TEKA Kom. Mot. i Energ. Roln. – OL PAN, 2010, 10A, 152-157

WAYS OF MANAGEMENT OF LOWFREQUENCY VIBROTREATMENT

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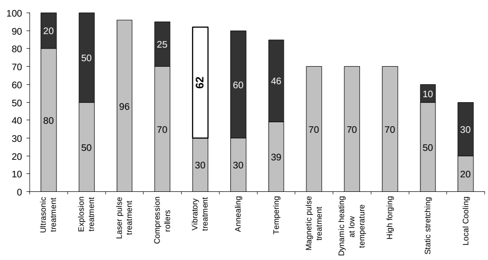
Summary. The results of researches of influence of vibrotreatment additional parameters on the number of resonance peaks is described in the article. The main possibilities of use of these parameters for management of process of lowfrequency vibrotreatment is determined.

Key words: residual stresses, standing waves, parameters of regime, inflexibility of supports, additional masses, position of supports.

INTRODUCTION

The field of own residual stresses is formed in details of construction and their units as the result of many stages of technological process such as casting, welding, stamping, mechanical treatment and so on. In most cases the peak means of stresses for structural steel are comparable with yield point of metal, the details and units are made from, and gradients of stresses are tens of MPa/mm. External loads cause the appearance of new stresses by the next treatment and usage, which can excess critical point and can lead to formation of cracks, deformation, decrease of tireless, corrosion durability and other negative consequences. It is often impossible to reduce the peak means and gradients of stresses to acceptable level by technological methods. That is why aftertreatment is necessary to prevent from undesirable consequences. Many methods of treatment of details with the aim of reduction of residual stresses lead to different results and demand different cost. The variety of methods of treatment was offered in different time. Thus following types of treatment are recommended: [Vinokurov, 1] thermal treatment, [Vinokurov, 2] plastic deformation, [Kasatkin, 3] impulsive force treatment, [Lashchenko, 4] vibrotreatment. Its necessary to admit that the costs for carrying out these operation are very different. Thus [Zubchenko, 5] worked out data let to estimate economical and technological effectiveness of different methods.



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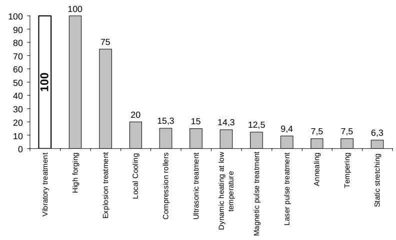

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Fig. 1. Distribution: 1 – minimum and maximum stress reduction after treatment;
2 – comparative economical effectiveness of method

It is possible to see from Fig. 1, that vibrotreatment is one of the most economically advantageous technologies, but the result of its usage is very unstable. This shows unsufficient knowledge of mechanism of interaction of residual and vibrostresses and necessity of detailed technological working out of process for introduction into industry.

OBJECTS AND PROBLEMS

Common lowfrequency treatment is process, during which the field of elastic waves of vibrostresses is formed in treated detail. These waves in sum with own stresses lead to some changes in construction and relaxation processes as well . However, as a rule, the distribution of own stresses in detail is very heterogeneous and vibrostresses are distributed heterogeneously as well. Thus, the main task is creation of vibrostresses of necessary value in determined zones of detail. In this case vibroteatment becomes purposeful and controllable. The determination of possible ways of management of vibrostress distribution in detail is the main task of this work.

RESULTS AND DISCUSSION

Numerous researches give evidence, that from the point of view of elevation of coefficient of efficiency of process it is rational to carry out the treatment on resonance frequencies, as in this case the largest diffusion of energy in detail takes place. The treatment of detail usually has some internal frequencies in accessible for equipment range of frequencies and the treatment is carried out on each or on some of them consistently. The steady field of standing waves is formed in detail by treatment on internal frequencies in the result of superposition of waves, spreading from vibrator and reflected from details sides. (Fig. 2).

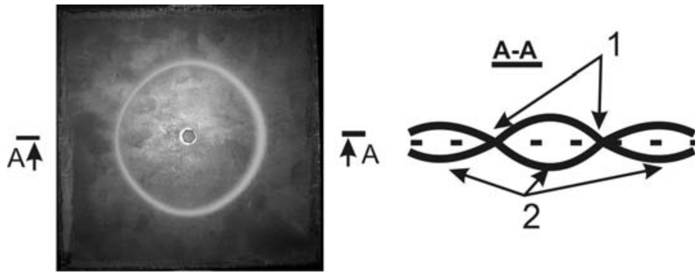
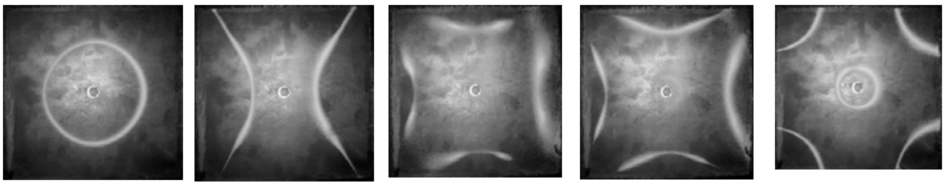


Fig. 2. Forming of standing waves: 1 – zero zones, 2 – zones of convexity

In this case oscillations have sharply increased amplitudes, convexity zones with maximum amplitudes and zero zones with amplitudes close to zero (internal forms of oscillations). The relaxation of stresses can take place intensively only in convexity zones, and residual stresses in zero zones change only as the result of distribution of stresses in convexity zones and these changes are insignificant. Transition to next resonance frequency leads to change of distribution of convexity zones and zero zones and in this case other sections are treated. Chladni figures (Fig. 3) can be the illustration of distribution of zero zones. These figures appear as the result of displacement of dry material from those sections of construction surface, which have big amplitudes of oscillations into zero zones. The appearing drawings are called Chladni figures.



210 Hz 280 Hz 340 Hz 430 Hz 670 Hz

Fig. 3. Pictures of standing waves (Chladni figures) in dependence of frequency.

However, internal frequency is very often absent in accessible frequencies range. This leads to forming of convexity zone in necessary section of detail. Therefore, it is necessary either to change the parameters of treatment to displace convexity zones into necessary sections or to evoke the appearance of new internal frequencies in bounds of accessible treatment range. These changes can be accomplished by the change of parameters of treatment regime.

The main parameters of vibrotreatment are frequency of treatment (f), quantity of applied force (P), duration of treatment (t). The additional parameters are quantity and place of mounting of vibrators, quantity, place of mounting and inflexibility of supports, presence of additional masses and oscillation law, which is usually sinusoidal law.

The main parameters do not influence on value of internal frequencies and distribution of standing waves. The research of oscillations during the work of several vibrators is out of this work. Here we will consider the influence of inflexibility of supports, the place of their mounting and usage of additional masses.

The researches were carried out on an example of beam type. The inflexibility of supports was regulated by usage of lining made from different materials. The character opposite to inflexibility was used to estimate the inflexibility of supports. It is called flexibility of material and was determined as depth of inculcation of side of cylinder with 30 mm in diameter with effort of 1 kg. Schemes of mounting of supports and additional masses are shown on Fig. 4.

The quantity of different distribution of standing waves, appearing in frequencies range of 40 – 4000 Hz by Hladni figures, was estimated.

The next data were determined in the results of researches.

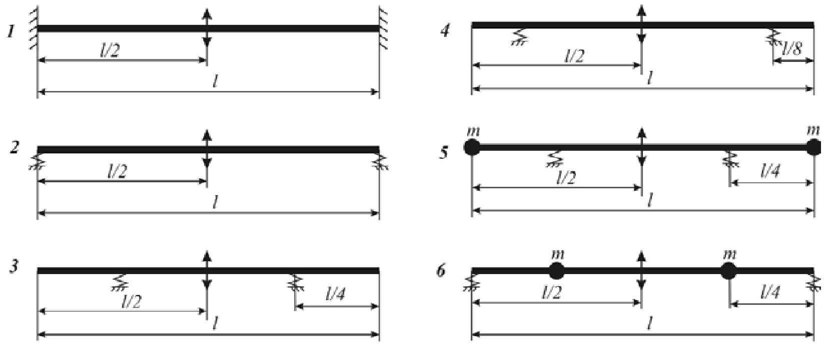


Fig. 4. Schemes of mounting of supports and additional masses.

The change of inflexibility (flexibility) of supports influences on quantity of resonance peaks insignificantly. The essential increase of inflexibility decreases the amount of resonance peaks (small values of flexibility P on Fig. 5, a).

The usage of additional masses lets to increase the amount of resonance peaks in dependence of scheme of fixation in 1,5 and more times. The dependence has greatly expressed maximum, which corresponds to value of additional mass 0,5 – 0,6 of articles mass (Fig. 5, b).

The change of position of supports by their transference to centre decreases the amount of resonance peaks in explored range in 2 and more times. Obviously their amount will decrease during rapprochement of supports (Fig. 5, c).

Difficult distribution of standing waves on the surface of beam did not let to determine regularity of transference of zero zones and convexity zones by change of additional parameters of vibrotreatment regime.

The equation of regression was made up, using these data. This equation connects the amount of resonance peaks and fixed values of quantity of additional masses with position of supports. The value of factor of equation of regression by fixed inflexibility of supports was determined as low and this parameter was excluded from equation. The final equation of regression is:

$$Y = 12{,}46 + 8{,}9 \cdot X_1 - 5{,}36 \cdot X_2,$$

where: Y - amount of resonance peaks in explored range, X_1 - fixed inflexibility of supports, X_2 - fixed position of support.

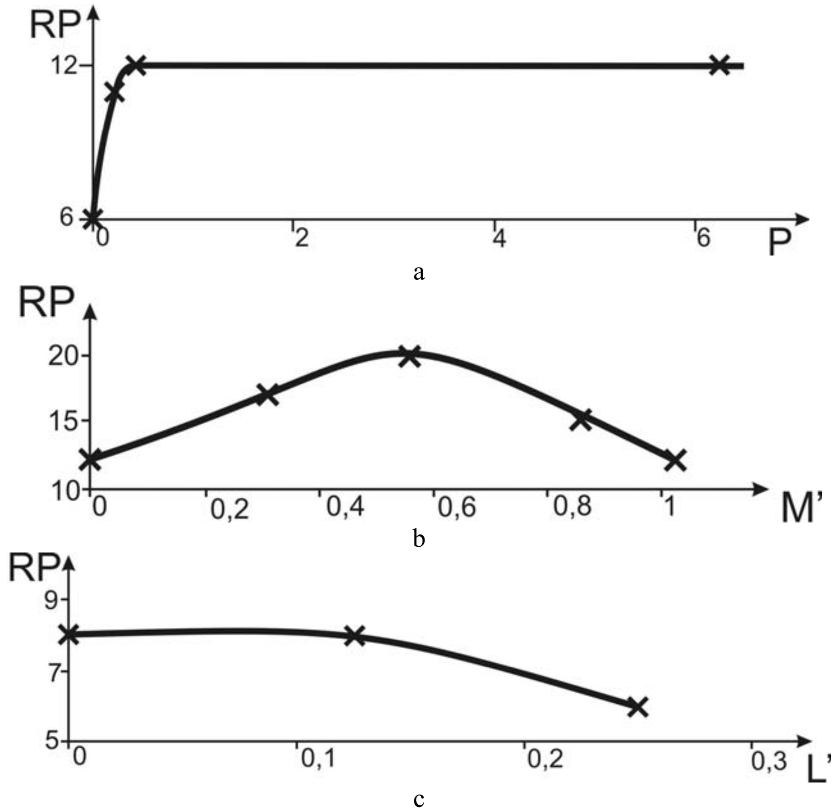


Fig. 5. Dependences of amount of resonance peaks (RP) on flexibility of supports (a); relative mass (b), relative position of supports (c)

Factor of determination R^2 for final equation is 0,7, this proves that the quality of worked out equation is high.

Thus, the influence of each of additional parameters on number of resonance peaks by vibrotreatment of beam construction was determined. The generalized regression equation, connecting additional parameters of vibrotreatment and number of resonance peaks was worked out. The change of these parameters lets to manage of lowfrequency vibrotreatment by change of number of resonance peaks, picture of distribution of standing waves and displacement of sections of treatment.

CONCLUSION

The usage of additional masses is most effective for increasing of number of resonance peaks, and consequently getting of more various picture of distribution of convexity zones. The change of position of supports to opposite centre decreases the amount of resonance peaks and is undesirable. The change of inflexibility of supports influences on amount of resonance peaks insignificantly, till the value of inflexibility of supports comparing with inflexible fixion, during which the amount of resonance peaks decreases.

The usage of most flexibility supports, situated with maximum wideness, as well as usage of additional masses, fixed according to scheme 5 or 6, is recommended for better usage of vibrotreatment possibilities (Fig. 4). The best value of masses is 0,5 – 0,6 of mass of beam. The usage of such parameters of regime gives possibility to form convexity zones in maximum amount of possible sections of construction and to decrease stresses in those section in most effective way.

REFERENCES

1. Vinokurov V.A. Holidays welded structures to reduce stress. – M.: “Mashinostroenie”, 1973. – 213 p.
2. Vinokurov V.A. Welding deformation and stress. - M.: “Mashinostroenie”, 1968. – 236 p.
3. Kasatkin B.S., Prokhorenko V.M., Chertov I.M. The stresses and distortions during welding. – K.: “Vysshaya Shkola”, – 1987. – 246 p.
4. Lashchenko GI Vibration treatment of welded structures. – K.: "Eco-Technology", 2001. – 56 p.
5. Zubchenko O.I., Shiitake A.A., Orekhov G.T., Sostin A.G. Application of vibration-tional loading to remove residual stresses in welded frames // Automatic Welding – 1974. – N 9. – p.p. 27– 32.

СПОСОБЫ УПРАВЛЕНИЯ ПРОЦЕССОМ НИЗКОЧАСТОТНОЙ ВИБРАЦИОННОЙ ОБРАБОТКИ

Гедрович А.И., Жидков А.Б.

Аннотация. Приведены результаты исследования влияния дополнительных параметров виброобработки на число резонансных пиков. Определены основные возможности использования этих параметров для управления процессом низкочастотной виброобработки.

Ключевые слова: остаточные напряжения, стоячие волны, параметры режима, жесткость опор, дополнительные массы, положение опор.