

Recenzované vědecké články

Analysis of the Surface Quality of Steel Bars with Use of Approximation Models

Analýza povrchové kvality tyčí za pomoci aproximačních modelů

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The article contains an analysis of the behaviour of the basic indicator of surface quality of bars on the basis of created physically adequate model describing heat and temperature conditions during casting of billets.

On the basis of simplified physical interpretation an approximating dynamic cybernetic model was created for the measured surface temperature of cast billets, then from it a mathematical continuous and discrete model was created, and finally a regression model. Since the indicator of the surface quality of bars shows the character of probability of occurrence of the phenomenon, a multiple logistic regression model was used.

For verification of appropriateness of the model we selected data from annealing of concrete operational heat of killed steel containing 0.18 wt. % C, 1.32 wt. % Mn and 0.33 wt. % Si at the outer casting strand No. 8 of the continuous casting machine No. 2 at the Trinec Iron and Steel Works, a.s., as well as from rolling of square billets of 150 × 150 mm to round bars with diameter of 70 mm on the continuous fine section rolling mill.

Key words: *surface quality of round bars; continuous casting of billets; physically-adequate model; cybernetic model; multiple logistic regression model*

Článek se zabývá teoretickou a praktickou analýzou základního ukazatele kvality povrchu ocelových tyčí na základě sestaveného fyzikálně adekvátního modelu, který popisuje tepelně-teplotní podmínky v průběhu plynulého odlévání ocelových sochorů.

Na základě zjednodušené fyzikální interpretace byl sestaven aproximační dynamický kybernetický model měřené teploty povrchu litých sochorů. V dalším kroku byl odvozen spojitý matematický model ve formě běžné diferenciální rovnice s konstantními koeficienty. Za použití postupu časové diskretizace byl pak tento konkrétní model převeden na diskrétní matematický model ve formě běžné diferenciální rovnice s konstantními koeficienty, a konečně pak na regresní model.

Jelikož ukazatel povrchové kvality tyčí vykazuje charakter pravděpodobnosti výskytu jevu, při regresní analýze naměřených dat byl použit vícenásobný logistický regresní model. Vhodnost modelu pak byla ověřena na souboru dat vybraných z konkrétní tavby uklidněné oceli s obsahem 0,18 hm. % C, 1,32 hm. % Mn 0,33 hm. % Si, která byla odlita na krajním proudu č. 8. na ZPO č. 2 v Třineckých železárnách, a.s., a následně a při válcování čtvercových sochorů 150 × 150 mm do kruhových tyčí průměru 70 mm na spojité jemné profilové trati.

Logistický model vysvětlil 87 % deviance ukazatele kvality povrchu tyčí, a překvapivě ukázal, že vliv změn rychlosti odlévání bylo cca. 2,6 krát větší, nežli její vliv střední hodnoty. Konečně pak na základě provedené analýzy byla zpracována určitá doporučení pro postupy odlévání.

Klíčová slova: *povrchová kvalita kruhových tyčí; plynulé odlévání sochorů; fyzikálně adekvátní model; kybernetický model; vícenásobný logistický regresní model*

In the heat Tx, realised at the machine for continuous casting of steel (billet CCM No. 2) at the Trinec Iron and Steel Works, a.s. (TZ), the necessary technological parameters were measured and evaluated in all 12 billets cast on the outer casting strand No. 8 (LP 8) from killed steel containing 0.18 wt. % C, 1.32 wt. % Mn and 0.33 wt. % Si.

Round bars with diameter of 70 mm were rolled from these billets on the continuous fine section rolling mill (KJT rolling mill), while the basic indicator of surface quality was monitored in them (in this case with regard to surface defects to the depth of max. 0.3 mm).

The purpose and content of the paper is to present the

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results of an analysis of influences *of heat and temperature conditions* (dependent on the casting speed and its change) at casting of billets on the *indicator of the bars surface quality*.

For this analysis we created for the billet surface temperature and for the indicator of the bars surface quality inter-related *approximation* (simplified) *physical, cybernetic, mathematical and statistical* (static and dynamic) *models*.

1. Basic data

Before the analysis it is appropriate to describe the basic data concerning the main objects of analysis (cast billets and wire rods), i.e. technological process and values measured at the LP8 of the CCM No. 2, as well as evolutions of the monitored measured and aggregated (calculated) variables in the analysed heat related to individual billets.

1.1 Situation at the LP8

Figure 1 shows location of pyrometers (and of linear temperature scanner) at the LP8 of the CCM No. 2.

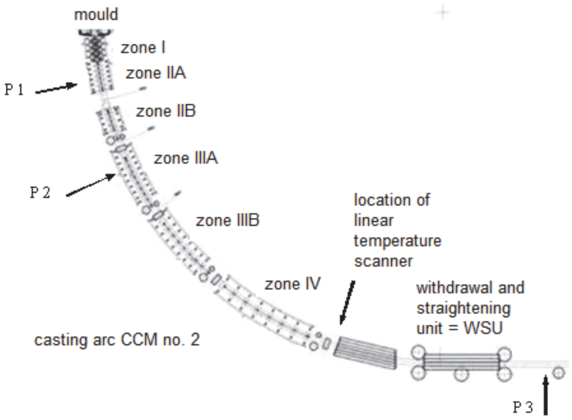

Fig. 1 Location of pyrometers and temperature scanner at the casting strand No. 8 (CCM No. 2)
Obr. 1 Umístění pyrometrů a teplotního skeneru na LP8 ZPO2

It is evident from Fig. 1 that the pyrometer P1 is located in the so-called zone IIA of the secondary cooling system (SCH), pyrometer P2 is located in the zone IIIA, linear scanner is situated behind the zones IV, and pyrometer P3 is behind the withdrawal and straightening units (WSU).

It can also be seen from this diagram, that the time-shifted data about the measured billet temperatures from pyrometers P1 and P2, from linear scanner and pyrometer P3, allow an approximate description of the temperature profile of surface of the cooled and the cooling down continuously cast billet, which can characterise appropriateness of setting of the basic technological parameters of the CCM No. 2. This time offset of temperature data is equal to the distance relation of the meter from the steel meniscus in the mould KR and average casting speed.

1.2 Evolution of monitored values

Basic overview of the monitored values is presented in the form of their evolution (index "billet") diagrams shown in Figs. 2, 3a and 3b.

Figs. 2a and 2b show evolutions of quantities (more precisely – of variables): *Q* - indicators of the surface quality of rods rolled from the billets (the higher levels of *Q* signify a better quality) and *v* - the average casting speed of individual billets.

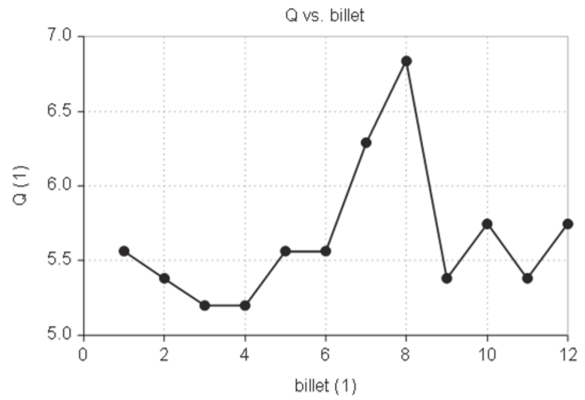

Fig. 2a Evolution of the indicator of quality of steel bars surface *Q*
Obr. 2a Průběh ukazatele povrchové kvality tyčí *Q*

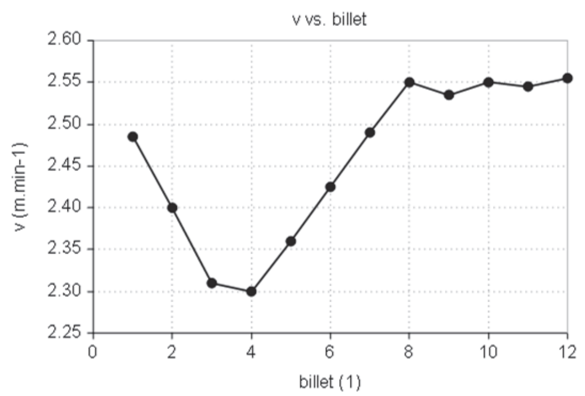

Fig. 2b Evolution of the average casting speed *v*
Obr. 2b Průběh průměrné rychlosti lití *v*

It can be seen from Figs. 2a and 2b that evolution of the indicator of the bar surface quality *Q* has certain systematic trend, which partially (till the 8th billet, inclusive) corresponds to the trend of the average casting speed *v*.

In the given heat greater overheating of steel took place (temperature above liquidus) and it moved in a mono-tonically decreasing interval from 54 to 37 °C. Operator reacted to this overall temperature change (variation range of 17 °C) by changing the casting speed.

Fig. 3 presents evolutions both of variable changes in the average casting speed *dv*, and the variable *P3*, i.e. the average surface temperature of the billets measured by the pyrometer P3.

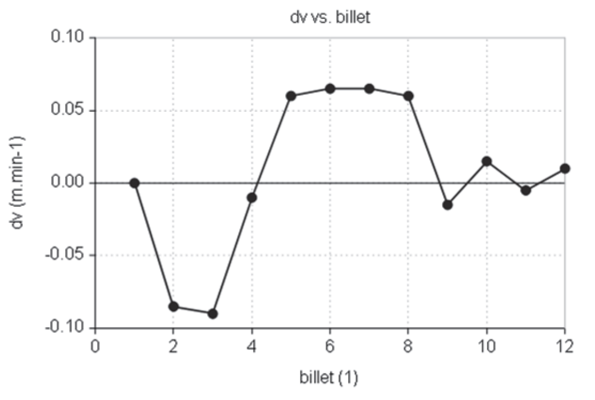

Fig. 3a Evolution of change of the casting speed *dv* at casting of billets
Obr. 3a Průběh změny licí rychlosti *dv* u sochorů

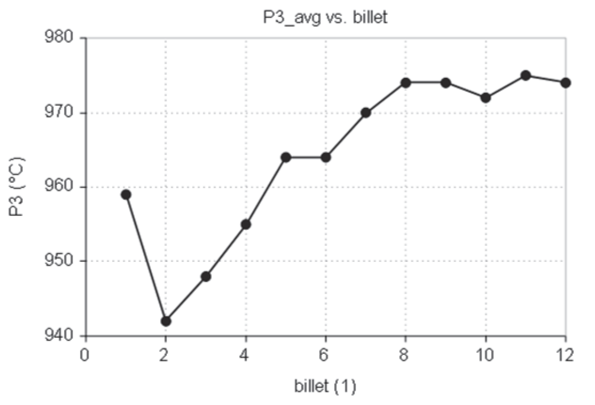

Fig. 3b Evolution of the billets average temperature P3
Obr. 3b Průběh průměrné teploty P3 u sochorů

It can be seen from Figs. 3a and 3b that change of the casting speed *dv* was negative from the 2nd to the 4th billet (casting speed decreased), from the 5th to the 8th billet it was positive (casting speed increased), and in case of the 9th to the 12th the billet the sign was alternating (the casting speed alternately slightly decreased and increased).

Furthermore, it is obvious that the evolution of the temperature P3 corresponds to a certain extent to the trend of the casting speed.

2. Approximation models

Approximation (simplified) models of (static and dynamic) behaviour (in time, i.e. in timelines) of both monitored quantities (surface temperature of billets *P3* and indicators of the surface quality of billets *Q*) were created in certain inter-related sequence.

2.1 Physical and cybernetic approximation model of the billet surface temperature

Physical interpretation of evolution of the billet surface temperature (*physical model*) and *cybernetic* (static-dynamic) temperature model are based on the idea that the measured surface temperature of the billet is influenced by *two* combined *contradictory effects*:

- stronger, longer-term effect of *re-heating* by thermal capacity of the billet liquid core and *heat flow* (directly proportionally dependent on the casting speed)

versus

- weaker shorter-term and temporary effect of *water cooling* in the secondary cooling system (SCH, which is proportionally dependent on the casting speed), as well as the long-term influence of *cooling* of the billet surface *by flow of ambient air* (probably the weakest effect).

A significant difference between surface and inside of the CC bloom temperatures is expected although no liquid core in the position *P3* exists (it is possible at the most that internal part of the CC bloom is not completely solidified with the occurence of two-phased „mushy zone“).

A higher degree of thermal flow in the cast and solidified bloom is the consequence of a higher casting velocity with the impact on a longer so-called „metallurgical length“ (i. e. the extent of liquid part in the centre of the CC bloom), which manifests itself in a higher reheating effect and thus in a higher temperature *P3* (and vice versa).

Thus the reheating effect is caused by considerably higher temperature in the vicinity of the CC bloom central part and the corresponding significant thermal flow.

Figures 4a and 4 b show schematically (physically and cybernetically) a counter-action (anti-parallel action) of both effects (where *S1* and *S2* are static approximation partial thermal systems of the billet, *Sp1* and *Sp2* are their cybernetic dynamic equivalents in terms of dynamic proportional systems of the 1st order):

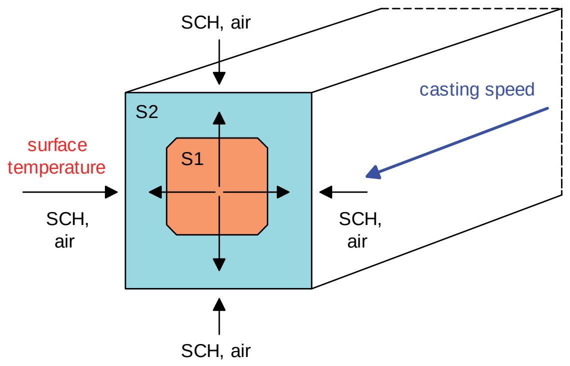

Fig. 4a Physical diagram of billet surface temperature
Obr. 4a Fyzikální schéma teploty povrchu sochoru

Hutnické listy č. 1/2016, roč. LXIX
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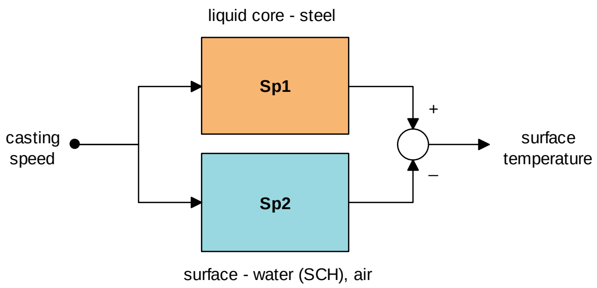

Fig. 4b Cybernetic diagram of billet surface temperature
Obr. 4b Kybernetické schéma teploty povrchu sochoru

The surface and interior of the billet can be understood as a multi-dimensional (two-dimensional) *thermal system*, the cybernetic description of which is given in the literature, e.g. [1 – 3].
It is worthwhile to describe in detail both various partial systems and their anti-parallel involvement.

A. Individual thermal systems

According to the literature [3] it is valid for the following basic and essential reality that responses of transient characteristics of the basic thermal systems have *aperiodic* behaviour. Heat accumulation in the heat capacity and change of the body temperature by heat conduction or convection is described by a linear proportional member, by dynamic system with inertia of the 1st order (hereafter marked as *Sp1*). Laplace transfer function G(s) of the given system *Sp1* has the following form:

$$G(s) = \frac{Y(s)}{U(s)} = \frac{k}{T \cdot s + 1}, \tag{1}$$

Where s – complex variable of the Laplace transfer function (1/s), Y - image of the system output, U - image of the system input, k - system transfer coefficient (so called amplification), T - time constant of the system inertia (s).

B. Two parallel thermal systems

On the basis of knowledge from literature it is possible to describe the approximating physical model of the billet surface temperature with regard to the influence of SCH and of the accumulated heat (re-heating) with use of two parallel systems with the following properties:

- they have character of proportional (inertial) systems of the 1st order (*Sp1*) with various amplified (transfer coefficients) and different time constants. Their Laplace transfers have generally the following form:

$$G_1(s) = \frac{Y(s)}{U_1(s)} = \frac{k_1}{T_1 s + 1}, \tag{2a}$$

$$G_2(s) = \frac{Y(s)}{U_2(s)} = \frac{k_2}{T_2 s + 1}, \tag{2b}$$

- both systems will be from the thermal perspective influenced directly or indirectly particularly by the *casting speed*, as the dominant quantity of continuous casting of steel.

According to the literature [1] in the case of anti-parallel action of two *Sp1* in one object (with common input variable) thus composed system can have approximately the transfer of the *real differentiator*:

$$G(s) = \frac{(k_1 \pm k_2) + (k_1 T_2 \pm k_2 T_1) \cdot s}{(T_1 s + 1) \cdot (T_2 s + 1)} \Rightarrow \tag{3a}$$

$$G(s) = \frac{(k_1 \pm k_2) + (k_1 T_2 \pm k_2 T_1) \cdot s}{1 + (T_1 + T_2) \cdot s + T_1 T_2 \cdot s^2}. \tag{3b}$$

After introduction of the simplified notation it is possible to obtain a clearer form of transfer of the given system:

$$G(s) = \frac{k_p + T_p \cdot s}{1 + a_1 \cdot s + a_2 \cdot s^2}. \tag{3c}$$

The fact that such thermal systems react proportionally not only on the input quantity *as such*, but also on *its change* (derivative) is of great importance.

In this case, the billet surface temperature will react both to the actual value of the casting speed, as well as to its change.

2.2 Mathematical and statistical approximation model of the billet surface temperature

In the analysed situation we assume one common output variable *Y(s)*, which is the *billet surface temperature*, and one input variable *U(s)*, which is the *casting speed* (Figs. 4a and 4b).

A. Image of output

These two input variables additively (in parallel, or more precisely in anti-parallel manner) synergically influence the output variable, so it is possible to formulate the following equation using the Laplace images of variables:

$$Y(s) = (G_1(s) \pm G_2(s)) \cdot U(s) \Rightarrow \tag{4a}$$

$$Y(s) = \frac{(k_p + T_p s) \cdot U(s)}{(T_1 s + 1) \cdot (T_2 s + 1)} \Rightarrow$$

$$Y(s) = \frac{(k_p + T_p s) \cdot U(s)}{1 + (T_1 + T_2) \cdot s + T_1 T_2 \cdot s^2} \Rightarrow$$

$$Y(s) = \frac{(k_p + T_p s) \cdot U(s)}{1 + a_1 \cdot s + a_2 \cdot s^2}. \tag{4b}$$

B. Original of output – continuous

We obtain from the mentioned L-image of the output variable its original (in time domain) using the inverse, reverse L-transformation, which has the character of an ordinary linear *differential equation* of the 2nd order with constant coefficients. It is therefore a *mathematical continuous model* of the given system:

$$y(t) = -a_1 \cdot y'(t) - a_2 \cdot y''(t) + k_p u(t) + T_p u'(t) \,. \tag{5}$$

C. Original of output – discrete

Assuming discrete data, we get a discrete form of the equation of output in the form of ordinary linear *differential* equation of the 2nd order with constant coefficients. It is therefore a *mathematical discrete model* of the given system:

$$y_i = d_2 y_{i-1} - d_3 y_{i-2} + f_1 u_i + f_2 \Delta u_i \,. \tag{6}$$

D. Dynamic regression equation

From the above general differential equation it is already possible to formulate for the temperature quantities a concrete multidimensional linear (in parameters and variables) *dynamic regression equation* with an error member:

$$\boxed{y_i = d_0 + d_2 y_{i-1} - d_3 y_{i-2} + f_1 v_i + f_2 \Delta v_i + \varepsilon} \,. \tag{7}$$

Where the response *y* is the billet surface temperature (P1, P2, P3), *d0* is the absolute member and ε is the error (residual) member of the regression equation, which should theoretically be of statistical nature N(0,σ).

2.3 Mathematical and statistical approximation model of the bar surface quality indicator

On the basis of the modified Laplace transfer of the combined member it is also possible to obtain basic mathematical-statistical model of bar surface quality indicator.

Due to the fact that the bar surface quality indicator shows the character of *probability of occurrence of the phenomenon*, a *multiple logistic regression model* was derived from the basic model, and it was used at regression analysis of relevant data.

A. Basic mathematical-statistical model

From the above analysis and from the Laplace transfer of the combined member (Equation 3c), it is possible to obtain a mathematical-statistical model, which has the following simplifying terms of use and properties: the values of variables of the casting speed (*v*) and of its change (*dv*), and the bar surface quality indicator (*Q*), are related to entire billets on one casting strand in the given heat, thereby performing certain suppression of the model dynamics, that's why this model is considered as static one:

$$G(s) = k_p + T_p \cdot s \Rightarrow Y(s) = (k_p + T_p \cdot s) \cdot U(s) \Rightarrow$$

$$y(t) = k_p u(t) + T_p u'(t) \Rightarrow \tag{8a}$$

$$y(t) = f_1 u_i + f_2 \Delta u_i \Rightarrow \tag{8b}$$

$$Q_i \approx d_0 + f_1 v_i + f_2 \Delta v_i + \varepsilon \,. \tag{8c}$$

The model therefore uses only average casting speed and its change, it does not use inertia output, i.e. inertia of the bar surface quality indicator, but only its value related to the entire billet.

B. Logistic multiple static regression equation

Bar surface quality indicator *Q* can be converted to an indicator *rQ*, which has the character of probability of occurrence of the phenomenon, so it achieves the values from the interval ⟨0;1⟩.

Multiple logistic regression models appear to be suitable for identification of models with the response of the mentioned type [4].

General logistic (logit) regression model is defined for the response of Y-type probability of occurrence of the phenomenon X, i.e. P(X), i.e. for *k* quantitative factors in the form:

$$Y = P(X) = \frac{1}{1 + \exp[-(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k)]} \Rightarrow$$

$$Y = \frac{1}{1 + \exp\left[-\sum_{j=0}^{k} \beta_i X_i\right]} \tag{9}$$

while the model may be after simple algebraic editing transcribed into the from, where the left side contains the so called logit transformation of probability (response)

$$\ln\left(\frac{Y}{1-Y}\right) = \ln\left(\frac{P(X)}{1-P(X)}\right) \Rightarrow$$

$$\ln\left(\frac{Y}{1-Y}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k = \sum_{j=0}^{k} \beta_i X_i \tag{10}$$

As shown, the transformed model with logit transformation has the character of *multiple static linear* (in its parameters) regression model.

The final form of the model of occurrence of surface defects of bars with respect to the casting speed and its change in the form of multiple logistic regression model (crated by transformation of the model according to the equation (10)) is then as follows:

$$u = b_0 + b_1 \cdot v + b_2 \cdot dv + \varepsilon \,, \tag{11a}$$

$$\boxed{y = rQ = \frac{\exp(u)}{1 + \exp(u)} = \frac{e^u}{1 + e^u} = \frac{1}{1 + e^{-u}}} \,, \tag{11b}$$

where *u* - auxiliary input variable of the speed character (m·min^{-1}), parameters *bi* - regression coefficients of the model, index *i* in the range ⟨0;k⟩ for *k* quantitative factors, *v* - casting speed (m·min^{-1}), d*v* - differential change, difference of the casting speed ≈ Δ*v* [m·min^{-1}], *y* - response ∈ ⟨0;1⟩ (-(, response *rQ* - probability indicator of the bar surface quality ∈ ⟨0;1⟩ (-).

Hutnické listy č. 1/2016, roč. LXIX
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3. Application of approximation statistical models

The above derived approximation statistical models (static and dynamic) were applied to the relevant data from the analysed heat Tx, mainly from the perspective of the monitored quantities – billet surface *P3* (behind the withdrawal and straightening unit = WSU) and the bar surface quality indicator *Q*.

For clarity we present also the results of monitoring other thermal-temperature quantities of the given casting strand at the CCM No. 2.

The results of the multiple *dynamic* regression analysis of and multiple *static logistic* regression are summarised in Table 1 and in Figs. 5a, 5b and 6.

Tab. 1 Overview of regression analysis results for variables of the heat Tx
Tab. 1 Přehled výsledků regresní analýzy veličin tavby Tx

Response	y(-1)	v	dv	R^2 (%)	Comments
P3	·	+	+	84.5	There was no evidence of inertia *P3*
P2	·	+	·	45.3	Influence only of the speed *v*
dP23	·	·	–	56.2	dP23 = P2 – P3, it reacts to the change of *dv*
dT	·	+	·	93.4	Delta T (PCH) = Tinp – Tout (cooling water)
Tout (PCH)	+	·	+	96.6	Influence of inertia and *dv* (heat removal from the mould KR)
rQ	·	·	+	40.5	Weak influence of *dv* only
rQ	()	+	+	87.4	Significant influence of *v* and *dv*

Legend:

Column, variable *y(-1)* ... by 1 step (by 1 billet) delayed values of the response *y*, *v*... average casting speed, *dv* ... change (1st backward difference) of the average casting speed, R^2 [%] ... so called regression rebate (a measure of explanation of the dependence by the model, 100× multiple of the determination coefficient of the regression model), signs + and - indicate the direction of influence of quantitative factors *v* and *dv*, sign · means statistical insignificance (at the significance level $\alpha = 0.05$) of the given quantitative factor (delayed response *y*(-1) *v*, *dv*), sign () indicates (principal) non-use of the given quantitative factor, PCH ... so called primary cooling system in the mould KR.

The first 6 models from the above 7 regressions models are of the *LDRM* type, i.e. multiple linear dynamic regression model, the last one is of the type *LgSRM*, which is multiple non-linear logistic static regression model.

It is therefore obvious that for regression of the indicator *rQ* two models were used and compared: *LDRM* and *LgSRM*, while the logistic static model showed more than twice more informative capability than the classical dynamic regression model.

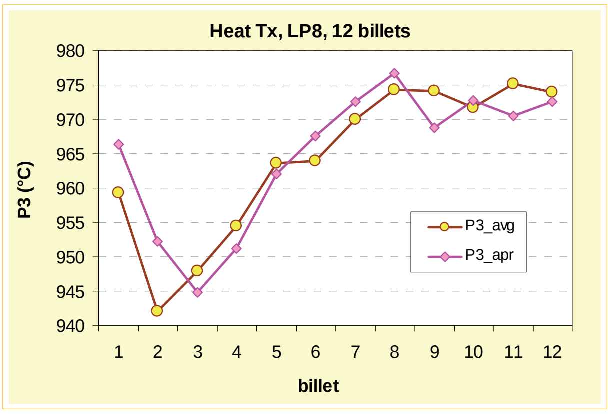

Fig. 5a Time prediction diagram *P3* for billets
Obr. 5a Časový predikční graf *P3* u sochorů

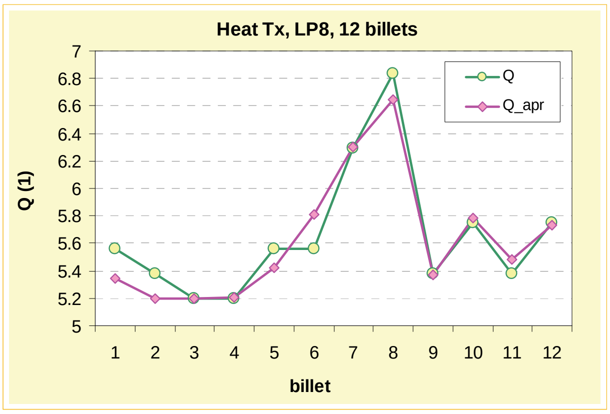

Fig. 5b Time prediction graph *Q* for billets
Obr. 5b Časový predikční graf *Q* u sochorů

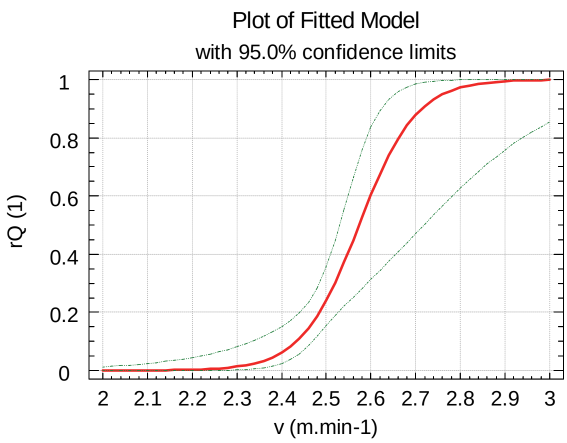

Fig. 6 Prediction *rQ* versus *v* for *dv* = 0 m·min^{-1}
Obr. 6 Predikce *rQ* versus *v* pro *dv* = 0 m·min^{-1}

Several essential facts are apparent from the above results of the regression analysis:

- both basic responses *P3* and *Q* were influenced by the *casting speed* and *its change* with the same positive sign and with approximately the same aggregate information capability around 86 % (when using the multiple linear dynamic and non-linear static logistic regression model)

- the ratio of regression coefficients of the change of the casting speed and the actual casting speed was in case of *P3* approx. 1.2, and in case of *Q* up to 2.6,
- however, the ratio of the influence of the change of the casting speed and the actual casting speed (determined on the basis of the ratios of t-statistics for *P3* and χ^2-statistics for *Q*) was in case of *P3* approx. 0.65 (influence of *dv* is therefore smaller), and in case of *Q* of approx. 1.9 (influence of change of the casting speed *dv* is nearly twice bigger than influence of the actual casting speed *v*).

Conclusions

Approximation physically adequate modelling, and ensuing from it cybernetic, mathematical and mathematical-statistical modelling of the influence of thermal and temperature conditions during casting of square billets (150 mm × 150 mm cast at the CCM No. 2 in TZ from particular grade of killed steel containing 0.18 wt. % C, 1.32 wt. % Mn and 0.33 wt. % Si in the selected heat at the outer casting strand No. 8 to 12 billets) on the surface quality of bars with diameter 70 mm (rolled from the billets at the continuous fine section rolling mill KJT) showed the following:

- a significant influence of the *casting speed* and especially *its change* on the billet surface temperature measured behind the withdrawal and straightening unit with impact on the bar surface quality indicator,
- based on the results of this analysis recommendations were formulated for control of the heat, which was implemented in practice in the sense of limiting the maximum changes of the casting speed and gradual – continuous increase or decrease of the actual casting speed on the basis of the speed set by the operator (desired speed).

Acknowledgements

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Trvalá tvorba hodnot v ocelářských oborech

Stahlreport *12/2015*

Podnikání v ocelářském odvětví prožívá proměnu z tuhých řetězců tvorby hodnot k dynamickým sítím tvorby hodnot. Takto shrnul Hans Jürgen Kerkhoff, prezident Hospodářského sdružení Ocel (WV Stahl) a předseda ocelářského institutu VDEh současný vývoj na relevantních trzích. Takto uchopil i on před obchodním ocelářským dnem v Brémách aktuální trend digitalizace, který umožňuje takovouto změnu k fragmentovaným systémům. Kerkhoff současně poukázal na skutečnost, že tradiční korelace mezi globální poptávkou po oceli a celosvětovým hospodářským růstem již v poslední době přestává platit. Pro ocelářské trhy v EU sice zásobování trhu vykazuje lehce stoupající tendenci (2015 odhad plus 1,5 % a na 2016 předpověď plus 2 %), zatím ale nebylo dosaženo ani jednou pokrizové úrovně z roku 2011.

Evropský ocelářský průmysl v nesnázích

Stahl und Eisen *12/2015*

Mezinárodní obchod se proměňuje: globální růst oslabuje, konkurenční tlak – také v ocelářském průmyslu – se zvyšuje a protekcionistická opatření jsou na denním pořádku. Tento vývoj staví německé ocelářské podniky před velké výzvy. Jak bude možné udržet otevřené trhy a současně vytvářet férové soutěžní podmínky? Jaké strategie přijmou Evropská komise, Světová obchodní organizace, evropský ocelářský průmysl a kovozpracující průmysl? Začátkem týdne, pod vedením Andrease J. Gosse, předsedy představenstva Thyssenkrupp Steel Europe, se sešli ministři průmyslu z Evropské Unie, aby si vytvořili přehled o současné situaci a konkurenceschopnosti evropského ocelářského průmyslu. Impulsem pro setkání byla mimo jiné situace v britských ocelárnách, kde několik oceláren ohlásilo masivní propouštění. Obsáhlý článek a diskuze probírají možné odpovědi na tyto důležité otázky.