THE COMPARISON OF THE KNOWN MODELS OF SELF-TAPPING SCREW JOINTS

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Abstract: *During the latest decades the polymer pieces have been appearing in the different areas of the industry. Nowadays polymer and composite materials are used not only as covering but as the material of concrete mechanical elements as they have a wide workable and usability spectrum. The pieces made of polymer materials in the telecommunication industry take an honoured place. It is because they are good insulators, they are light, and cheaper than the metal materials. In the European Union it is a regulation that the most of the pieces must be recyclable. It means not only the reuse of the raw material but the recycle of the pieces. So the new and economical types of connection in the polymer pieces have appeared, and their examination have become important, too. Detailed technical literature is available for self-tapping screwed joints applied on thermoplastic polymers and duromers. The screwed joints' aspects (screw geometry, binding strength, parameters of assembly, possibilty of automatization) have been examined by way of experiments and by theoretical models. On the basics of these experimental investigations they have created application-oriented connections which give an important fact to the calibration of the self-tapping screwed joints and to the choice of the material. The aim of this essay is to make a basis for the further research by the comparison of known experience and theory so as to create a more developed, and extended model with more parameters.*

Keywords: SELF-TAPPING SCREWS, VOLUTION, THREAD CUTTING, BIASING FORCE

1. Introduction

We have a detailed literature connected to the screwing joint. Experts have investigated various aspects of screwing bonds for example the geometry of screw, the stability of the joint, the parameter of setting-up, the possibility of automation of setting-up, the forms of crash. These parameters have been investigated by theoretical ways and by models. On the basics of these theoretical investigations they have created connections based orientation on adoption, which present a basis for choosing the material or the measurement of the bolted joint. Nowadays experts often describe the behavior of the joint or the different work phases by numerical models.

The screwing machines in most cases have got torque limit, which undo at a given pull torque and at the same time it ensures the same pull torque to each screwing joint. During the latest decades higher and higher demand emerged on the automation of the screwdriving process, which have developed to a reliant area of research. The aim of these researches is the development of the automatic controlling and supervisory strategies in support of increase of production. The aim is to make a model, which can determine that in the case of given pull torque how big is the axial moving away of the screw.

2. Theoretical overview

The experts separated and examined four different processes to estimate the pulling torque of the joint. They made [1] a force illustration (the whole force acting on the screw) suitable to the quasi-static condition in each process. They built it into their model in a form of an equilibrium equation.

1. Thread forming or cutting: The formation of the female thread depending on the type of the screw and the type of the material can be made by pressure or cutting. In the first case the thread comes into being by the plastic deformations, while in the second case it is made by chipping. We call cutting part or nib the beginning part of the thread which is responsible for the thread forming or cutting. It is on the cone-shaped end of the screw. On the nib the cross-section grows gradually till it goes up to the maximum value (A_c) (Fig. 1). The measure of the torque which is required to the force of forming or cutting is directly proportional to the female yield point, to the cross-section of the thread profile, to the measure of the radial distance between the centre of thread profile and the longitudinal axis of the thread, to the cosinus of the angle of pitch, and it is inversely proportional to the measure of the angle measured around the axis of rotation. The quotient of the cross-section of the thread profile and this latter shows the progress how the cross-section of the thread profile grows inside the cutting part of the screw.

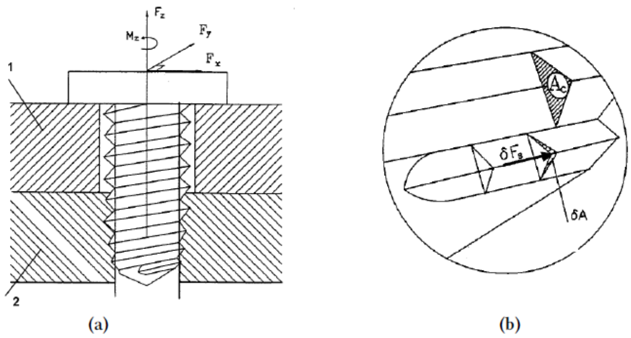

Fig. 1 *Theoretical model of self-tapping screw joint (a) and the change of cross-section of the thread profile*

2. The sliding friction of connected thread surfaces: During the process of screwing in the reaction force on the cutting part of the screw pushes the material in the wall of the female around the inner thread out. In accordance with the rule of action and reaction the female thread pushes the screw-thread with the same but contrary direction force. In short between the connected thread and the female thread there is a certain sized connected pressure, while the screw – during the process of screwing in - moves forward gradually along its longitudinal axis. So as to overcome the frictional force between the thread surfaces we need to exert torque.

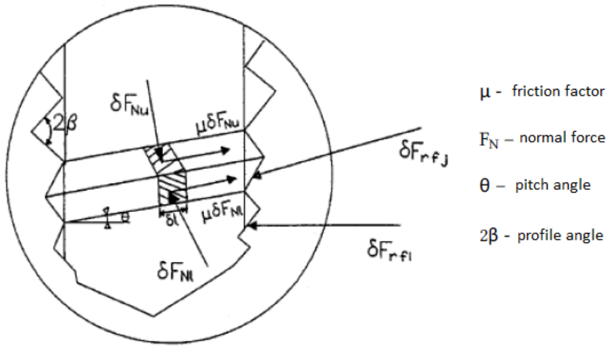

Fig. 2 *The frictional force acting on the thread of the screw*

The torque needed to overcome (Fig. 2) the friction is directly proportional the value of friction factor between contact thread surfaces, to the measure of the radial distance between the centre of thread profile and the longitudinal axis of the thread, to the cosinus of the angle of pitch and to the value of contact pressure between contact thread surfaces.

3. The joining of the screw: The arithmetics above supposed that the thread was already moving along helically while it was making the suitable to the thread profile inner thread in the female. The authors drew our attention to the fact that this motion state will not form very quickly. There is a junction till the moving position of the screw changes from the free moving into the thread producing moving. So it is an examination of the starting etap, when the thread snatches at the body of the female. By the presumption of the authors this etap takes as long as the screw takes a total rotation around its axle. It means that the screw takes a 360^o rotation and an axle direction moving suitable for the pitch. According to the worked out theoretical model – which gives the change of the torque during this initial period – the torque which needed to the moving of the thread is directly proportional to the female yield point, to the radial distance of the connecting point (between the screw and the female) and the longitudinal axis of the thread. The relationship – beyond more other parameters – considers the measure of the frictional factor between the surfaces and the measure of the cross-section of the thread profile.

4. The pretension of the screw connection: The conditions examined in points 1-3 cover the process when the thread goes forward inside the female and it makes the inside thread in the previously made countersink. After some time the bottom surface of the screw-head leans up the piece fixed between the female and the screw-head. By the turning onwards of the thread amount of stock between the connected threads and the screw-head suffers additional pressing employment. During the examinations the authors considered that in the piece (1) in Fig. 1 the diameter of the passing bore is bigger than the diameter of the screw. And that between the piece 1 and the piece 2 (as female, too) there is no relative moving. It means that during the biasing force in the consideration of the additional frictional resistance it is enough to concentrate only on the bottom surface of the screw-head. In terms of the future examinations it is useful to analyse in detail the part of the worked out model related to the biasing force.

The force(F) parallel with the axle of the thread can be calculated by the next general relation:

(1) $F = \int \sigma \, dA$

where σ shows the compressive stress acting on the bottom surface of the screw-head, while A marks the measure of the nominal surface of contact of the screw-head. The compressive stress supposed steady stress distribution can be written like this:

(2) $\sigma = E * \varepsilon$

where E and ε are the elastic modulus of the fixed piece, and the specific stretching of it

(3) $F = E * \varepsilon * A = E * \varepsilon * \frac{(D^2-d^2)\pi}{4}$

where D marks the diameter of the cylindrical screw-head, and d marks the nominal diameter of the screw. The force acting on the screw-head is delivered through the threads of the screw on the threads of the finished females, while the same size but countermove the force influences on the threads according to the low of action and reaction. The requisition of the screw shank is pulling. In that case if additional axial force does not influence from the screw-driver on screw-head the force working on the threads of the female is equal with force (F) influencing on the screw-head. This force works in a form of distributed force system on the surface connected with the female thread. If we take in consideration the force equal with the power F influencing on the piece fixed on the surface but the contrasting direction force, too, we can establish, that these forces cause bending load in the threads and compression load in the piece to be fixed and the female. In Fig. 3 I_{t1} shows the thickness of the fixed piece, I_{t2} shows the thickness of thread as a female. In case the screw is inside the thread – so it did not cross through the female (Fig. 1) – the heigh of the cylindric part put out to compressive stress can be calculated by

(4) $l_{zem} = \frac{\left(\frac{\varphi}{2\pi}\right)*p}{2}$

relation, where p is the pitch, φ is the angle turning in radian suited to made turnings by the screw from the beginning of the thread making. While the screw – calculated from the bedding of the screw-head - traverses with $\Delta\varphi$ angle, the equipollent cylindric part becomes compressed with the measure of ΔI_{t12} and the connecting threads bend because of the bending stress. The bending of the threads (f_m) will decrease the deflection of the equal cylindric part, which can be considered by the equation bellow

(5) $\Delta l_{t12} = \frac{p*\Delta\varphi}{2\pi} - f_m$

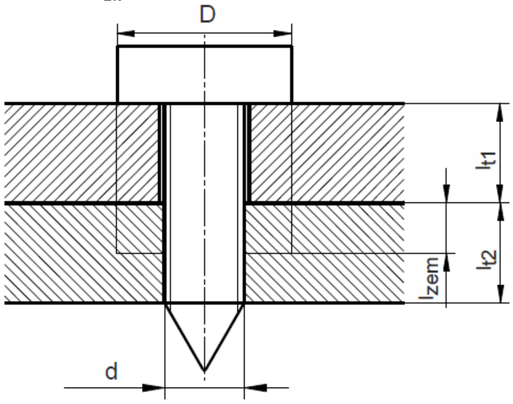

Fig. 3 *Model of self-tapping screw joint with abutment screw head*

On the basis of these the form-change of the equal cylindrical part is:

(6) $\varepsilon = \frac{\Delta l_{t12}}{l_{t1}+l_{zem}} = \frac{\left(p*\frac{\Delta\varphi}{2\pi}\right)-f_m}{l_{t1}+l_{zem}}$

By the reduction of equations (6) and (3) the force having an effect on the screw-head can be written as

(7) $F = \frac{\pi*E*(D^2-d^2)}{4*(l_{t1}+l_{zem})} * \left(\frac{p*\Delta\varphi}{2\pi} - f_m\right) = s * \left(\frac{p*\Delta\varphi}{2\pi} - f_m\right)$

where s is the rigidity of the spring of the material parts exposed to the press-force between the screw-head and the connected threads.

The torque required to defeating friction resistance on the bedding surface of the screw-head can be determine by the relation below

(8) $M_s = \int \mu_f * \sigma * r * dA = \int_{R_1}^{R_2} 2\pi * \sigma * r^2 * dr$

where μ_f is the frictional factor between the screw-head and the fixed piece and $R_1 = \frac{d}{2}, R_2 = \frac{D}{2}$. We suppose that the distribution of pressure is steady and the friction factor is continual inside the contact domain, the equation after the integration can be written like below

(9) $M_s = \pi * \mu_f * \sigma * \frac{D^3-d^3}{12}$

The equations (1)-(7) determined the rigidity of the spring of the material exposed to the press-force between the screw-head and the connected threads (s). Here it is worth to examine that supposition, that additional axial force from the screw driver does not influence on the head of the screw, in fact there is always some axial force so that the screwdriver does not slide during the pulling in the bolted. The authors suppose by their model, that the measure of the additional axial force influencing on the screw-head in each etap is the same as the resultant of the axial reaction force consequently because of the press onto the screw. In other words the additional axial force makes the axial force system to balanced force system. But in this case the additional axial force influencing on the screw-head from the screw driver balances the force influencing on set up surface of the screw head, that means that there is no pulling force in the tang of the screw and consequently the connected threads are unloaded. The direct consequence of it, that the threads can not bend. On the basis of it the measure of the force influencing on the surface of the screw-head can be given like this:

(10) $F = s * \left(\frac{p*\Delta\varphi}{2\pi}\right)$

Torque greatness of the $\Delta\varphi$ angular increment:

(11) $M_s = \mu_f * s * \left(\frac{D^3-d^3}{3*(D^2-d^2)}\right) * \left(\frac{p*\Delta\varphi}{2\pi}\right)$

In the following to examples the material of the plate used for producing the female was ABS (acrylic-butadiene-styrene) and PC (polycarbonate). Using the model we need data of the geometry of screwing joint (parts we need to fix), the characteristics of the material, friction facts, the diameter of the pilot hole and the geometric measures of the screw. On the Fig. 4 we can see the theoretical torque-turning away curve belonging to the PC female. The numbers on the table show the characteristic linear phases of the graph.

Phase 1: The cone-shaped end of the screw is touching the pilot hole of the female (Fig. 5 T0). Then the screw is going into the female by the time when its tang touches the pilot-hole (Fig. 5 TE). The first step of the screwing-in process, the screw is snatching at the female. The torque which influences on the screw is devoting to the overcoming of the resistance caused by the making thread and the friction.

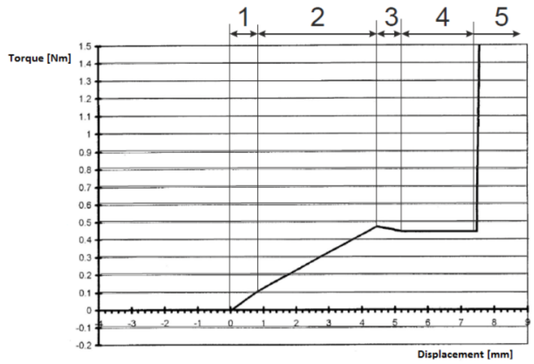

Fig. 4 Theoretical displacement-torque graph of polycarbonate female (l_{t1}=0mm, l_{t2}=3mm, E=2.3GPa, p=1.1mm, D=5.03mm, d=2,87mm)

Phase 2: The screw is continuously going in the pilot-hole (Fig. 5 TP). The torque on the screw is now devoting to the overcoming of the resistance of the thread making by the cutting edge and the friction between the screw and the female thread. The thread in the female is growing and it causes more and more friction resistance.

Phase 3: The cone-shaped and of the screw is turning up at the end of the pilot-hole (Fig. 5 TB), then it is emerging step by step till the cylindrical part of the screw is at the end of the pilot hole. In this phase there is thread-making and friction yet. The ready thread made in the female at the end of this phase achieves its final length.

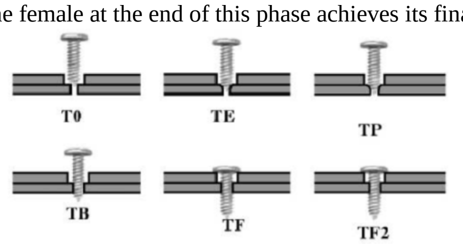

Fig. 5 *Phases of making self-tapping screw joint*

Phase 4: The cylindrical part of the screw is turning up at the end of the in and out pilot-hole (Fig. 5 TF), then it is coming out. In this phase there is no thread-making, the torque on the screw is totally devoted to overcoming the resistance of the friction on the threads. The torque is the same, because the length of the thread in this phase does not change, so the friction resistance remains the same, too.

Phase 5: The head of the screw lies on the piece (Fig. 5 TF-TF2). The torque on the screw is devoted to the overcoming of the resistance friction on the surface of the screw-head.

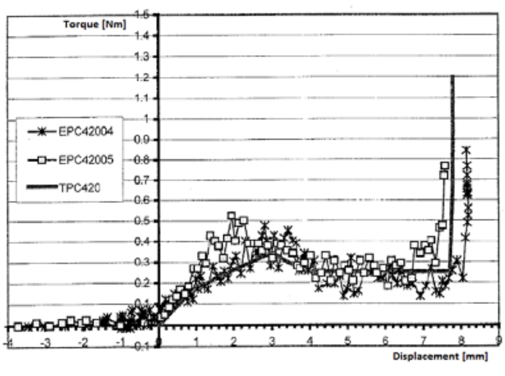

Fig. 6 Theoretical (unmarked graph) and measured (graphs with symbol) torque-displacement graphs in case of polycarbonate female

The different conditions of the 5 phases are well seen on the Fig. 5. And at last the comparison of the estimated and the measure torque-moving-away graph is on Fig. 6. The results show good conformities, which support the usefulness of the model.

3. Comparison of models

Seneviratne and his colleagues report [2] torque-displacement graphs decided by measuring. These measurements account for the presence of expected five different steepnessic quadrant inside the torque-displacement by the earlier showed theoretical model.

Althofer and his colleagues [3] show a new method for the control of the self-tapping screwed joints. The artifical neural network on the basis of the worked out, built on the theoretical torque-displacement graph is able to distinguish the well or badly worked out screwed joints. By the authors the torque-displacement diagram depends on the self-tapping screw connecting them geometric and mechanic nature of the pieces fixed to each other. So the graph depends on the elastic modulus, the frictional factor, the rigidity of the materials, the thickness of the fixed pieces, the diameter of the countersink holes.

Ellwood and his colleagues [4] worked out an axisymmetric finite element model to model the process of making threads. The connected thermomechanic model is able to take into the heat generation and the plastic deformationon the threads of the tube.
The source of the calorification in their finite element model is the plastic deformation produced during the thread forming, and the sliding friction between the connected thread surfaces while making the model. The most important assumptions are the nain data as follows:

1. The deformation speed and the temperature dependent yield point of the examined policarbonat (PC) and the polipropilen (PP) tubes can be modelled by the Eyring theory.
2. The modulus of elasticity in the case of both material depends on the temperature, while the value of the Poisson factor is permanent.
3. The making of the thread is made by thread-press screw, which means the screw – on the contrary of the thread cutting screws – does not remove material out of the wall of the mortise of the tube during the producing thread.
4. The material of the examine screws is steel, which can be modelled as an ideal rigid material because of its much bigger elastic modulus; plus the heat conveying factor and the specific heat of the steel screw independt of the temperature can be considered permanent.
5. The rising of the thread compared to the diameter of the screw is small, so the segment belonging to one turning round of the thread can be modelled as a ring command a suitable to the thread profile cross-section and an axis of rotation concidental with the longitudinal axis of the screw; the individual rings are in a distance of thread pitch (Fig. 7). The supposition of the modelling of the thread with the series of rings is important in that respect we can treat the problem as an axisymmetric task.

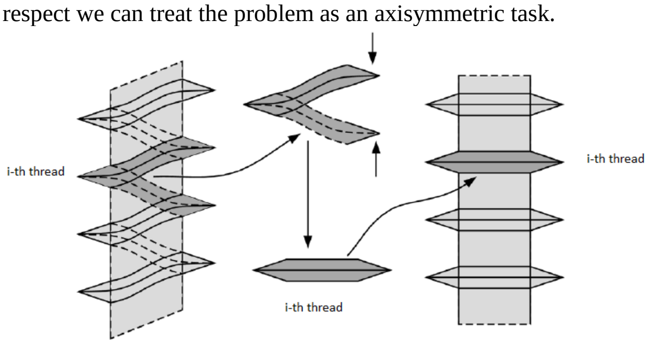

Fig. 7 *Approximation of screw thread by series of axisymmetrical rings*

6. The thermal conductivity factor and the specific heat of tubes PC, PP depend on the temperature.
7. The screw-shank is cylindrical.
8. The material of the examined tubs is homogeneous and isotropic.

9. The measure of the frictional factor depends on the connecting press, but it is independent from the temperature.

10. The process of thread seen by the Fig. 8 can be modelled according to the discretized approach.

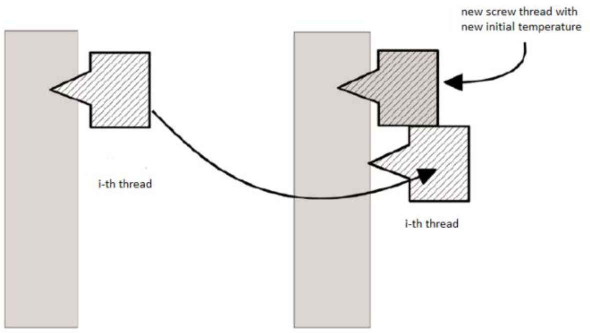

Fig. 8 *Modelling of screw thread making by separate segments of screw shank*

According to the discretization the thread screw shank is made up by pitch length segments each of which is capable of independent axial and radial displacement. The axial displacement of during one turning round can be modelled so that the authors moved away the screw shank segment into the axial direct. Of course we need the radial movements, too.

The responsible for the producing of the thread suitable for the beginning thread-press part first or more screw shank segments. The outside diameter is continuously grows by advanced on the thread. The diameter of the threads after the thread press part is on the contrary is constant, so the screw shaft segments belonging to these to axial movement during the process of screwing. The screw is pressured into the wall of the tube during one turning round the first screw shaft segment done from the depths of the geometry. At the end of the total turning this segment moves forward a distance of thread pitch, while it makes a radial movement, too. The aim of the radial movement is, that in the new position the i thread-press screw segment will touch the wall of the hole. Of course the screw shank's axial movements happens by the safe of nodal temperatural values. In the case of the continuity of the screw shank the other segment arrives in the place of the other screw shank, and it is shown in Fig. 8.

During the producing of the thread this process goes on again and again, which causes warming in the screw, in the female, and plastic deformation in the female. They solved the thermodynamic task connected to making thread as a transient thermal problem, during that the generating heat was distributed in the ratio of the thermal conductivity between the connecting surfaces. In this case the biggest part of evolved heat goes on the twice bigger thermal conductivity steel screw. The network structure of the finite element model and its characteristic geometrical measurements can be seen in Fig. 9. The discretization of the ideally rigid screw was needed because of the solving of the thermal finite code task.

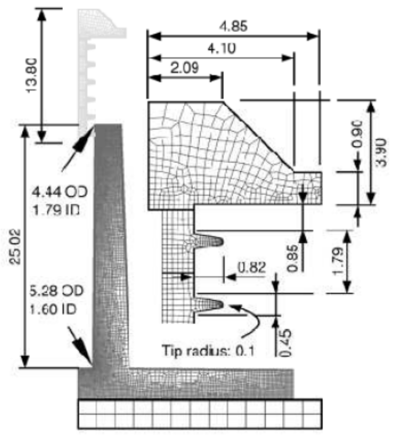

Fig. 9 *Axisymmetrical finite elements model (dimensions in mm)*

The measure of the time step used during the connected thermo-mechanical task was equal with the 1/80 part of the turning round of the screw. During the examinations the authors considered the speed of engagement 340 rotation/minute. The temperature distribution belonging to the end of the thread producing is shown in Fig. 10.

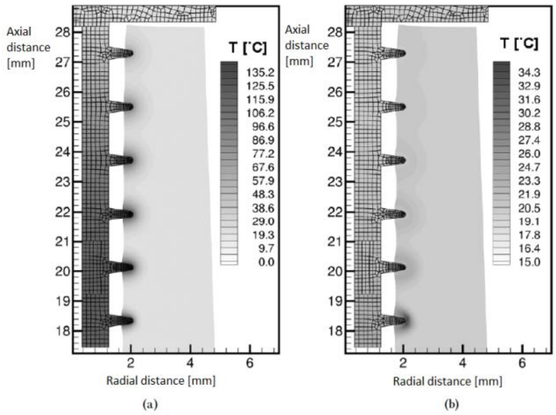

Fig. 10 *Temperature distribution after the thread making (PC tube): in case of (a) plastic deformation and sliding friction, (b) only plastic deformation [4] (initial temperature T=20°C)*

By the comparison of the results it emerges that the dominating quantity of the temperature grows because of the sliding friction. By the statement of the authors the measure of the the friction factor can be changeable between wide limits with the help of lubricant or coating, so as the behaviour of the polimer tube. During the examination of the influence of the speed engagement on the thermal condition the authors established the measure of the speed engagement is secondary important in the respect of the forming temperature in the female. The dicrease with 50% of the speed engagement in the female dicreased the highest temperature formed in the female only with 15%. The torque operated on the screw after finishing the thread producing mainly goes on the biasing force of the screwed joint.

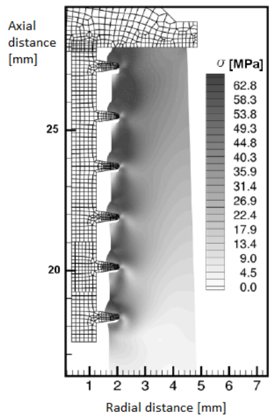

Fig. 11 *Vertical normal stress distribution in the PC tube after the screw joint preload [4]*

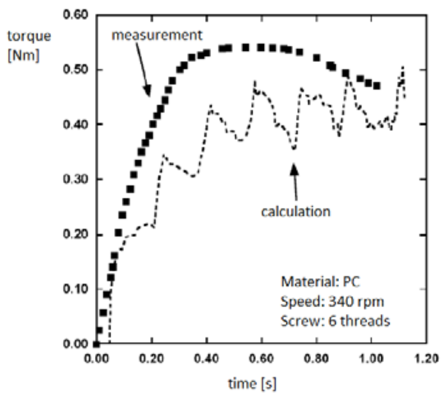

Fig. 12 *Comparison of measured and calculated torque-time graphs (PC tube) [4]*

To model this the authors used the next technics. They put in contact the screw head movable independenty from the screw shank with the top surface of the polimer tube, and then they adjusted the biasing force with the axial vertical moving of the screw shank (Fig. 11).

To justify the results of the model the authors used torque-time graphs and determined by measurings temperature values. Fig. 12 shows the comparison of the torque-time graphs lasting till the end of the thread making process detected by measurement and finite element model. The authors explain the slight dicrease of the measured torque with the stress relaxation formed in the polimer tube, but they do not take up modelling of it.

Erdős-Sélley [5] suggest axisymmetrical finite element model to model the screw engagement process and the biasing force, too. The mechanical behaviour of the screw and the thermal condition after the screwing-in was modelled, but not as a connected, but an individual thermal task. They modelled the screwing-in and the biasing force by MSc. Marc programme, while the friction heat generation between the connected threads they modelled by Cosmos/M finite element programme. The study does not talk about the consideration of the forming heat bacause of the plastic deformation worked out during the thread making. The more improtant suggestions during the establishing the model will be displayed in the same sequence in order to be comparable to the study [4]:

1. The material of the examined tube is poliamid strenghtened with short fibrous glass. The yield point of the tube is constant independently from the heat and speed of deformation. To estimate the contact press in the finite element thermal model independent from the stress analysis the author uses a specialized literature analytic relation, which determines the measure of the average contact press in the function of the yield point of the tube. The thermal model considers the yield point of the tube depending on temperature.
2. A room-temperature elastic plastic material model describes the material behaviour of the tube in the mechanic model, which shows increasing plastic deformation and dicreasing hardening. The elasticity modulus is independent from the temperature, while the value of Poisson factor is constant.
3. By the author thread will be produced by thread press, so the screw does not remove material from the wall of the tube while it produces the thread. In reality, the self-tapping screws used in the fiber strengthed composite tubes do thread-cutting amd thread-press, too.
4. The steel screw can be considered ideally rigid. The forming heat because of the slidding friction between the threads in the individual thermal finite model was modelled by heat source in a distance of pitch from each other, which come into activation in different times depending on the progression of the screw shank. The thermal conductivity factor and its specific heat is independent from the temperature.
5. An axisymmetric serial of rings replaces the screw thread.
6. Thermal conductivity factor and the specific heat of the composite tube are independent from the temperature.
7. The screw shank is cylindrical.
8. The tube material is homogeneous and isotropic.
9. The measure of the friction coefficient is independent from the temperature and the contact press.
10. The author takes the process of the thread producing in consideration in a very simplified form. He examined the process in a form of independent from time stress analysis, when the shank with threads of the screw (each working thread in the same time) presses into the wall of the bore of the tube doing a radial rigid body movement. After the 50 steps modelled indentation the thread shank of the screw makes the needed biasing force by the axial movement. A rigid profile curve replaces the thread shank in the finite element model.

Mathurin and his colleagues suggested a 3D 1/8 finite element model [6] to model the process of screwing in. The modelled thread press screw makes thread in 4mm deep steel plate, which lets us think of using of the model in the car industry. By the estimation of the authors the time (calculated) needed for the running of a total 360^o model would result nearly one month, which means an unreal long time. The suggested model means a compromise solving between the accuracy of the calculated time and the process of the thread producing. Similarly to the previous studies the authors modelled the screw as an ideally rigid body. The main aim of the examinations was the calculating of the press needed for the screwing in, which consists of the press needed for the thread producing and the press needed for ocercoming the friction. In order to being easily fixed the geometry of the screw – avarding the analytic describing – the authors devided the screw into end units. The finite element model and the applied netted structure can be seen in Fig. 13. The model does not take the influence of the generating heat during the thread producing. It is estimated to mention that the calculated time belonging to the simulation of the process of screwing in was remarkable (1,5-4,5 day).

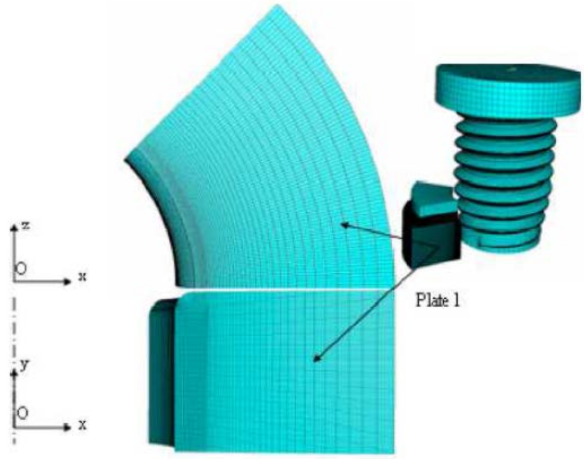

Fig. 13 *1/8 finite element model for modeling of screw in process*

Onasch [7] in his dissertation communicates experimental and theoretical results, too. He examined the mechanic processes step during the screwing in his work dealing with the different thread shaping screws. He established directives from the connection of stress-deformation and the torque and pulling-out force meterings reffered to the measuring of screwed joints. He examined the polimer material accumulated around the threads by microsectional pictures.

Drahtschmidt [8] compared different kinds of weaves (self-cutting screws, copper inserts, polimer inserts) usable in polimer structures while static and dynamic demand. He estimated the measure of the biasing force relaxation in the case of self-cutting screwed joints by a modified Findley relation.

Tome [9] in his study threw light upon very important connections by theoretical examinations in the biasing force relaxation in self-cutting screwed joints: the biasing force relaxation comes out of mainly because of the different heat expansion of the two units taking part in the joint (metal screw and polimer tube), the stresses forming by the heat output in the polimer tube cause plastic/permanent deformation. Depending on the place of force input this influence in case of cyclic thermal load leads to running off a characteristic biasing force, where the main parts of the relaxation effects happen during the first heating of the joint. In this work there are detailed experiments which examine the screwing in parameters, the material of the tube, and the types of the thread in the respects of their influences on the biasing force.

The literature [10] which shows further experimental examinations, mainly deals with the self-cutting screwed joints exposed to dynamic impact load, and the same time it contains some measurements in the connection with the surface deformation of the polimer piece.

Tome's and his colleagues study [11] deals with the deteriorating forms of the self-cutting screwed joints and the joints equipped with copper insert. They examined the joints with dynamic load. They loaded the self cutting screwed joint with the help of tensile test machine with maximum 3,4kN tensile load in one case with intermittent burden, and in the other case with single burdened. They established that in the case of tensile load the drawing out of the screw, while in the case of single burden the breaking of the screw is the typical form of ruining.

Further deteriorating forms are shown by Drahtschmidt and his colleagues [12]. The authors call attention to the deterioration of the polimer tubes caused by the defective shaping. If the thickness of the tube wall is too small, then it can be broken characteristically at the last thread. And also if the thickness of the tube wall is not suitable or if the profile angle of the thread is too big, cracks can be formed in the polimer.

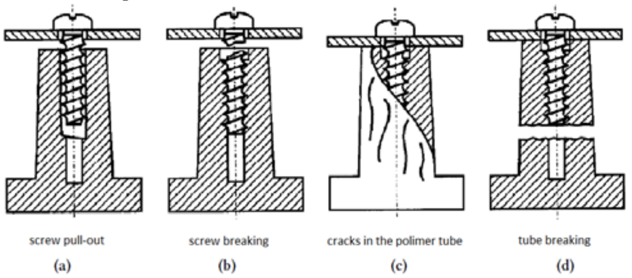

Fig. 14 *Typical breakdown forms of self-tapping*

4. Conclusion

After studying the technical literature [1], [2], [3] we can establish that numerous essays deal with the examination of the pulling torque and with its optimization. A number of theoretical models have been produced, which have examined the pulling torque taken as a function of the screw moving away. These theoretical models determined the value of the pulling torque by the help of analytic functions. They take into consideration the sizes of the screw and the countersink hole and the characteristics of the material, but they neglected the generating heat. The theoretical models in most cases were verificated experimentally, but there are no results on the further operating phases of screw joints.

A group of essays brings the screwing in process into focus by the adoption of numerical methods. We can meet axisymmetric finite element models in most case.

[5] devides the screwing in process into two separated tasks. It does not deal with the heat generated during the process of the thread producing, but it examines the condition after the screwing ina s sepapate thermodynamical model. A more detailed model is shown in [4]. The here appearing heat generation was modelled as a connected thermodynamical task. We can see here a more realistic model to model the screwing in, since here the total threads are not impressed in the wall of the tube at the same time.

To sum it up it can be told that none of the numerical examinations deals with the viscous behaviour of the polimer unit, and with its modelling, with the examination of screw joints and/or of that polimer unit sin different loading cases, and with the influence of the relaxation of the biasing force and of the deformation of the tube. And also they do not deal with the screw fixing adhesive, the lubrication and the coating.

5. References

[1] Seneviratne, L. D.; Ngemoh, F. A.; Earles, S. W. E.; Althoefer, K. A.: Theoretical modelling of the self-tapping screw fastening process, Proc. Instn. Mech. Engrs, Vol. 215 (C), pp: 135-154 (2001)

[2] Seneviratne, L. D.; Ngemoh, F. A.; Earles, S. W. E.: An experimental investigation of torque signature signals for self-tapping screws, Proc. Instn. Mech. Engrs, Part C, Journal of Mechanical Engineering Science, Vol. 214 (C2), pp: 399-410 (2000)

[3] Althoefer, K.; Lara, B.; Seneviratne, L. D.: Monitoring of self-tapping screw fastenings using artificial neural networks, Journal of Manufacturing Science and Engineering, Vol. 127, pp: 236-243 (2005)

[4] Ellwood, K. R. J.; Fesko, D.; Bauer, D. R.: An axisymmetric model for thread forming in polycarbonate and polypropylene screw and boss fasteners, Polymer Engineering and Science, Vol. 44, No. 8, pp: 1498-1508 (2004)

[5] Erdős-Selley, Cs.: FE modelling of the mounting process of metal screw and composite part, Periodica Polytechnica, Vol. 48, No2, pp: 133-143 (2004)

[6] Mathurin, F.; Guillot, J.; Stephan, P.; Daidie, A.: 3D finite element modeling of an assembly process with thread froming screw, Journal of Manufacturing Science and Engineering, Vol. 131, pp: 151-158 (2009)

[7] Onasch, J.: Zum Verschrauben von Bauteilen aus Polymerwerkstoffen mit gewindeformenden Metallschrauben, Dissertation Universitat GH Kassel (1982)

[8] Drahtschmidt, F.: Zur Verbindungstechnik von glasfaserverstarktem Polyamid - Schrauben und Inserts, Dissertation Lehrstuhl fur Kunststofftechnik, Universitat Erlangen (1999)

[9] Tome, A.: Vorspannkraftrelaxation von Kunststoff-Direktverschraubungen, Dissertation Lehrstuhl fur Kunststofftechnik, Universitat Erlangen (2000)

[10] Renz, R.; Wendtland, T.; Kasper, F.-J.: Recyclinggerechte Befestigungstechnik bei Bauteilen aus thermoplastischen Kunststoffen. Abschlussbericht zum FKMForschungsvorhaben Nr. 216 (1998)

[11] Tome, A.; Ehrenstein, G. W.; Drahtschmidt, F.: Joint Performance of Mechanical Fasteners under Dynamic Load – Self-Tapping Screw in Comparison with Threaded Inserts in Brass and Plastic, In: Moalli, J. (Editor): Plastic Failure Analysis and Prevention, William Andrew Inc., New York, pp: 53-63 (2001) ISBN 1-884207-92-8

[12] Drahtschmidt, F.; Ehrenstein, G. W.: Threaded Joints in Glass Fiber Reinforced Polyamide, Polymer Engineering and Science, Vol. 37, No 4, pp: 744-755 (1997)

[13] Soós E.: Műanyag alkatrészeken alkalmazott önmetsző csavarkötések kisérleti vizsgálata. GEP LV:(10-11) pp: 149-152 (2004)

[14] Soós E.: Önmetsző csavarkötesek kisérleti vizsgálata ciklikus hőterhelés esetén. GEP LX:(10-11) pp: 84-87 (2009)