# Thermographic detection of thermal bridges - aims, possibilities and conditions

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**Abstract**

One dimensional heat flow assumption may be used when modeling the heat transfer only with reference to those parts of the building shell that comply with the following requirements:
- flat surface,
- continuous internal structure,
- adequate dimensions (large enough).

Those parts, that do not comply with the above requirements are usually called thermal or cold bridges and should be modeled with the multidimensional heat flow. It must be clearly stated, that it is not possible to avoid the presence of the thermal bridges in buildings. The proper choice of the building technology and correct design of the structural components may sometimes allow to completely escape or at least minimize the influence on the total heat flow of so called "structural bridges". But it is not possible to avoid the negative influence of the "geometrical bridges", that are connected with basic physical phenomena, which take place in double or triple corners, wall and floor joints, around openings etc.
The importance of the thermal bridges for building users consists in:
- increased heat losses,
- decreased temperature of the internal surface, that may result in local vapor condensation, mold growth and finally air contamination.

Thermopgraphic inspection allows not only instant location of cold bridges, but also specification of the range and surface temperature evaluation. So easy identification of cold bridges may result in certain overinterpretation, especially when narrow measuring range was used and recorded thermal image shows highly contrasted colors but insignificant temperature differences. Because we are not ready to resign from right angles or perpendicular structural joints in buildings we have to accept the physical phenomena that appear in those places. In the similar way, designers should be aware of the thermal bridging effect when they introduce material discontinuity because of the structural reasons and should protect them with thermal insulation. In general, inequality of the heat flow through building shell is unavoidable effect, that should be possibly minimized, but also correctly interpreted and considered in thermal calculations.

Thermal inspection of the existing buildings is not aimed at answering the question whether cold bridges exist, but how significant they could be for the total thermal heat losses and if surface condensation may appear. This kind of approach is connected with transfer from quantitative to qualitative assessment of the building thermographic images.

For this purpose general conditions of the inspection should be specified, that would assure reliable and sufficient data acquisition. Subsequently, common criteria of the objective thermal image evaluation should be precisely stated. Thermal requirements, regarding internal surface temperature to avoid critical surface humidity, included in European standard EN 13788 may be used in this context. Dimensionless temperature coefficient $f_{Rsi}$ allows to separate evaluation from actual temperature values.
The main aim of the paper is to specify:
- internal and external conditions that allow to gather reliable thermographic data (required temperature difference, climate conditions, temperature fluctuations),
- inspection methods connected with the structure of the building shell (two- or three-layer shell, location of insulation, interior or exterior survey),
- data range needed for thermal bridge evaluation.

Research work oriented on quantitative evaluation of the cold bridges is based not only on experience and thermal images recorded by the authors but also on computer simulation of the multidimensional heat flow in building shell.

An example of the structural cold bridge with the temperature profile is shown below. Thermographic image with easily observed temperature differences at the internal surface of the wall is in Fig. 1. Concrete post is hidden in the structural layer of the external wall made of hollow masonry blocks and covered with internal plaster. External thermographic view of the wall is shown in Fig. 2. The whole wall is insulated with the external layer of 10 cm Styrofoam and thin plaster. No significant temperature differences can be observed on the outside surface of the wall in this region. External inspection only would not discover the presence of the thermal bridge.

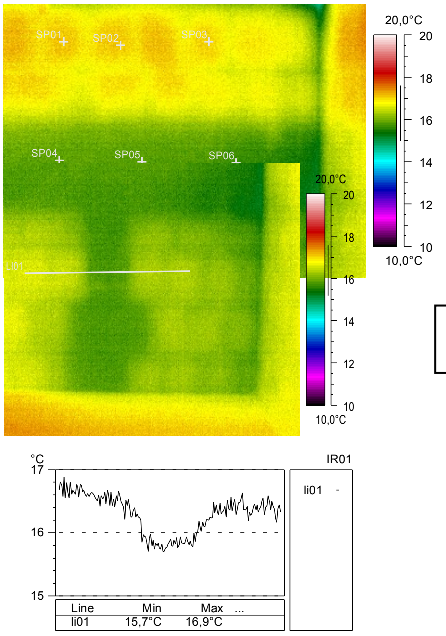


Fig. 1 Internal thermographic image

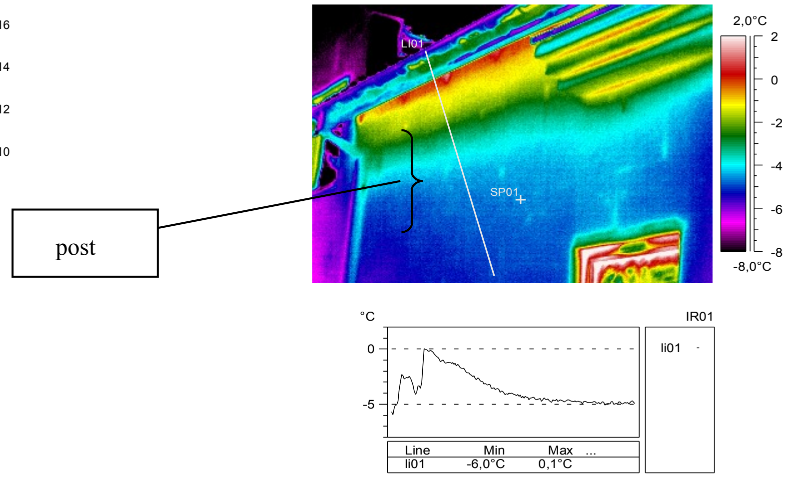


Fig. 2 External image

Computer simulation confirms in general the above observations, Fig. 3. Temperature distribution is practically uniform in external part of styrofoam (parallel isotherms at the bottom of Fig. 3 and differentiated at internal surface of the wall, as shown in Fig. 4. There is a discrepancy between the measured and simulated temperature differences, due to the material features and irregular structure of the post.

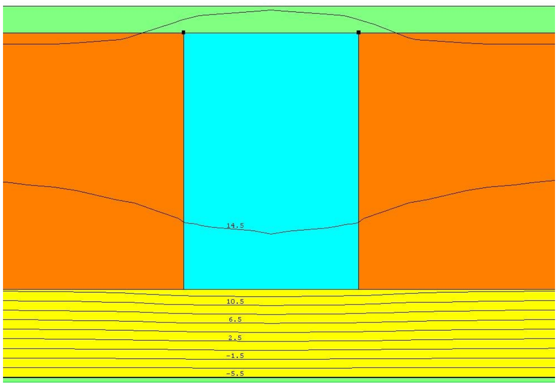

Fig. 3 Temperature distribution in the whole wall section, 2D heat flow simulation

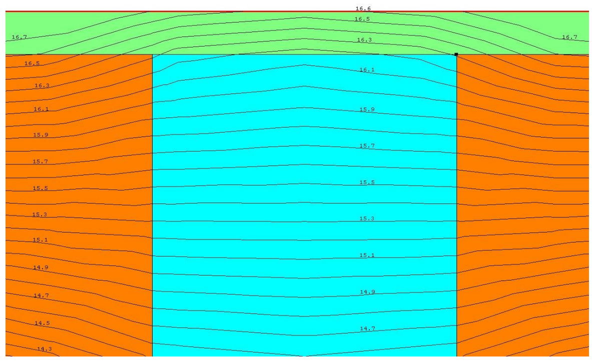

Fig. 4 Magnified internal part of the simulated wall with increased isotherm resolution