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ENERGY CONSERVATION IN CHURCHES

Rapidly rising oil prices have necessitated great efforts to save energy in Sweden during the past few years. Sweden has a cold climate and long winters, and indoor heating accounts for a great deal of the country's energy consumption. The State offers grants and loans on favourable terms to persons undertaking improvements to save energy. This scheme has aroused a great deal of interest on the part of property owners and administrators, and churches are also affected by the comprehensive energy economization drive. The Central Board of National Antiquities has therefore drawn up recommendations and directions concerning energy conservation measures in churches. The directions presented here were circulated in the autumn of 1979 to all parishes and to consultants concerned with church restoration. Extensive work is currently in progress with a view to energy conservation in Sweden's churches. Thermal insulation and improvements to windows are among the commonest measures being taken in this connection.

Introduction

Problems connected with the heating of churches

Modern technology has made it possible for us to maintain a steady, pleasant temperature in our homes, and the same standard of comfort has also come to be expected of indoor facilities of other kinds, churches included, with the result that buildings which are often centuries old and were never heated previously are being subjected to heavy strains and in many cases being severely damaged.

The main problems which arise are as follows.

— Wooden furnishings and fittings dry out because the air humidity inside the church is too low, especially in winter. The wood cracks and the paint flakes. A large proportion of our unique treasury of medieval painted sculptures is today suffering a great deal of damage because of the way in which churches are heated. Organs, pulpits and old pews are also being damaged. Even " protective " heating causes dehydration.

— Walls and vaults are increasingly blackened, with the result that they have to be cleaned more often. Mural paintings cannot be cleaned without parts of the original work being destroyed, and many of our unique medieval church murals have already been gravely damaged in this way.

— Moisture travel is affected in outer walls of brick and natural stone, which among other things causes salt erosion in plaster and masonry.

Temperature over 18°C for sustained periods — a week or more — cause damage of this kind relatively quickly. The greatest risk of damage is in winter, when the relative humidity of the atmosphere is low. The only way to overcome these problems is by heating less. Artificial humidification, for example, usually causes other, quite serious, forms of damage.

Churches ought not, therefore, to be heated to more than 16-18°C for services, and at other times the temperature should be kept as low as possible. Care must be taken, however, to ensure, that there is no danger of water and heating pipes freezing. The problems which may arise from the viewpoint of the organist and a caretaker or verger can often be solved by installing radiant heat (infra-heating) where necessary or by means of individual, freestanding radiators.

Energy conservation through reduced heating

Thus by reducing the temperature and the heating input one protects the church from damage while at the same time cutting down running and maintenance costs. This is by far best, easiest and cheapest way of saving energy.

Other ways of saving energy

Even if these energy conservation principles are already being applied in a church, however, there are other ways too of saving energy, though the special characteristics of many old churches often preclude the energy conservation methods used in private homes, for example. Even apparently minor modifications for energy conservation purposes can cause extensive damage, especially if indiscriminate use is made of modern insulation

techniques. Consequently the information supplied to parish authorities in connection with the general energy conservation drive is not always relevant.

Energy conservation measures in churches should therefore be made to concentrate on the examination of heating systems, the sealing of doors, windows and vaults and, in some cases, the thermal insulation of the framework of the ceiling. The methods recommended in this memorandum under the headings Heating systems, Sealing and Thermal insulation have been designed with a view to minimizing the damage caused to buildings and furnishings.

Here are the most important energy conservation measures in order of priority.

1. Maintain a low temperature inside the church during the cold season of the year. Keep the church heated for the shortest possible periods. The church should not be heated to more than 16-18°C during services, and at other times the temperature must be kept considerably lower.
2. Trim and adjust the heating installation. Draw up operating instructions.
3. Check the sealing of windows and doors.
4. Thermal insulation of masonry vaults. Seal and insulate wooden vaults.
5. Install inside windows.
6. Seal and insulate floors.
7. Seal wooden walls of timber.

Energy conservation grants

There are a variety of energy conservation measures in churches which qualify for energy conservation grants, e.g. installation of control devices, improvements to windows, thermal insulation of the framework of the ceiling and connection to district heating. These grants cover 50% of the estimated standard cost of the measures taken.

Permission from the Central Board of National Antiquities

Since alterations to church buildings, even when undertaken for reasons of energy conservation, have to be approved by the Central Board of National Antiquities according to the law, a parish should contact the Central Board or its county museum while things are still at the planning stage; the Board and the county museums can also issue recommendations and directions concerning these matters. Permission for any measures then planned must

subsequently be applied for to the Central Board of National Antiquities in the usual way.

Heating systems

The first thing to do when setting out to reduce energy consumption in a church is to review the use and design of the heating system. This, generally, is where the heaviest savings can be made. As has already been mentioned, a low indoor temperature and the shortest possible heating periods are very important determinants of energy consumption when the heating system is in use.

The heating system and the building should be treated as an integral climatic whole. Thermal insulation of the vaults, for example, will reduce the heating requirement and may thus render the capacity of the heating arrangements excessive, in which case there is a risk of the indoor temperature being raised by a degree or two, intentionally or unintentionally, causing increased dehydration of furnishings and fittings. If the church is heated by an oil- fired boiler, the shorter running period will reduce the efficiency of the boiler, resulting in a corresponding impairment of heating economics. A reduced heating requirement due, for example, to a reduction of temperature or a thermal insulation most often makes it necessary for the burner — sometimes the boiler — to be modified or replaced. More often than not, excess capacity is uneconomical for continuous heating, while on the other hand a high power rating may be required in order to heat the church rapidly for an isolated occasion. The risk of condensation and moisture in old chimney stacks should also be borne in mind in this context.

When planning energy conservation measures, therefore, it is advisable to start by finding out whether the heating system needs to be modified or replaced. If, for example, the church furnishings are cracked and the paint is flaking off, if walls and ceiling vaults are heavily blackened or if the organ gives trouble in wintertime, a specialist should be engaged to investigate climatic conditions in the church and to ascertain how a good standard of comfort can be achieved with a minimum of damage to the fabric and furnishings.

This memorandum does not deal with the procedure for modifying an existing heating system or choosing a suitable new one in different circumstances, but the axiom should be that it must be possible for the heating system, which has a far shorter service life than the church, to be installed, repaired and replaced without unnecessary damage to the fabric or furnishings. It should also be borne in mind that all modifications to heating systems are subject to approval by the Central Board of National Antiquities.

The heating system should be fitted with a central control device to govern heating at weekly or daily intervals. Radiator thermostats are not advisable in churches. An adjustment of the heating system, in the sense of setting the radiators to emit the right amount of heat according to their position etc., may sometimes be justified.

Where oil-fired heating is concerned, meticulous operation of the boiler and burner are the foundation of low energy consumption. Extra chimney sweeping is also a commendable step in the same direction, and the condition of burner and boiler are vital factors in the economics of heating.

Sealing

The air change rate in a building, and with it energy consumption, can be reduced by sealing leaks and chinks in walls, ceilings and floors and also around doors and windows. But it is important for this sealing to be correctly done in relation to the structure and special circumstances of the building. For example, spaces which require ventilation on account of damp and the risk of rot, must not be sealed. Methods applied to modern dwelling houses are often unsuitable for old churches. New and untried materials should be avoided.

Sealing doors and windows

Doors and windows are sealed with 0 or V-section weather strips of rubber. Doorways with large chinks may need — if appropriate — to be fitted with wooden strips underneath the weather strips, or else with specially made strips. The old method of sealing doors with strips of sheepskin is still to be recommended in many cases.

If there is a door between the porch and the nave, this too should be sealed.

A wind trap inside the outer door has an important effect on energy consumption and on the possibilities of maintaining an acceptable level of air humidity inside the church during winter. A seal between ledge and wall may also be justified, using mineral wood caulking strips.

The addition of inside windows may be justifiable if the existing church windows have single panes only. When inside windows are to be constructed, tracery, stained glass, ventilation and cleaning access usually present such serious problems that a designer with technical and historical qualifications

has to be consulted. Insulation panes are not to be recommended, because window shapes and problems of fit cause heavy expense in most cases, added to which the energy saving effected is marginal compared with the installation of single-pane inner windows. Replacement of the entire window with triple glazing is almost invariably unacceptable for aesthetic and historical reasons, especially as insulation glass cannot be properly sash-mitred.

Note that energy conservation grants can be applied for towards the cost of improvements to existing windows.

Sealing outer walls

Apart from sealing around windows and doors, the question of improving the weather-proofing of outer walls only arises where timber churches are concerned. Sealing should be done in connection with the replacement or repair of shingling. No supplementary, thermal insulation on the walls may then be undertaken. Stone or brick churches do not as a rule require sealing.

Sealing floors

Great improvements can be obtained by sealing timber floors. Reduction of floor draught generally makes it possible to reduce the temperature inside the church without impairing the standard of comfort. It is particularly important for measures of this kind to be carried out with a close knowledge of the structure and functioning of the building, so as to avoid rot. For this reasons, inspection by a qualified building engineer is always essential.

Sealing of vaults and framework of the ceilings

Concerning measures to seal these parts of the building, see the following section on thermal insulation.

Thermal insulation

Climatic changes in an old building due, for example, to thermal insulation, can have undesirable effects on the building itself and on its furnishings and fittings. Measures should therefore be taken which involve a minimum risk of this type of damage. Since our experience of measures of this kind is still very limited, however, it should be realized that there may still be a risk of negative effects. Consequently, the recommendations

made here are not to be considered universally or indiscriminately applicable to all churches. The Central Board of National Antiquities is planning to carry out a survey of churches fitted with thermal insulation in order to study the effects.

Thermal insulation for churches ought as a rule to be considered only above vaults and ceilings. Supplementary insulation of the outer walls is precluded for aesthetic and historical reasons, and in any case the economization to be achieved by such means is small in most cases, especially when compared with the heavy cost of the work involved.

Thermal insulation in addition to sealing of cold wooded floors can distinctly improve the standard of comfort, but in order to rule out the danger of rot and other damage, modifications of this kind must always be preceded by expert investigation and planning. The injection of such materials as foam plastic insulation should always be avoided, especially in wooden floors on bare ground, owing to the damp retention properties of foam plastic. Measures involving excavation beneath floors often necessitates an archaeological investigation.

We shall now turn to consider suitable methods for the thermal insulation of vaults (ceiling frameworks) in churches.

Cleaning vaults prior to thermal insulation

The church loft has to be cleaned before thermal insulation is fitted to the vaults. We know from experience that lofts often contain objects and remains of great historical interest, and cleaning therefore has to be conducted under the supervision of a trained historian, who is also responsible for recording the vaults, roof trusses, and any traces of medieval murals etc. which may be found there. The county museum should therefore be contacted in good time before work begins. If there are murals on the walls above the vaults, the Central Board of National Antiquities must be specially consulted.

Earlier insulation materials and filling, e.g. wood shavings, can quite well be retained if they are clean, dry and undamaged. Earlier filling materials usually have better moisture-equalization properties, i.e. they absorb and distribute moisture more efficiently, than modern insulation materials; this can be important in the event of the roof leaking, for example.

If rot has occurred, however, the earlier filling should be removed, at least near the eaves and roof trusses etc. Careful examination should be undertaken, because rot is not always immediately apparent.

A wooden ceiling can in some cases entail the risk of sawdust etc.

escaping through the chinks between the planks and falling down into the church. If so, the earlier filling material should be removed and the top then cleaned with a vacuum cleaner or by some similar method, so as to remove any dust and dirt which could otherwise fall down into the church.

Earlier filling materials must always be removed under antiquarian supervision.

Sealing vaults

Before the insulation material is laid out, the vaults must be carefully sealed; this has a vital bearing on the efficiency of thermal insulation and, consequently, on the energy economization achieved.

In both wooden and stone vaults, all carry-throughs for flue gas ducts, electrical wiring etc. should be caulked with oakum. Masonry walls are generally so well built that no further sealing is required. Cardboard or plastic foils diffusion barriers are not to be used.

The topside of a wooden vault should be covered with windproof cardbiard, i.e. not with steam-proof cardboard and never with plastic. Alternatively the existing board can be left in situ, provided it is of the same type, and in both cases all joins must be glued. Sealing against the structural timbers etc. of the vault must be carefully done using battens or suchlike. The care with which board sealing is fitted has a vital bearing on the efficiency of thermal insulation.

Diffusion barriers in the form of plastic foil or suchlike may not be used, for the following reasons. Damp in the insulation impairs its insulating capacity. There are two ways in which damp from the body of the church can be conveyed through the ceiling, namely diffusion and convection. Diffusion occurs because the water vapour tries to spread itself as evenly as possible in the atmosphere, even between two different spaces, and is capable in this connection of penetrating materials which are not steam proof. Convection occurs when warm water vapour endeavours to rise while cold vapour falls. The convection of water vapour is stopped by an airtight stratum, e.g. a masonry vault or a properly glued layer of board, while diffusion is unimpeded. Moisture production in a church is low and diffusion is practically negligible. Diffusion barriers in the form of plastic foil or suchlike, therefore, ought not to be used in churches. Another reason for this is that temperature conditions in a church wich is not continuously heated are liable to be inverted, so that plastic foil can cause condensation in the insulation. We also know from experience that condensation problems

never occur if plastic foil is dispensed with, while on the other hand they often occur if it is used.

In the event of leaks in a wooden barrel vault, for example, the conveyance of damp due to convection can entail some risk of condensation in the insulating material. An airtight but permeable board, glued at the joins, or a tight masonry vault will prevent this, and no plastic foil is needed.

Thus the thermal insulation arrangements incorporating plastic foil which are described in the brochures issued by manufacturers of certain insulation materials should not be applied to old churches.

Thermal insulation of vaults

Thermal insulation should be effected using at least two layers of mineral wool, laid with staggered joints. 10 cm per layer is a suitable thickness. Mineral wool matting without cardboard windbreak should be used. For fire prevention reasons cardboard windbreak cannot be accepted in historic buildings. Although " fire-resistant " board is used, it is still so combustible that it must be avoided. To offset the loss of the windbreak effect of this board, the insulation thickness can be increased slightly, preferably by laying an extra mat 5 cm thick.

The stiffest type of mineral wool should not be used, owing to its relatively high content of phenoplast, which in the event of fire can cause serious smoke damage.

It is sometimes difficult to get the insulation to lie flush with steeply sloping vaults, in which case it can be secured, for example, by superimposing glass fibre netting at the points of the arches and fastening it at suitable points to the joists or roof structure. Metal nets should not be used, owing to the risk of their being struck by lightning.

Flocculated mineral wool should only be used in spaces which are inaccessible for insulation in the normal way, and special care should then be taken to avoid blocking the ventilation holes near the eaves.

Windbreaks

As has already been made clear, cardboard windbreaks should not be used on top of the insulation, for fire prevention reasons. There are no other suitable materials on the market at present.

If the church loft is ventilated via holes in the eaves, however, the air current striking the insulation along the outer walls may justify the installation of a windbreak at this particular point. One arrangement of this kind which is acceptable in terms of fire prevention is for a 3 cm

mineral wool matting with a cardboard windbreak to be rolled out along the eaves, on top of the finished insulation, but with the board cover downwards. The outer edge of the mat should be secured to the inside of the outer wall or to some other suitable point, using battens or suchlike.

Ventilation

If the loft is not heated — and it seldom is — one should make sure that it is properly ventilated, so that any condensation or any rainwater, snow etc. that may leak in will be ventilated away. Thermal insulation normally leaves the loft much colder than before, and this increases the need for ventilation. Holes in the eaves are the commonest type of ventilation aperture. If the church loft is not efficiently ventilated, this should be rectified, for example in the manner already described. When insulation is fitted on the framework of the ceiling, care must be taken to avoid blocking existing ventilation holes. At the same time as thermal insulation is fitted to the framework the roof should be examined, because any leaks here can cause graver damage to an unheated, insulated loft.

Ladders and catwalks

The church loft should be fitted with permanent ladders and catwalks, so that the roof and vaults can be inspected without the insulation being trodden on and damaged. These should be reviewed while work is in progress on the insulation. An electric lighting contact should be installed if possible, to facilitate inspection of the loft.

Other points

When fitting thermal insulation to the ceiling joists, one should also check the condition of the roof and roof trusses, particularly the supports at the eaves.

After energy economization measures have been carried out, operating instructions should be drawn up for the church heating installation and for the climate regulating device in the church. This is necessary in order for the measures taken to have their full effect and at the same time to protect the fabric and furnishings from damage due to heating.

NOM: KERSTIN ALEXANDERSSON, EINAR BRYDOLF, INGMAR HOLMSTRÖM, JAN UTAS - Suède.

THEME: MATERIAUX

TITRE: CONSERVATION DE L'ENERGIE DANS LES EGLISES.

RESUME:

Cette communication présente la réalisation des Recommendations et Directives pour la conservation de l'énergie dans les églises publiées par la Direction Centrale des Antiquités nationales en Suède en 1979.

Les problèmes qui proviennent de la demande du public pour plus de comfort et de chauffage dans les églises sont discutés. De cette amélioration, résulte une baisse relative d'humidité mais aussi des dégâts imprévus aux objets et aux matériaux. D'importantes tensions se créent dans les poutres accompagnées de rétrécissement et de fissure, la peinture s'écaille, les murs noircissent, et les orgues avec des sculptures en polychrome, les chaires, les bancs sont endommagés. Le taux d'humidité s'accroît, s'accompagnant de cristallisation de sel dans le plâtre et la maçonnerie. L'humidification artificielle cause d'autres dommages.

Il est recommandé de réduire la température (qui ne dépasse pas 16 à 18° degrés temporairement), en utilisant un chauffage radiant pendant les offices. Il est recommandé des mesures pratiques de conservation de l'énergie: vérifier le rendement de la chaudière et le fonctionnement des brûleurs à huile qui ont besoin de mise au point et d'ajustement.

On doit revoir le calfeutrage des fenêtres et des portes, les voûtes nécessitent de l'isolation mais les espaces situés au-dessus doivent être bien ventilés. Les planchers en bois ont besoin d'être scellés et isolés et des coupevents extérieurs ajouteront à l'économie. Il est également recommandé de prendre des mesures qui permettent l'accès à tous les espaces pour le contrôle.

NAME: KERSTIN ALEXANDERSSON, EINAR BRYDOLF, INGMAR HOLMSTRÖM, JAN UTAS - Sweden.

SUBJECT: MATERIALS

TITLE: ENERGY CONSERVATION IN CHURCHES.

SUMMARY:

The paper deals with implementation of the Recommendations and Directions for energy conservation in churches published by the Central Board of National Antiquities in Sweden in 1979.

The problems arising from the public's demand for higher standards of heating and comfort in churches are discussed. This improvement results in low relative humidities and much unexpected consequential damage to objects and materials. Heavy strains occur in timber with shrinkages and cracks, paint flakes, walls are darkened and polychrome sculpture, organs, pulpits, pews are damaged. The rate of moisture movement is increased with salt crystalisation in plaster and masonry. Artificial humidification causes other damage.

Reduced temperatures with the use of radiant heating during services is recommended with temperatures not more than 16 - 18° C temporarily. Practical measures of energy conservation are recommended such as checking the boiler capacity and performance of oil burners which need trimming and adjustment. The sealing of windows and doors must be reviewed, vaults need insulation but spaces above must be well ventilated. Wooden floors need sealing and insulation and outside wind breaks will help economy. Means of enabling all spaces to be reached and inspected are also recommended.

NOMBRE: KERSTIN ALEXANDERSSON, EINAR BRYDOLF, INGMAR HOLMSTRÖM, JAN UTAS - Suecia.

TEMA: MATERIALES

TITULO: CONSERVACION DE ENERGIA EN TEMPLOS.

SUMARIO:

La ponencia trata sobre la implementación de las Recomendaciones y Normas para conservar la energía en los templos, publicadas en 1979 por la Junta Central de Antigüedades Nacionales en Suecia.

Se discuten los problemas que han surgido de la demanda pública para lograr un alto nivel de calidad en la calefacción y confort de las iglesias. El mejoramiento en las instalaciones ha traido como consecuencia, un bajo nivel de humedad relativa que ocasiona daños en los objetos y materiales. Las estructuras de madera quedan sometidas a fuertes esfuerzos que originan contracciones y hendiduras, la pintura se escama, las paredes se enegrecen, la escultura policromada, los órganos, los púlpitos y los bancos se deterioran. Los efectos del cambio de humedad se agravan con la cristalización de sales en recubrimientos y mamposterías. La humidificación artificial causa otro tipo de daños.

Temperaturas moderadas no mayores a 16° o 18° C se recomiendan para el uso de radiadores durante los servicios. Se sugieren también otras medidas prácticas para conservar la energía, como comprobar la capacidad de los boilers y el funcionamiento de los quemadores que a menudo necesitan reparación y ajuste. Debe revisarse el sellado de ventanas y puertas; las bóvedas necesitan aislamiento, pero los espacios sobre ellas deben mantenerse ventilados. Los pisos de madera requieren ser junteados y aislados; defensas exteriores contra el viento pueden también ayudar. Son recomendables todos los medios que permitan la visita e inspección de todos los rincones o espacios del edificio.

Оглавление : СОХРАНЕНИЕ ТЕПЛОТЫ В ЦЕРКВЯХ

Имя : Александерсен Керстин, Бридольф - Финэр
—— Ингмар Холмстром и Утас Иан (Швеция)

Предмет : Материалы

Краткое описание :

Этот труд рассматривает приведение в жизнь Рекоммендаций и Указаний для сохранения тепловой энергии в Церквях, изданных Центральном Комитетом Национальных Древностей в Швеции в 1979 году. Проблемы вытекающие из усиленных требований публики о более высоких уровнях обогревания и комфорта в церквях здесь обсуждаются. Улучшение это выражается в понижении относительной сырости и,как последствие, большой неожиданной порчей предметов и материалов. Крупные следы появляются в дереве вместе с сокращением и трещинами; краска лопается, стены темнеют, полихромная скульптура, органы, кафедры, сидения портятся. Процент увеличения сырости растет по мере отложения соляных кристаллов в штукатурке и каменных частях здания. Порча происходит от искусственного отсырения.

Уменьшение температур, с использыванием теплоты при помощи излучения во время Богослужений здесь рекомендуется при временных температурах не более чем в 16 - 18 градусах. Рекомендуются практические меры т. к. контроль вместимости котла и исправность горелок, которые нуждаются в подрезке и в приспособлении.

Нужна проверка окон и дверей. Подвалы нуждаются в изоляции, но пространства находящиеся над ними должны иметь хорошую вентиляцию. Деревянные двери нуждаются в закреплении и в изоляции и устройство экранов против ветра поможет экономии энергии. Необходимо также иметь легкий подход ко всем отдельным частям здания

NOME: KERSTIN ALEXANDERSSON, EINAR BRYDOLF, INGMAR HOLMSTRÖM, JAN UTAS - Svezia.

TEMA: MATERIALI

TITOLO: LA CONSERVAZIONE DELL'ENERGIA NELLE CHIESE.

SOMMARIO:

Il presente saggio tratta dell'adozione dei suggerimenti pubblicati dal Central Board of National Antiquities in Svezia nel 1979, sulla conservazione dell'energia nelle chiese.

Vengono discussi i problemi sollevati dalla pubblica domanda per un maggiore livello di riscaldamento e comodità nelle chiese. Un tale miglioramento provoca una bassa umidità relativa e molto, insospettato, conseguente danno agli oggetti ed ai materiali. Ciò provoca, infatti, pesanti tensioni nelle travi di legno, con inevitabili contrazioni ed incrinature.
Inoltre, le pitture si sfaldano, i muri si anneriscono, le sculture policrome, gli organi, i pulpiti, le panche vengono danneggiati.

Il livello del movimento dell'umidità aumenta con conseguente cristallizzazione di sali negli stucchi e nelle parti in muratura. Umidificazioni artificiali sono causa di ulteriori danni.

Si raccomandano temperature ridotte durante le cerimonie religiose, che non superino i 16 - 18 gradi C, mediante l'uso di riscaldamento radiante. Si consigliano misure pratiche di conservazione dell'energia quali il controllo della capacità della caldaia e l'uso di bruciatori ad olio (ma che necessitano di continua manutenzione).

È necessario controllare la chiusura di porte e finestre, l'isolamento delle volte, mantenendo però gli spazi superiori ben ventilati. È necessario anche sigillare ed isolare i pavimenti di legno, mentre alcuni frangivento esterni agevoleranno un certo risparmio.

Vengono, inoltre, suggeriti dei mezzi per poter raggiungere ed ispezionare tutti gli spazi.