spire initially included in report of July 1967, though the survey was then limited and particularly considered replacement of corroded ties around the tower. This work was undertaken in 1968-9. A more general survey followed.
Stone shell of spire seems to be in sound condition both inside and out. There were cracks in the tower but they were not considered particularly important. Much time was spent trying to assess the strains on the tower and spire from wind and a design wind speed of 115 mph was calculated.
In essence it seems that the condition of the tower and spire did not cause concern.

1979 Report on Structural matters Peter Taylor
This report is by Gifford & Partners and Alan Rome the cathedral architect. It contains details of measurements which were taken periodically throughout the year from 1973-9 to check for movement in the structure.
The tower and spire were shown to be generating small movements which suggests it was ‘breathing’, most probably because of climatic changes.
Nothing much seems to have been done to the tower or spire, the emphasis still being on measurement and assessment.

Very large report by Gifford & Partners, Alan Rome (cathedral architect) and Roy Spring (Clerk of Works) dated November 1980.
Points out that much ironwork was inserted as it was built. Distortion to supports (columns) most probably arose when it was constructed and is usually caused by pressure from the thrust of side arches, transepts, aisles etc. Much extra iron added by Wren and more again by Scott in 1869. Spire was struck by lightning in 1741 and caused fire in oak timbers.
Movement now checked annually.
Biggest threat is to decoration of spire and especially the decorative bands. Plan to create a supporting frame.
In 1978 first aid repairs were carried out and many angel crockets replaced. Corroded ironwork was removed in 1977-8. Some reinforcing bands of concrete and steel were added in 1967-9. Decayed stonework was left.

Planned work includes

1. Installation of reinforcement to decorative bands
2. Masonry repairs to spire shell.
3. Repairs to 4 main pinnacles and stairwell pinnacles.
4. Each face of the spire to be treated separately, starting with the north and working clockwise.

Decayed stone will be replaced with Chilmark stone. Non-loadbearing carving will be retained and restored after water cleaning. The ironwork will be checked and repainted as needed but no major problems expected. Other general work to floors and windows plus fire prevention work.

1983 Report of structural matters Peter Taylor


Much discussion of work on foundations and assessment of ‘lean’ of tower and spire.

Work yet to commence on repairs to decorative bands of spire. Plan for insertion of internal reinforcing frame – cost c.£40,000 to £60,000. Stand cable tie inserted just above 8-doors.

W.A.Forsyth also produced a report listing the main repairs that had been undertaken between 1921 and 1940.

1926 Inserted 4 large raking oak struts below the main beams of the tower floor. Cost £193.
1927 Lightening conductor inspected and repaired. Cost £24. 18. 4d.
1931 Iron tie bar at level of 13th century stage of tower much corroded at south-east pier by weather. New rod inserted in 1931. Cost £44. 5. 5d.
1938-40 Tower.

Staircases and walls cause for concern.

Staircases filled with crossed brick walls ie in shape of a cross up through the staircases. Also the 8 lancet windows in the lantern were filled with stonework. This was all done in 1939.

Extra work done at base of north-east staircase.

An oak staircase was installed to provide access to the upper tower and spire.

Spire.

Main problem was rusting of ancient ironwork which had fractured the masonry in places. A Delta metal tie rod has been inserted at the squinch level so as to resist any sudden thrust should a reinforcing bar above fail.

Wooden spire scaffolding had been attached by beetles and from rain rot. A new centre portion had been installed plus many new struts and ledgers.

Work in tower and spire started in 1938 and ended in 1940. Cost £2,585. 11. 10d.