REPORT OF STRUCTURAL INSPECTION AT:-

THE TOWER OF THE PARISH CHURCH ST BARTHOLOMEW'S GREAT GRANSDEN, CAMBRIDGESHIRE

A. DEMPSTER BSc CEng MIStructE MICE

for

WARD + COLE (NOTTM) LTD
2 COMMERCE SQUARE
NOTTINGHAM
NG1 1HN

TEL: 0602-504645
FAX: 0602-504646

FEBRUARY 1995
JOB NO: 21/160

STRUCTURAL INSPECTION OF THE TOWER AT THE PARISH CHUCH ST BARTHOLOMEW'S , GREAT GRANSDEN, CAMBRIDGESHIRE

1.0. INTRODUCTION

1.01 On the instructions of the incumbent and the PCC the church was visited on Wednesday 25 January 1995 for structural inspection purposes. An inspection of the tower had been requested with particular reference to the existing installation of bells and proposals to re-hang them and provide a new ringing room floor. This report relates specifically to these items.

1.02 The tower is of fourteenth century rubble masonry construction and stands at the west end of the church with its north and south walls being approximately coincident with the north and south walls of the nave and its east wall being coincident with the west wall of the nave and side aisles. Externally the tower is approximately 7m square at its base and there are buttresses to the north west and south west corners which extend upwards from ground level to clock chamber level. The approximate height of the tower is 24m.

1.03 We have not inspected woodwork or other parts of the structure which are covered, unexposed or inaccessible and we are, therefore, unable to report that any such part of the structure is free from defect.

2.00 OBSERVATIONS

2.01 External Observations

The external walls of the tower were viewed from ground level with the use of binoculars.

North Elevation Wall

This elevation has three openings, being louvre windows at bell chamber level, one small window just above the clock face and a small window giving light to the first intermediate chamber below the clock face. The stone masonry appears to be in fair condition consistent with its age with no apparent signs of significant cracking, recent or ongoing movement.

West Elevation Wall

There are five openings in this elevation, being louvre windows at bell chamber level, a small window at clock chamber level, a slightly larger window at first intermediate chamber level, a large window opening immediately above the entrance door and the entrance door itself. In addition to these are small windows giving light to the spiral staircase which is situated internally in the south west corner of the tower. Again the stone masonry appears to be in fair condition consistent with its age with no apparent signs of significant cracking, recent or ongoing movement. It is evident that some repairs have been carried out in the past to the wall, particularly towards the south west corner. These repairs have remained stable since they were carried out.

South Elevation Wall

There are three openings in this elevation of similar size and position to those in the north elevation wall. In addition there is a small window giving light to the spiral staircase access in the south west corner. Again the stone masonry is in fair condition consistent with its age with no apparent signs of significant cracking, recent or ongoing movement. As with the west elevation wall it is evident that some repairs have carried out in the past to the masonry, particularly in the south west corner. These repairs have evidently remained stable since they were carried out.

East Elevation Wall

These observations are limited to that section of wall which is visible above nave roof level. There is only one opening in this elevation externally, being the louvre windows at bell chamber level. The stone masonry to this elevation appears to be in fair condition consistent with its age with no apparent signs of significant cracking, recent or ongoing movement.

2.02 Internal Observations

East elevation Wall (Within Church)

There is a large archway in the east elevation which takes up most of the internal elevation width of the tower and extends to just below the floor of the first intermediate chamber which approximately corresponds with the cills to the clere storey windows above the nave. It should be noted that the south wall of the nave is not exactly coincident with the south wall of

the tower but is slightly off-set towards the south aisle wall. The wall has been plastered and painted at sometime with the exception of the dressed stone reveals to the arch opening. There is evidence of minor cracking and crazing to the plaster work which appears to be mainly due to ageing and minor shrinkage/thermal movement. Some cracking is evident at the junction of the wall with the north and south elevation walls of the naive particularly just below roof level. There are however no apparent signs of significant recent or ongoing movement to this wall.

Tower Internally

Ground Floor Chamber

The walls have been plastered and painted at some time and the timber floor to the first intermediate chamber is visible from this level. The ground floor is covered with quarry tiles which appear to have remained relatively true to line and level since their installation. There is some evidence of cracking and crazing to the plaster, particularly to the internal wall of the staircase access in the south west corner of the tower. Cracking is also evident to the reveals of the arch opening in the west elevation wall. This opening extends to the same height as the opening in the east elevation wall although it is not quite so wide. The cracking, which is mainly vertical, appears to be mainly due to ageing and shrinkage/thermal movement and it should be noted that there are no apparent signs of significant recent or

ongoing movement to the main walls of the tower. The internal dimensions of the tower at this level are 3.7m in the east west direction and 4.1m in the north south direction. The height to the underside of the intermediate chamber floor is approximately 8.5m.

First Intermediate Chamber

The walls have been roughly rendered and painted at some time and the timber floor of the clock chamber above is visible from this level. The floor of the intermediate chamber is of timber board and joist construction with a central trap door and appears to be in fair condition. Vertical cracking is evident to the render in both the east and west elevation walls and some patch repairs have been carried out below the window cill in the west elevation wall. Some cracking is also evident above the door opening on to the spiral staircase. The cracks are between 2mm and 3mm in width and appear to be mainly old and long standing. The internal tower dimensions at this level are 3.7m in the east west direction and 4.1m in the north south direction. The height to the underside of the clock chamber floor level is approximately 4.4m.

Clock Chamber

Again the walls have been roughly rendered and painted at some time. The timber floor to the underside of the bell frame is visible from this level. The floor of the clock chamber is of timber board joist construction and although old appears to be in fair condition consistent with its age. Vertical cracking is evident in the wall above the door opening on to the spiral

staircase. This cracking appears to be mainly old and long standing and several glass tell-tales have been installed across the cracks at some time. Some minor cracking is also evident to the window reveals in one or two locations. Vertical cracking is also evident in the render above the window openings to the north and west elevation walls. This cracking is generally minor in nature and appears to be mainly old and long standing. The internal dimensions of the tower at this level are 3.7m in the east west direction and 4.1m in the north south direction. The height to the underside of the bell chamber floor is approximately 4.0m.

Bell Chamber Level

The walls are of unpainted rubble masonry construction with dressed stonework around the reveals to the louvre window openings in each elevation. The masonry to some of the stone mullions between the louvre window openings in each wall has been cut away in some cases to allow room for the installation of the timber bell frame. The timber roof support structure is visible from this level. The stone masonry at this level appears to be in generally fair condition consistent with its age although it is apparent that some patch repairs have been carried out particularly above the archways to the louvre window openings. A ring of six bells has been installed at this level in a timber frame which sits diagonally within the tower. The frame is dated 1658. A layout of the existing bell frame in given in Appendix A to this report. The bells are hung in timber headstocks. Bells No. 3, 4 and 5 are on plain bearings, the remaining bells being on ball bearings. A considerable amount of strengthening work has been carried out to the frame in the past consisting of some extra diagonal vertical timber braces and some iron straps at corner joints and also at

straight joints within the frame.

The internal dimensions of the tower at this level are 3.7m in the east west direction and 4.1m in the north south west direction. The height to the underside of the timber roof support beams is approximately 6m.

Spiral Staircase

The spiral staircase is situated internally in the south west corner of the tower. Some vertical cracking is evident throughout its height and crack gauges have been fixed across the cracks in several locations. The cracking appears to be mainly old and long standing.

Roof

The roof is slightly pitched in the central area with a lead covering and has flat lead lined gutters around the internal perimeter of the parapet walls. There is a small lead covered spire situated in the centre of the roof to the top of which is fixed a lightning conductor. The lightning conductor appears to have broken such that it points downwards rather upwards. Some debris has collected in the flat lead lined gutters and some vegetation is growing in certain areas. The stone parapet walls are approximately 1.3m high and are of random stone construction with dressed stone reveals and copings to the crenellations. The lead flashing tucked into the parapet walls is loose in several areas and the mortar joints immediately above the flashings are in generally poor condition. Some minor vertical cracking is evident at all four internal corners close to where the parapets join.

Observations Whilst Bells Were Ringing

The bells were rung in various combinations so that the effects on the existing bell frame and the tower structure could be observed.

Bells Nos. 1, 2, 4 and 6, swinging in a north east to south west direction, were rung first, followed by bells Nos. 3 and 5 which swing in a north west to south east direction. In both cases, differential movement between the top cills of the frame and the walls of the tower was noted in the order of $\pm$ 1.5mm. Vertical movement of the bottom frame members was also evident and several joints in the timber frame were observed to open and close.

Bells Nos. 1, 2, 4, 5 and 6 were then rung together and the differential movement between the top cill members and the walls increased to approximately $\pm$ 2.5mm. Vertical movement of the lower frame members and movement at the joints was also evident.

Some minor movement of the tower walls was noted with the bells ringing, which is normal in these circumstances. However, there was no evidence of any differential movement across the cracks evident in the intermediate chambers and in the spiral staircase.

3.0 PROPOSALS

It has been proposed to rehang the existing ring of six bells in new fittings in a new metal H frame lower down the tower in the existing clock chamber

leaving the existing frame in its present position. It will obviously be necessary to move the existing clock mechanism downwards and alter the clock face drive system to make room for the new frame. There is also a proposal to install a new ringing floor between the ground floor and first intermediate chamber. Whilst the proposed layout of the new bell installation has not been finalised it has been suggested that bells 1 and 2, should swing north south and bells 3, 4, 5 and 6 should swing east west and be adjacent to the north elevation wall. This proposed layout is shown in Appendix A to this report.

4.0 DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

4.01 It was evident that the timber bell frame was undergoing significant movement whilst the bells were ringing full circle with frame joints opening and closing and significant deflection being evident to the bottom frame members and top cill members. It is considered that the frame is reaching the end of its useful life and it would therefore be appropriate to consider rehanging the existing ring of bells with new fittings in a new rigid metal frame.

The existing frame is set diagonally with the tower and as a result the bells swinging full circle impose a greater horizontal load on the tower in the north south and east west directions and than they would if the frame had been set square on in the tower. The fact that there is a great deal of flexibility in the existing timber frame also means that greater horizontal loads are imposed on the tower than would be if the frame was more rigid.

Whilst there is no evidence that any significant detrimental effect on the tower is being caused at the moment by the existing ring of bells swinging full circle, the condition of the existing frame is bound to deteriorate and some damage may result. In any event the bells are made difficult to ring by the excessive movement of the frame and the small amount of movement also evident in the tower walls.

4.02 In Appendix A to this report are given a cross section through the tower, plans on the existing and proposed bell installations and horizontal loads imposed on the tower walls by the bells ringing full circle both for the existing installation and for the proposed installation.

It should be noted that the proposed bell installation, i.e the orientation of the bells, has been assumed at this stage and it should be confirmed by a specialist bell hanging company that this or a similar arrangement can be achieved.

From the figures on page A4 it can be seen that the reduction in horizontal load by rehanging the bells such that the frame is square on to the tower are reduced by approximately 50 per cent in the east west direction and approximately 80 per cent in the north south direction. Obviously this reduction in horizontal loading will reduce the horizontal deflection of the tower.

It should be noted that the stiffness of the tower at any level is proportional to the cube of its height above ground level. The height of the existing bell installation is approximately 17m above ground level and the height of the proposed installation is approximately 13m above ground level. Since the

horizontal deflection is directly proportional to the tower stiffness it follows that there is a further reduction in horizontal deflection of approximately 56 per cent if the bells are hung in the existing clock chamber.

It is considered therefore that there are significant structural advantages in rehanging the existing ring of bells at a lower level in a rigid metal frame and at the level and in the configuration shown in Appendix A to this report. It is considered unlikely that the new installation will have any significant detrimental effect on the tower structure.

It should be noted that the new rigid bell frame should be supported on a proper grillage of foundation beams with the main foundation beams being built in to the north and south elevation walls and the secondary foundation beams being built into the east and west elevation walls.

4.03 Some cracking was noted to the tower walls internally both in the various intermediate chambers and in the spiral staircase. It is considered that this cracking is mainly old and long standing and has been caused by a combination of shrinkage/thermal movement and possibly some minor differential settlement of the tower wall foundations which has occurred in the past. There is also a possibility that some of the cracking may be aggravated by the migration of rubble fill within the tower walls.

It was noted that several of the cracks were being monitored using crack gauges. Providing that this monitoring shows that there is no significant ongoing movement occurring then the cracks can be repaired using traditional cosmetic methods. The advice of the church architect should be sought in this respect. If, however, further ongoing movement is found to

be occurring then it may be necessary to effect more substantial repairs in the future. It should be stressed however that the cracking noted at the time of the visit was of a minor nature only and it is evident that the cracking is not being aggravated by the ringing of the bells full circle.

4.04 At tower roof level it was noted that some debris was building up in the perimeter gutter and also that the flashings in the parapet wall were loose with open mortar joints in certain locations. It is recommended that the gutters are thoroughly cleaned and that the flashing is wedged back in position and the mortar joints repaired by raking out and repointing with a suitable mortar. Again the advice of the church architect should be sought on appropriate details.

It is also evident that some repairs are required to cracked mortar joints which are evident at the junctions of the parapet walls.

4.05 Also at roof level it was noted that the lightning conductor had come loose at the top of the spire and it is recommended that this is repaired as soon as possible.

A. DEMPSTER BSc CEng MIStructE MICE

APPENDIX A

CROSS SECTION THROUGH TOWER EXISTING BELL

INSTALLATION

PROPOSED BELL INSTALLATION

HORIZONTAL LOADINGS

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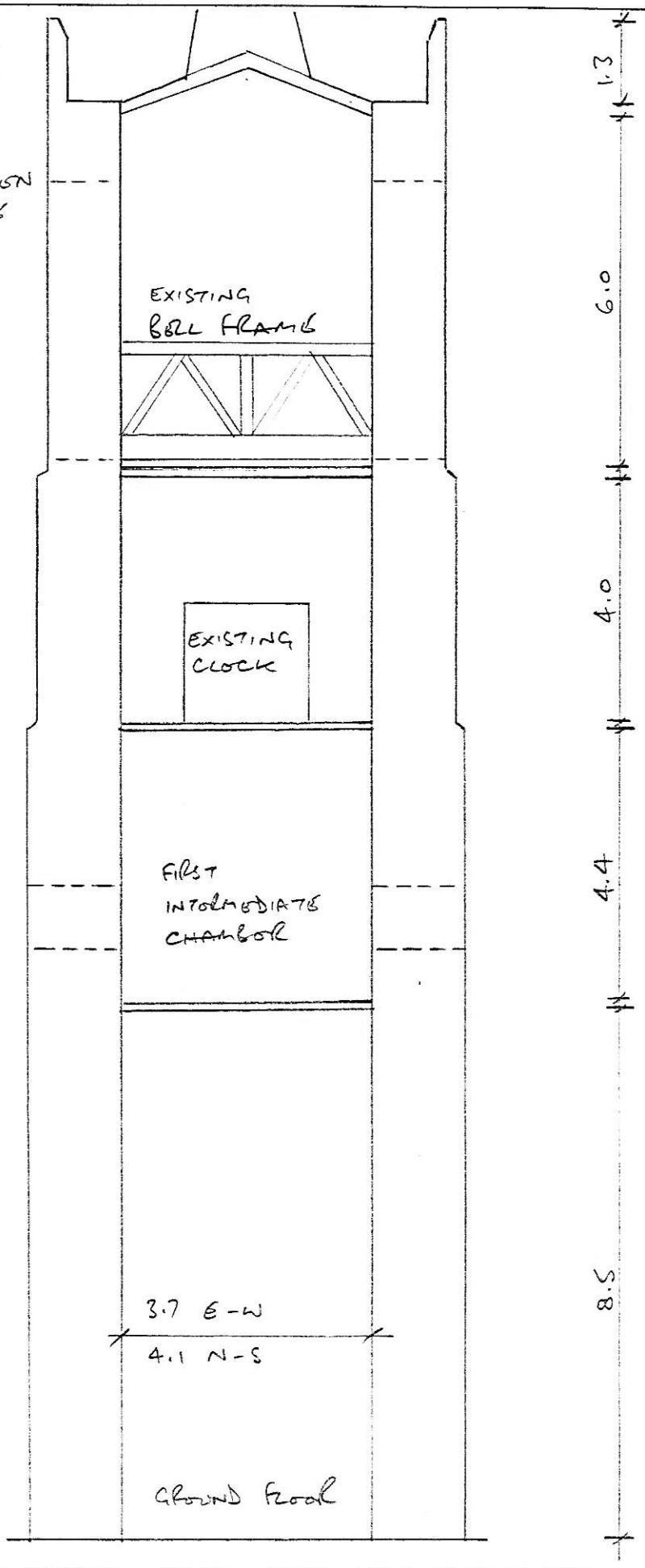
ST BARTHOLOMEW'S CHURCH, GREAT BRANSDEN

TYPICAL CROSS SECTION

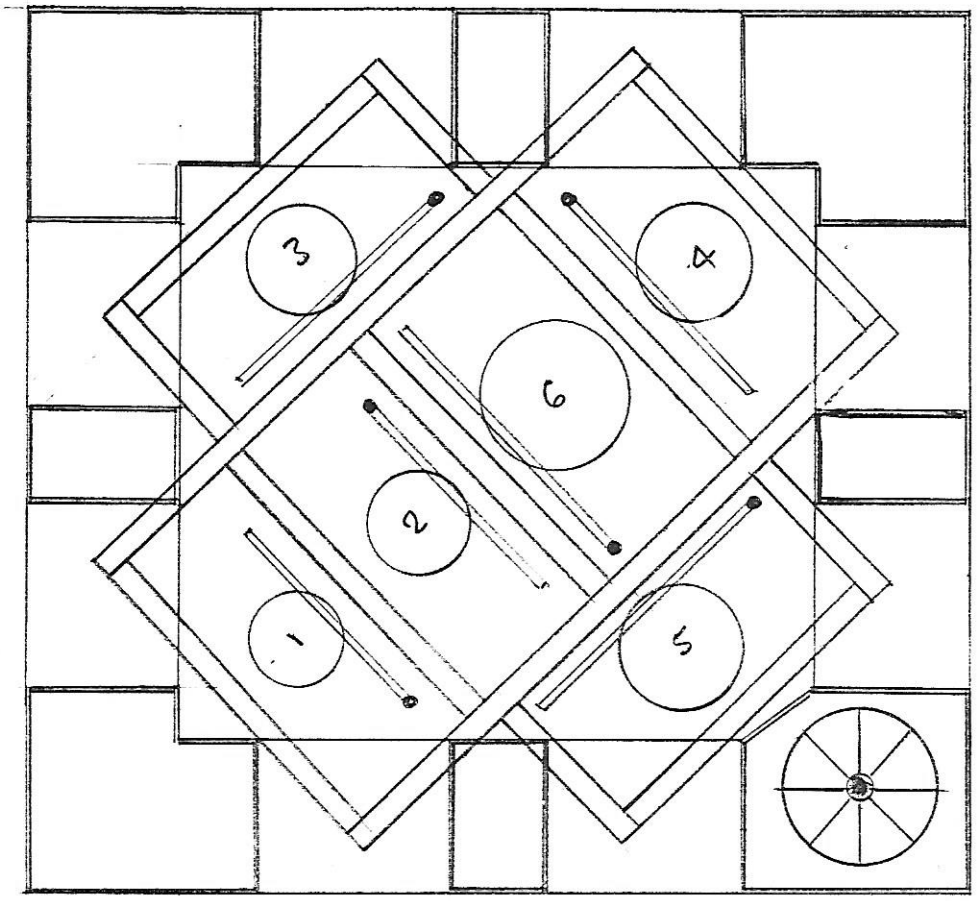
(DIMENSIONS GIVEN ARE APPROXIMATE ONLY)



ST BARTHOLOMEW'S CHURCH, GREAT GRANSDEN

EXISTING BELL INSTALLATION

EAST



NORTH

SOUTH

WEST

BELL	WEIGHT (APPROX)	
	CWT	QR
TREBLE	4	2
2	5	2
3	6	2
4	8	2
5	10	0
TENOR	14	2

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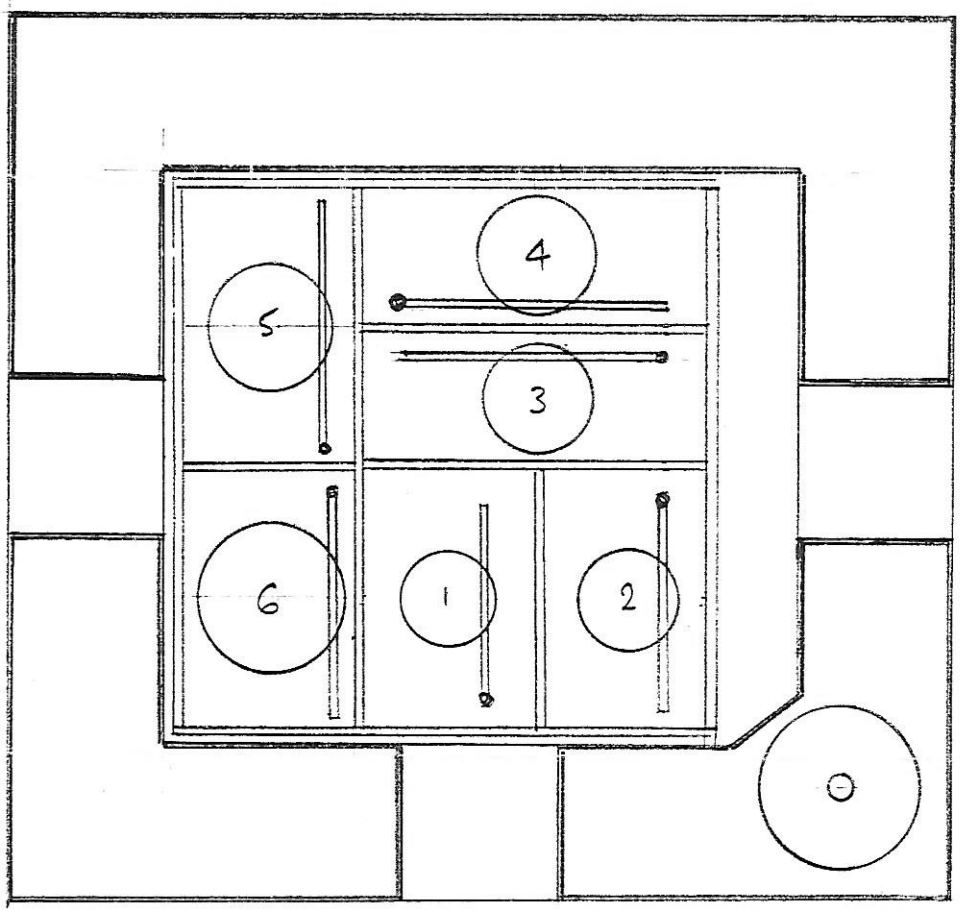
ST. BARTHOLOMEW'S CHURCH : GREAT CHALFIELD

PROPOSED BELL INSTALLATION (ASSUMED)

EAST



NORTH

SOUTH

WEST

ST. BARTHOLEMEW'S CHURCH GREAT CRANSDON

HORIZONTAL LOADS DUE TO BELLS SWINGING

EXISTING INSTALLATION

BELL	LOADS (APPROX) E-W (kN)	N-S (kN)
TREBLE	6.4	6.4
2	7.8	7.8
3	9.2	9.2
4	12.0	12.0
5	14.1	14.1
TENOR	20.5	20.5
TOTALS	70.0	70.0

ASSUMED PROPOSED INSTALLATION

BELL	LOADS (APPROX) E-W (kN)	N-S (kN)	
TREBLE	4.5		4.5
2	5.5		5.5
3		6.5	6.5
4		8.5	8.5
5	10.0		10.0
TENOR	12.5		14.5
TOTALS	34.5	15.0	31.0 18.5