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Multilevel Optimization of Steel Gantry Structures on IBM PC

Regarding the gantry structure, it consists of steel frames and the crane. The scope of structural optimization in this case is to find the best dimensions of the plane frame, and the main girder of the overhead travelling crane on such a way, that the structures, and so the whole structure be economic. The subsystems optimization are as follows:

Economic design of the main girder of overhead travelling crane

The double girder of the crane is made of welded box section, with stiffened webs, which have different thicknesses (Fig.1.)

Variables: number of unknown independent variables is five, these are the dimensions of the asymmetric box sections: height of webs $h = x(1)$; thickness of webs: $t_{w1} = x(2)$; $t_{w2} = x(3)$; width of flanges: $b = x(4)$; thickness of flanges $t_f = x(5)$.

Objective functions: number of functions is four.

1) mass of the main girder,
2) welding cost,
3) surface preparation and painting cost,
4) total cost, including material-, welding-, surface preparation and painting cost.

Inequality constraints:

1) maximum stress due to main loading,
2) local buckling of flanges due to main loading, taking into account bending, shear and torsion,
3) local buckling of flanges due to main loading, when only the compression of the flange is considered,
4) local buckling of main web, under the rail, taking into account the compression of the weel,
5) local buckling of the secondary web,
6) maximum stress due to total loading,
7) local buckling of flange due to total loading,
8) local buckling of the main web,
9) local buckling of the secondary web,
10) fatigue of weldments due to shear and local compression,
11) fatigue of weldments due to tension and compression,
12) deflection of the girder

and ten constraints on the upper and lower limits of independent variables,

$$x_i^L \leq x_i \leq x_i^U \qquad (i = 1,2,\ldots,5).$$

So the number of constraints is 22. The constraints are formulated according to the Hungarian standards: MSZ 9749, MSZ 15024 and for the local compression of the weel we used the formulae of TGL 13503/2.

Main data of the crane

Span: 25 (m); lifting capacity 240 (kN) weight of trolley 30 (kN); axle base of trolley 2 (m); type of welding: K, number of load cycles $> 6\cdot10^5$; web stiffeners are 120 x 80 x 8 (mm) angle profile, material Fe 370 is used.

The cost factors are:

material cost: 17 Ft/kg; welding cost: 54 Ft/kg; surface preparation and painting cost: 108 Ft/m^2.
In mostcases the active constraints were the fatigue, local buckling of webs and the size constraints of thicknesses. The deflection limit in this case was span/600. There is no significent effect of welding and total cost on the mass, but the effect of surface prepation and painting cost is great.
Using higher strength steel (Fe 520), the mass of the structure can be reduced, the cost depends on the cost ratio of steels.

Economic design of the plane frame

The plane frame made of welded I-members, the heights of webs both at columns and rafters are linearly increasing ones. The frame has pinned bases. The analysis was made in the elastic range.

Variables: number of variables is ten, these are the dimensions of the I-sections both in column and rafter and the tenth variable is the span (Fig.2).

Objective functions: number of functions is three.

1) mass of the frame
2) mass/floor space of the frame
3) cost of the frame including material-, welding-, surface preparation and painting costs.

Inequality constraints:

1- 4, statical stress constraints in various nodes,
5- 8, local web buckling constraints,
9-10, local flange buckling constraints,
11-12, lateral buckling constraints in the eaves point
13, elastic lateral buckling of the compressed flange at rafter
14-15, vertical and horizontal displacement constaints for the apex and eaves points of the frame,
16-35, size constraints, upper and lower limits for the unknown variables.

The constraints are formulated according to the standars: MSZ 15021, MSZ 15024, BS 5950.

Main design data

Height of eaves points: 8 m; height of apex: 12 m distance between frames: 6 m; the length of the hauch from the eaves point: 6 m; distance of purlins: 2 m; the uniformly distributed vertical load: 0,4 kN/m^2; concentrated loads and bending moment from the crane runway.

There is no significant effect between the mass and the cost of the frame. The second objective function decreases the mass/floor space ratio of the frame. Using higher strength steel (Fe 520), the mass of the structure can be reduced, the cost depends on the cost ratio of various steels.

Bibliography:

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Figure 1.

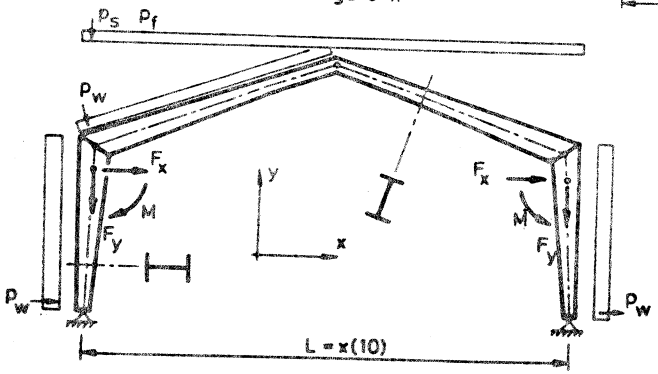

Figure 2.

Practical sensitivity and insensitivity in computer and communication network models

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Abstract

Essential problem in modelling, simulation or other analyses of real computer and communication systems is establishment of model parameters. Accessibility and reliability of parameters has influence on model formulation so, that e. g. for simulation often too detailed models are used, because the behaviour (parameters) of elementary parts are well known, which is not true for appropriate groups or parts build from these elements.

From the problem of parameter identification a question arises in what extend the individual parameters influence the resulting behaviour of the system under consideration. In this paper we proceed from queueing systems often used for modelling of computer, communication and other systems on the level of demands and system sources.

For quantitative evaluation of the parameter variation influence the notion of absolute and relative sensitivity was introduced [1], [2]. It is supposed that each quantitative characteristic v of systems behaviour is differentiable function of intrinsic system parameters p. The absolute sensitivity is simply partial derivative of functional dependence v = f(p) with respect to one parameter. The relative sensitivity it is possible to understand as percentage of change of characteristic v due to one percent change of one parameter when other parameters are fixed. For electrical networks the sensitivity was introduced in 1945 by H. Bode, for queueing systems in [1], [2], [3].

The insensitivity (invariance) [4] is a property defined so, that stationary probability distribution of system states is independent of shape of statistical distribution of statistical variable of the system, e. g. service time, or other conditions. The dependence on mean value remains, of course. In praxis is important not only insensitivity to shape of distribution, but also insensitivity to kind of service place, i. e. manner of service and queueing [4], [5], [6].

In the paper both these approaches are given and compared. It is shown that using sensitivity analysis and some results of insensitivity theory it is possible exclude not essential parameters and find in one step the measure of influence of the individual parameters on system's behaviour.