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Newspaper reel core and chuck specifications

Ensuring newsprint runnability on newspaper presses demands perfect interaction between the reel core and the chuck in the reel stand. So far, studied details about different core types and their operability with different chucks has not been published.

All core manufacturers produce several types of cores, changing mainly in sterngth indicated by the crush strength of the core. In the reel stands both conical and expanding chucks are widely used demanding sometimes different kinds of properties from the core. Naturally, the dimensions of the cores and chucks, on the other hand, must be standardized as far as possible.

The scope of this project was to deliver information about these variables to printers as well as to carry out test procedures to find out optimal combinations in order to set a platform for standardisation. With the help of this data communication and co-operation can be directed to maximize runnability and printability properties.

During the project, carried out by the Technical Research Centre of Finland, full scale printing trials were made at three different printers using four kinds of chucks.

Niko Ruokosuo
Research Manager

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1. Introduction

Apart from paper properties todays specifications for newsprint reels are insufficient and include at most general figures like reel dimensions and their tolerances, allowed number of paper machine splices (mill joins) and wrapper specifications. The internal structure of the reel, which strongly affects reel handling and runnability in the press, is normally excluded in these specifications. The cores already represent a variety of materials, thicknesses and dimensions. Existing specifications and recommendations for reel cores are contradictory and may vary between organisations. Moreover, they do not take into consideration the interactions between core and chuck.

Chucks used in newspaper presses basically fall into two categories: conical and expandable chucks. Although there is a trend towards expandable chucks, both categories will be used in parallel also in the future. In addition, a large variety of both types of reel chucks exists and is under development. The chuck strongly influences operation stability, web break frequency and reel change security.

For this reason, there has been an obvious need to clarify the interrelations between, on the one hand, the on-press behaviour of the reel and on the other hand the necessary core and reel chuck parameters. After this, more adequate specifications for newspaper reel cores and chucks could be presented — at the same time taking into account the development in press design and reel formation.

It has been the scope of this project to estimate the effect of the parameters of reel, core and reel chucks on reel handling efficiency and paper runnability, and ***to set a platform for standardization*** *of these parameters taking the requirements of AGVs into account.*

The approach has been made practically by collecting existing specifications and recommendations for paper reels and reel cores, empirically by collecting the experiences of press manufacturers, core manufacturers and printers about chuck and core interactions and the development trends in chuck design, and experimentally by performing full scale printing trials with a series of chucks and cores in four different press lines.

The project has been carried out at the Graphic Arts Laboratory of the Technical Research Centre of Finland **(VTT/GRA)** on behalf of **IFRA**. Project leader was ***Ulf Lindqvist***. ***Hannu Linna*** was responsible for the survey on reel specifications and ***Pertti Moilanen*** for the survey on cores and chucks and for the full scale printing trials.

The project has been conducted by a Working Group, at the same time acting as an expert panel for the scientists. The members of the Working Group were:

J. René Argouarc'h,	M.E.G.,	Evry, F
Sture Blücher,	Göteborgs-Posten,	Gothenburg, S
Wim van de Camp,	Sonoco,	Maastricht, NL

Klaus Eckermann,	Madsack,	Hanover, D
Steve Gifford,	Rockwell,	Preston, GB
Anton Gutmann,	Paul & Co.,	Wildflecken, D
Teemu Javanainen,	Corenso United,	Loviisa, SF
Markku Järvinen,	Ahlström,	Karhula, SF
Manfred Kunert,	Paul & Co.,	Wildflecken, D
Åke Lindquist,	SCA,	Sundsvall, S
Lauri Mäkipaja,	Corenso United,	Varkaus, SF
Ian Parkinson,	Rockwell,	Preston, GB
Terry Parry,	UPM/Shotton,	Shotton, GB
Klaus Röder,	KBA,	Würzburg, D
Ron Tiffin,	Sonoco Ltd.,	Vancouver, CAN

From IFRA Boris Fuchs, Bruno Thoyer and Niko Ruokosuo as a moderator took part in the project.

In addition, the following companies contributed to the project by supplying cores, paper reels, expertice or by performing printing trials or measurements free of charge:

Ahlström Oy,	Karhula, SF
Kaleva,	Oulu, SF
Paul & Co.,	Wildflecken, D
MAN Roland,	Augsburg, D
Satakunnan Kirjateollisuus,	Pori, SF
Turun Sanomat,	Turku, SF
United Papermills,	Kaipola, SF
WIFAG,	Bern, CH

The authors and IFRA are greatly indebted to all the members of the working group and the companies listed above for their valuable contribution to the project.

2. Background information — survey

2.1. Existing reel specifications

Specifications presented for newsprint reels are of a very general nature including mostly only geometrical dimensions and tolerances of the reel. IFRA's Newsprint and Newsink Guide deals with newsprint reel characteristics in the following chapters:

- Preferred Reel Dimensions
- Reel Production Quality
- Newsprint Reel Cores
- Reel Wrapping, Packing and Labelling.

Reel specifications and recommendations concerning the reel itself listed in the guide are as follows:

1. Reel diameters

   Recommended nominal diameters including thickness of wrapping: 1000, 1070, 1150 and 1250 mm

   Manufacturing tolerance should be +0/− 30 mm
2. Reel width tolerances

   No more deviation than +/− 3 mm
3. Winding quality

   The web should be free of winding defects, e.g. wrinkles. However, for production reasons the newsprint manufacturer is unable to guarantee that the web is entirely free of winding defects within 10 mm of the core.

   The hardness of the reel, radially and across the width, should be as uniform as possible. The edges of the reel should be cleanly cut and free from coarse edges and tears. The ends of the reel should be free of paper dust caused by the reel slitting operation. The ends of the reel should be as leveled as possible but where deviation exists this shall not exceed 5 mm (Figure 2-1).

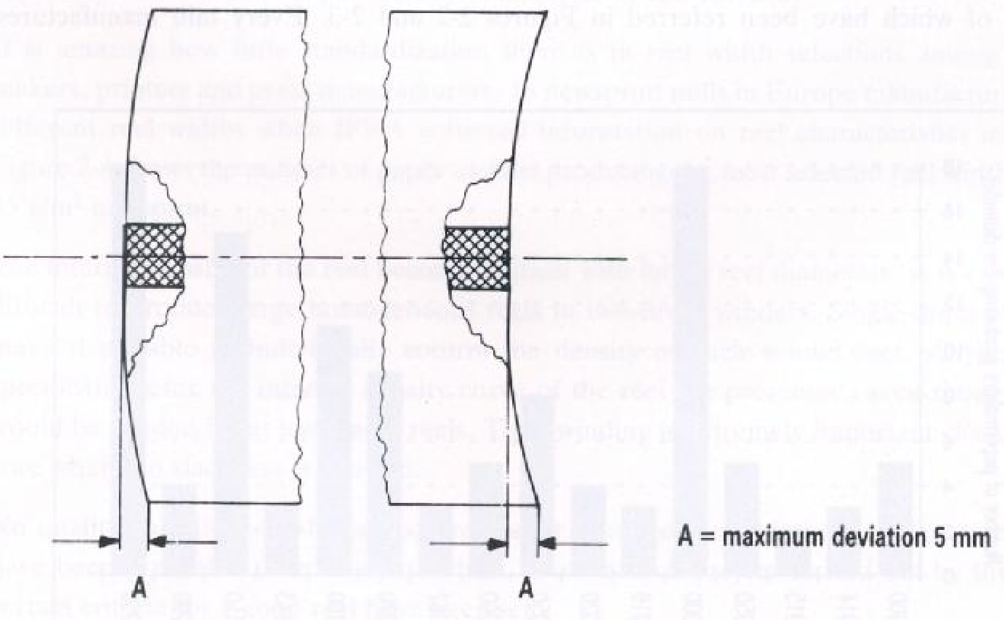

Figure 2-1. Deviation from the level end of the reel.

4. Mill joins

   No more than three mill joins should exist in a reel. Mill joins should not occur within 15 mm of the outer layers of the reel or within 70 mm of the core.

5. Water marks

   Water marks are to be eliminated

6. Winding direction

   With improved, more even-sided sheets there is usually no need to specify a winding direction.

7. Reel wrapping, packing and labelling

   General instructions concerning reel wrapping, packing reels together, and reel marking and labelling are given.

The internal structure of the reel and the properties, which determine the runnability behaviour of the reel, are normally excluded in the specifications and no limit values are specified. As both, the use of double width presses and the reel diameters increase, demands for the internal structure of the reel and its homogeneity are being extended as well. This includes homogeneity from the outer layer of the reel to the core and also across the whole width of the reel.

Information on the production of different newsprint reel diameters and widths was collected by IFRA in 1991. A total of 18 newsprint mills answered the questionnaire study, the results of which have been referred in Figures 2-2 and 2-3. Every mill manufactures

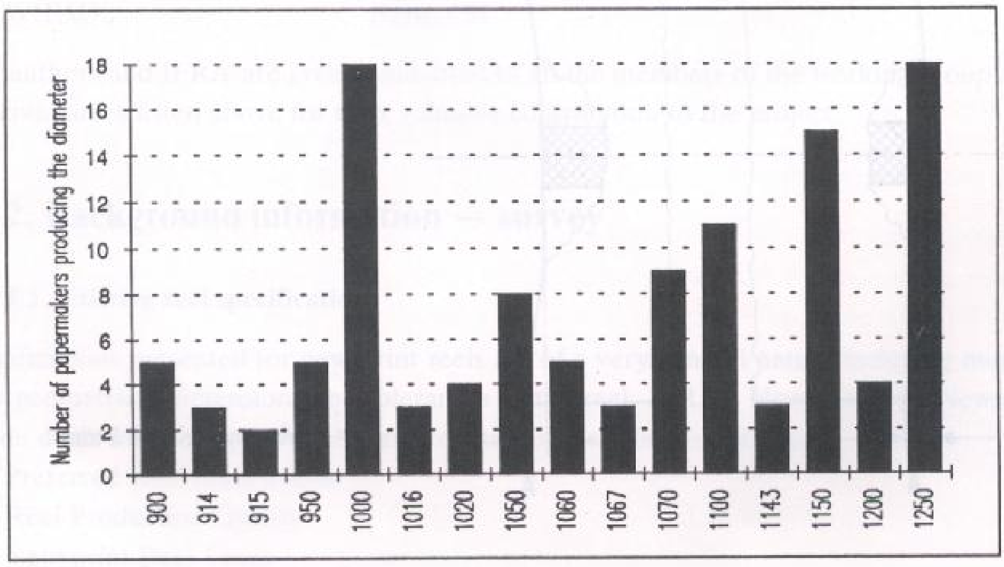

Figure 2-2. Number of paper makers producing different reel diameters for 45 g/m² newsprint.

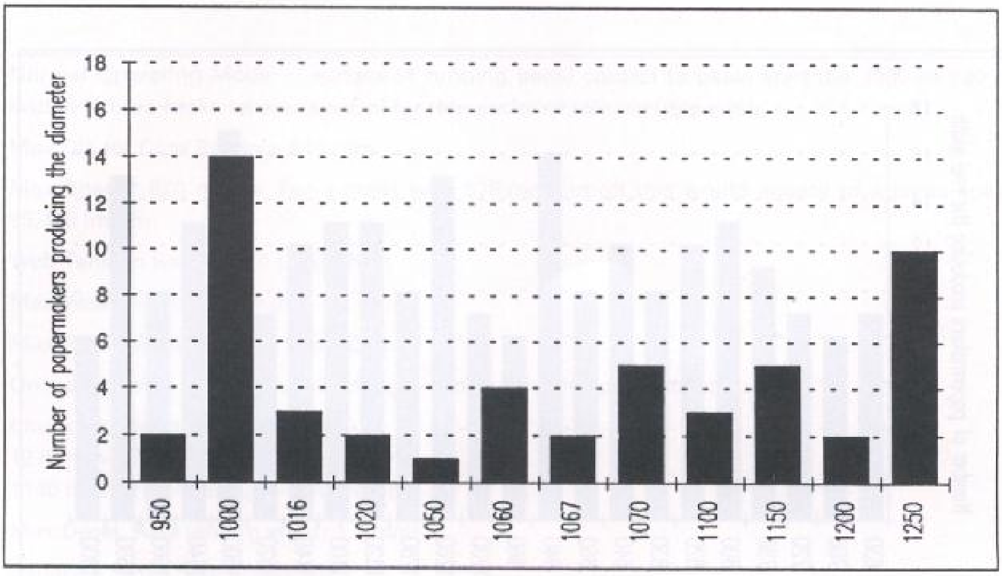

Figure 2-3. Number of paper makers producing different reel diameters for 40 g/m² newsprint.

diameters of 100 and 125 cm in grammage 45 g/m². 14 mills produce a diameter of 100 cm and 10 mills a diameter of 125 cm when the grammage is 40 g/m². The next most common diameters are 115 and 110 cm. But there is a great variety in reel diameters even outside the recommendations. According to the information received from Finnish newsprint mills a diameter of 100 cm is the most common in single width presses but more than half of the reels used in double width presses is of a diameter of 125-127 cm.

It is amazing how little standardization there is in reel width selections among paper makers, printers and press manufacturers. 18 newsprint mills in Europe manufactured 365 different reel widths when IFRA collected information on reel characteristics in 1991. Figure 2-4 shows the number of paper makers producing the most selected reel widths with 45 g/m² newsprint.

The internal density of the reel becomes critical with larger reel diameters. It is especially difficult to produce large homogeneous reels in two-drum winders. Single-drum winders make it possible to individually control the density of each wound reel. Anyhow, no specifications for the internal density curve of the reel are presented, even though they would be needed for at least large reels. Tight winding is extremely important close to the core where no slackness is allowed.

No quality specifications for a good reel exist, but recommendations and requirements have been presented from many quarters. In a research project carried out by the VTT certain criteria for a good reel have been set:

- A diameter error of 2-5 mm is usually allowed, but the meaning of this tolerance has not been studied. A diameter error of more than 10 mm is already considered alarming.

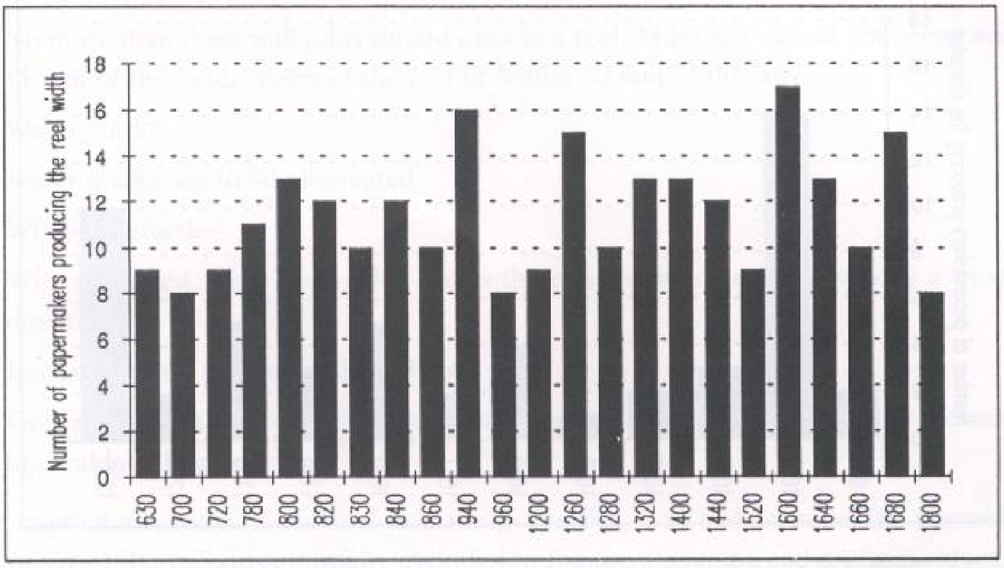

Figure 2-4. Number of paper makers producing different reel widths for 45 g/m² newsprint.

— The reel hardness should be even across the web, so that no differences in hardness occur between the edges and the centre. The acceptable range in a reel is 10 units measured with the Schmidt Hammer.

— The web tension should be even across the web, so that no differences in tension exist between the edges and the centre. The acceptable range in a reel is 120 N/m and at the most 60 N/m over a distance of 30 cm.

— The reel density should decrease from the centre to the outer layers of the reel. If the density is too high in the outer layers, the reel is starred.

— There are no dislocations sideways in a good reel.

— A good reel is not perceptibly telescoped.

— The variation level in the cross direction is so small that there is no rope figure or other clearly perceptible defect.

2.2. Development in core specifications

Paper makers and press manufacturers often have their own specifications for the core. These specifications are most commonly related to the individual constraints of their processes. In practice, the constraints are set by the winder of the paper mill or by the chuck constructions of the press. In the following table 2-1 examples of such "de facto specifications" set by one press manufacturer are presented.

1. Normal Operating Mode — surface (4 running belts) control to paste start dia. (180 to 230 mm), switch to core brake tension control for remainder of roll run (to paste).
2. Max Dia for Core Braking: 510 mm
3. Max Speed: 820 m/min. For a press with 578 mm cut-off this would equate to a press speed of 85,450 imp/hr.
4. Web Tension Range: 110 to 530 N/m
5. Max Web Width: 1520 mm
6. Max Roll Weight: 1300 kg (newsprint)
7. Only chuck side extends for chucking — chuck force is applied continuously.
8. Chucking Thrust Force:
   1270 mm RTP — 950 kg — 0.52 N/mm^2
   1140 mm RTP — 820 kg — 0.41 N/mm^2
9. Max Decel. Rate (emerg stop): 1.3 m/s^2
10. Separate Brake Side Cones For:
    returnable vs. non-returnable cores
    no key used with either
11. Max Torque Transmitted to Core: 170 Nm

Table 2-1. Specifications of one press manufacturer.

Usually the core manufacturers can easily produce cores with the required quality. Problems start if the requirements of the printing plant have not been taken into account. Most core manufacturers also have their own quality standards for their products, which meet the requirements listed. In the following table examples of such product specifications set by one core manufacturer are given.

Property	Quality 1	Quality 2	Quality 3
Inner diameter (mm)	76.2 +0.3/-0.2	76.2 +0.4/-0.1	76.2 +0.4/-0.1
Outer diameter (mm)	106.2 +0.7/-0.7	106.2 +0.6/-0.6	106.2 +0.8/-0.4
Weight (kg/m)	3.1 min 2.8	3.2 min 3.0	3.6 min 3.4
Moisture content (%)	6 - 9	6 - 9	6 - 9
Crush strength (N/100 mm)	2700 min 2200	3400 min 2800	5000 min 4200
Chuck test (N/100 mm)*	—	—	10000
Elasticity modulus (N/mm^2)**	—	—	3100
Bending (mm/m)*	2.0	2.0	2.0
Out of roundness (mm)	—	0.25	0.25
Max reel weight (kg)	1000	1500	2500
Reel width (m)	—	—	≤ 2.45

*) Indicative: Uncalibrated; not included in the test of each make

**) Indicative: According to the specific frequency of the property

Table 2-2. Core specifications of one core manufacturer.

1.	Normal Operating Mode — surface (4 running belts) control to paste start dia. (180 to 230 mm), switch to core brake tension control for remainder of roll run (to paste).
2.	Max Dia for Core Braking: 510 mm
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Moisture content (%)	6 - 9	6 - 9	6 - 9
Crush strength (N/100 mm)	2700 min 2200	3400 min 2800	5000 min 4200
Chuck test (N/100 mm)*	—	—	10000
Elasticity modulus (N/mm²)**	—	—	3100
Bending (mm/m)*	2.0	2.0	2.0
Out of roundness (mm)	—	0.25	0.25
Max reel weight (kg)	1000	1500	2500
Reel width (m)	—	—	≤ 2.45

*) Indicative: Uncalibrated; not included in the test of each make

**) Indicative: According to the specific frequency of the property

Table 2-2. Core specifications of one core manufacturer.

In rotogravure printing the demands for the cores are far more severe than in newspaper printing because reels are wider and heavier. This may cause heavy vibrations in the expiring reel at critical speeds — i.e. close to the reel end and reel change.

From these studies we know the relationship between the critical unwinding speed and the web width for different cores without any rest layer of paper (Figure 2-5), with different rest paper diameters (damping layer) (Figure 2-6), and the effect of an increase in core diameter on the critical unwinding speed (Figure 2-7).

As can be seen from the figures, the normal operation area for newspaper production — regarding printing speed and reel width — is still far away from the critical frequencies. Nevertheless the development is also here going towards higher speed and web width.

Core specifications are being developed by ISO/TC 6 (Paper and Board-Testing of Cores Parts 2-9).

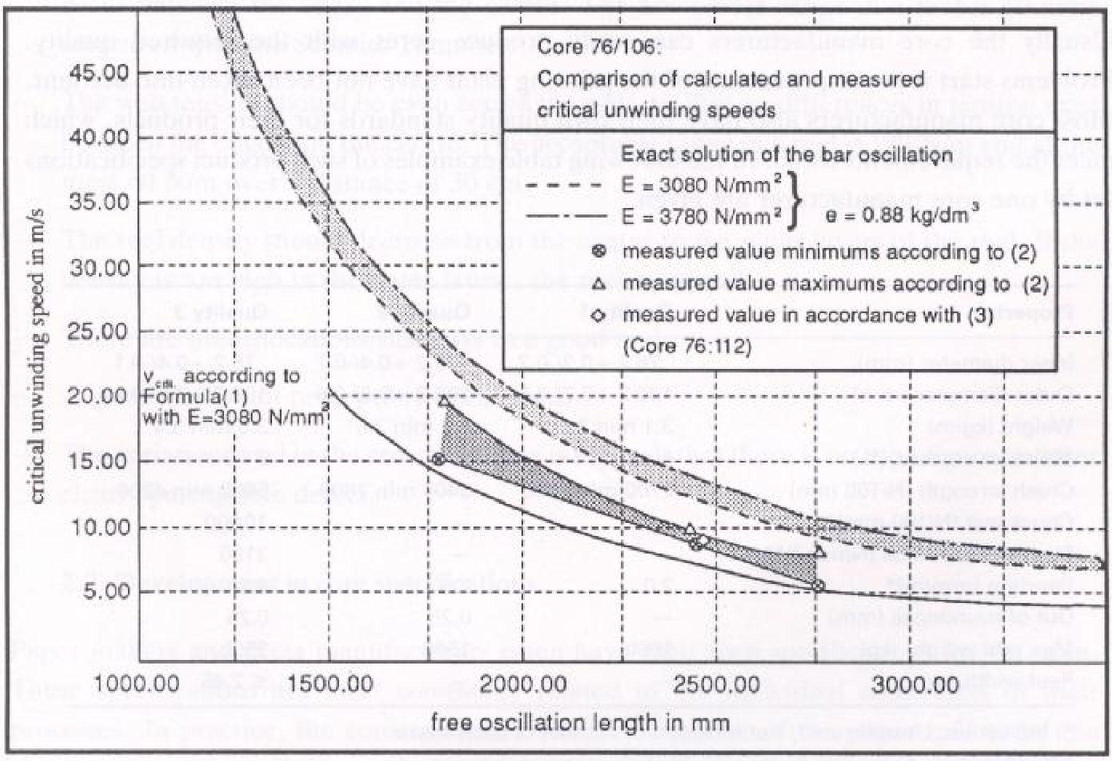


Figure 2-5. The effect of web width on the critical speed for an empty core.

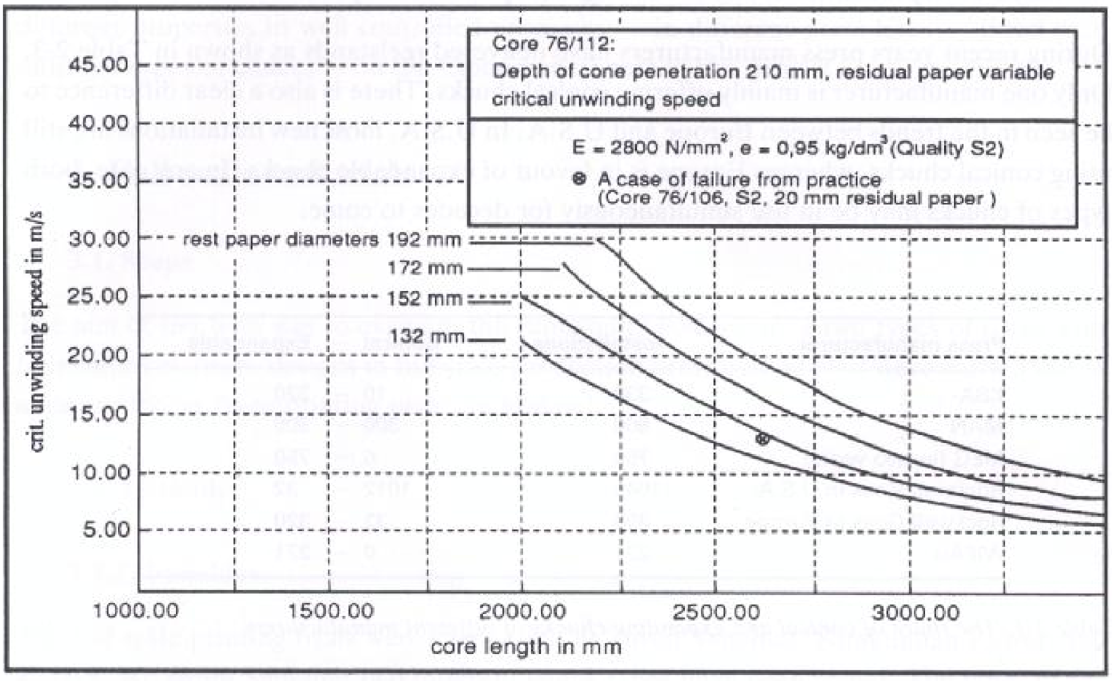


Figure 2-6. The influence of reel diameter on the relation between web width and critical speed.

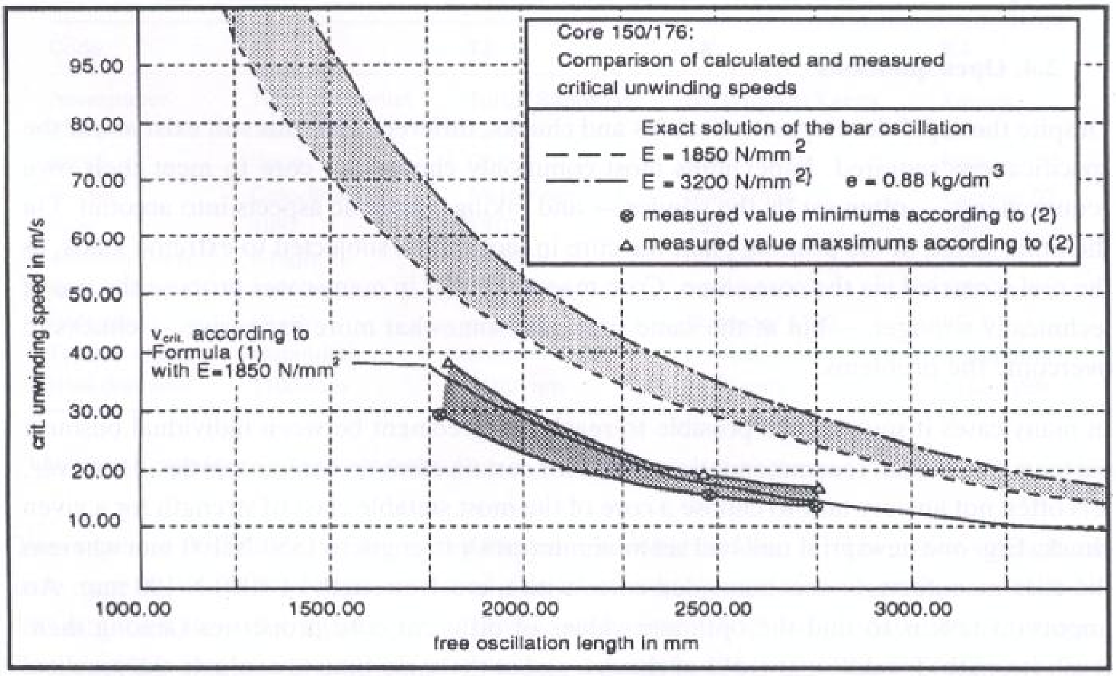


Figure 2-7. The effect of increased core diameter on the critical speed.

2.3. Development trends in chuck designs (experiences of press manufacturers)

During recent years press manufacturers have delivered reelstands as shown in Table 2-3. Only one manufacturer is mainly offering conical chucks. There is also a clear difference to be seen in the trends between Europe and U.S.A. In U.S.A. most new installations are still using conical chucks, whereas Europe is in favour of expandable chucks. In any case, both types of chucks may be in use simultaneously for decades to come.

Press manufacturer	Installations	Conical – Expandable
KBA	330	10 – 320
MAN	600	300 – 300
MEG (in two years)	750	0 – 750
Rockwell Goss in U.S.A.	1045	1012 – 32
Rockwell Goss in Europe	353	33 – 320
WIFAG	271	0 – 271

Table 2-3. The share of conical and expanding chucks of different manufacturers.

One general trend in conical chucks seems to be the development towards longer cones and less destructive shape of the end of the cone – i.e. smoothened edges. Development in expandable chucks seems to go towards more individual designs with a variety in number and shape of the expanding elements. This complicates the standardization of chucks.

2.4. Open questions

Despite the rapid development in cores and chucks, different opinions still exist about the specifications required. Paper mills most commonly choose the core to meet their own requirements – often set by the winder – and taking economic aspects into account. On the other hand, in the printing plant the core in fact will be subjected to extreme loads, as the reel is carried via the core alone. Core manufacturers in many cases propose the use of technically stronger – but at the same time also somewhat more expensive – chucks to overcome the problems.

In many cases it seems to be possible to reach an agreement between individual business partners about what recommendations to set for certain cases on core properties. However, it is often not an easy task to choose a core of the most suitable class of strength for a given chuck. E.g. one newsprint mill had set minimum crush strength to 1850 N/100 mm whereas the core manufacturer recommended cores with a crush strength of 4000 N/100 mm. An important task is to find the optimum values of different core properties (among them crush strength) for different types of chucks, and at the same time to evaluate the practical importance of these properties for on-press runnability of the reel.

For this reason it was decided to study the performance of cores — manufactured to different properties in well controlled processes — in different press lines — fitted with different types of chucks — in the experimental part of this project.

3. Full scale test trials

3.1. Scope

The aim of the tests was to evaluate the runnability behaviour of two types of cores with four different chuck designs in full scale production presses. The tests were carried out in autumn 1992 at three printing plants in Finland.

3.2. Methods

3.2.1. Variables

The full scale printing trials were carried out at Turun Sanomat, Satakunnan Kansa, and Kaleva. At Turun Sanomat two different chuck types have been tested. The types of the presses and chucks are shown in Table 3-1. The press lines were coded as shown in the table.

Code	T1	T2	SK	KA
Newspaper	Turun Sanomat	Turun Sanomat	Satakunnan Kansa	Kaleva
Place	Turku	Turku	Pori	Oulu
Press	Goss	Goss	MAN	KBA
Model	Colorliner	Metroliner	Mediaman	Express 60
Year	1992	1978	1992	1988
4-colour units	4-high	satellite	4-high	satellite
Web width	1600 mm	1600 mm	1600 mm	1600 mm
Reel stand	CT-45	old type	Flypaster 1150	RE 2
Type of chuck	expanding	conical, short	conical, long	expanding
Reel diameter	1100 mm	1100 mm	1150 mm	1150-1250

Table 3-1. Newspapers, presses and chucks.

Two types of cores were delivered by Paul & Co, Wildflecken, D. The crush strength of core type A was 2700 N/100 mm, and the crush strength of core type B was 3100 N/100 mm. In Kaleva also a third core type was used: core type C was produced by Ahlström, Ruukki, SF. The crush strength of this core type was 5040 N/100 mm. Some technical quality specifications of the cores are shown in Appendix 2.

3.2.2. Performance of the tests

With core types A and B, United Paper Mills, Kaipola, SF produced three similar reels of standard newsprint 42.3 g/m^2 for each chuck type. The reel diameter was 1100 in Turku and 1150 mm in SK and KA. This gave (2 cores × 3 reels × 4 chucks) totally 24 reels. In addition, United Paper Mills, Kajaani, SF produced three reels with core type C for Kaleva. The diameter of these reels was 1250 mm.

The reels were printed in normal production. Normal production speed of the printing plant was used. The reel-stand of a four-colour web was chosen for the test. Printed samples were taken at the start and after every 10,000 copies.

In SK and KA an emergency stop procedure was carried out with all core types tested. After this procedure it was expected that some noticeable differences could be discovered.

3.2.3. Measurements

In Kaipola a visual inspection of reel handling was carried out. In each printing plant an overall inspection of the reel and core condition was made before the reel was placed on the reel stand. Reel hardness was measured with a Schmidt Hammer. Out-of-roundness was measured with a measuring tape resp. a reel roundness meter from INGRAF.

During printing out-of-roundness was measured with an optical displacement sensor. Web tension in machine direction was measured with Tenscan from ABB-Strömberg. Web tension profile was evaluated with C-AN Tensor, vibration of the reel arms was measured with special instrumentation constructed by the Laboratory of Production Engineering of VTT. In some cases the reel changes were video-taped. After printing a visual inspection of the core was performed. Experiences were collected from the printers regarding runnability behaviour.

3.3. Results

At the Kaipola paper mill paper reels with an A and B type core were cut by use of a single drum winder. The winding speed was 30 m/s (1800 m/min) and the average web tension level was 420 N/m. After cutting, the reels were moved with an automatic conveyor line, on which reels were wrapped. At the end of the line, reels were transported for storage with trucks. In the optimum case rolls undergo only one treatment with a truck, when loaded straight to a train or lorry.

At Turun Sanomat and Kaleva two press lines print the newspapers simultaneously. The circulations of the newspapers are: Turun Sanomat 134,000, Satakunnan Kansa 62,000 and Kaleva 97,000. During one night the production of one press line was 60-70,000, 62,000 and 45-50,000 respectively. The printing speed was 29,000 copies/h (540 m/min), in T1 and T2 and 28,000 copies/h, (520 m/min) in SK and KA.

3.3.1. Experiences of the printers

In all cases the reels arrived at the printing houses in very good condition without visible defects. This was expected because the transport distance was short and the reels underwent only little handling. A general opinion among the printers was that there were very few problems and no serious ones with the cores and chucks.

Turun Sanomat prints 10,000 reels/year. In a year approximately one core is damaged. This gives a 0.01 percent share of core damages. After a trial period of one year TS has abandoned the use of plugs for core protection.

SK has a new printing press with long conical chucks and they experienced, as they say, no core problems with this machine. Only the diameter of the fingers of the chuck they experienced to be slightly too big. Now, with a very hard core they put some **grease between the core and the chuck**. This makes it easier to take the used core away from the chuck. This kind of a procedure is an example of a possible core/chuck problem that can lead to a risk of withdrawing the core from the reel as the chuck is pulled out. This could be avoided by using an expanding chuck. Earlier SK used a Goss press with short conical chucks (same type as T2). With this press one typical problem was the unproper manual tightening of the chuck.

KA have had only one core/chuck problem in three years. This was not related to the core or the chuck itself, it was an error in the working procedure. KA have the possibility to use reels with a 125 cm diameter. During the visit they used a diameter of only 115 cm, but they have plans to go up to 125 cm.

3.3.2. Reel hardness

Good runnability of a reel includes an even hardness profile. Big differences in hardness within a reel may cause runnability problems, e.g. wrinkles and tension peaks. The hardness profile is controlled by the winder and paper profiles.

The reel hardness profile was measured from each reel every 10 cm. Reels were mounted in the reelstand before measuring. All the measured average hardness profiles with variation range are shown in Appendix 3. Figure 3-1 shows variation range of hardness profiles measured at T1 and T2. Profiles are fairly even with both core types. Reels made on core type B were somewhat harder than reels made on core A.

At SK (Figure 3-2), hardness of the reel for both types were on the same level. Profiles were quite even as in Figure 3-1. The level of hardness values observed with core type B reels were about the same at T1,T2 and SK. Core type A reel gave a slightly higher hardness at SK than at T1 and T2.

At KA trials were carried out with reels made on three different core types; A, B and C. Hardness levels obtained with A- and B-type cores were very similar as measured at SK. The level of hardness values measured from reels made on C-type cores was a little bit

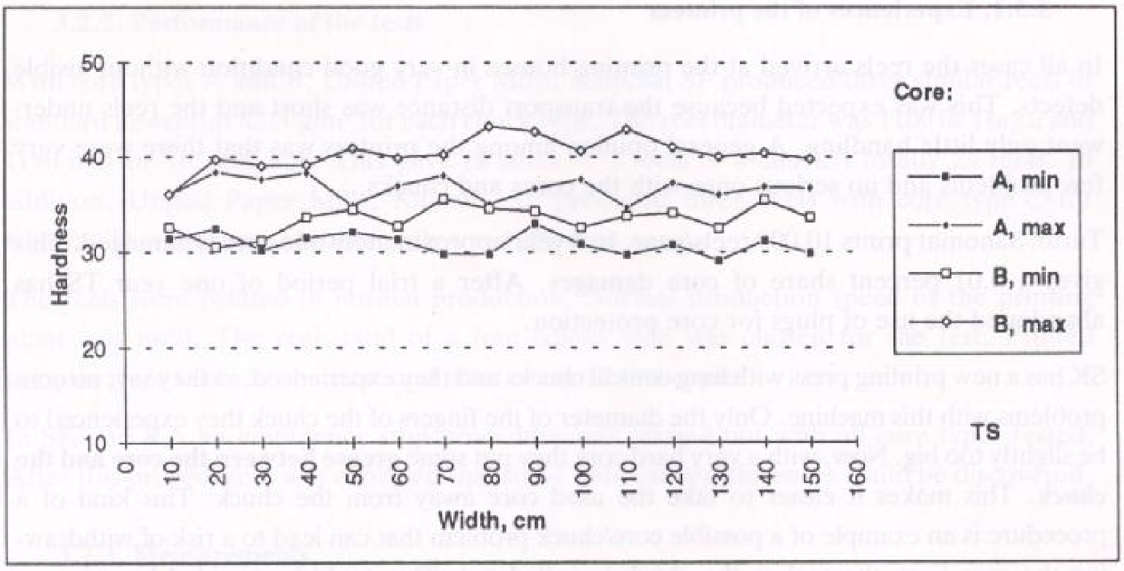


Figure 3-1. Variation range of hardness profiles of reels made with A- and B-type cores at T1 and T2.

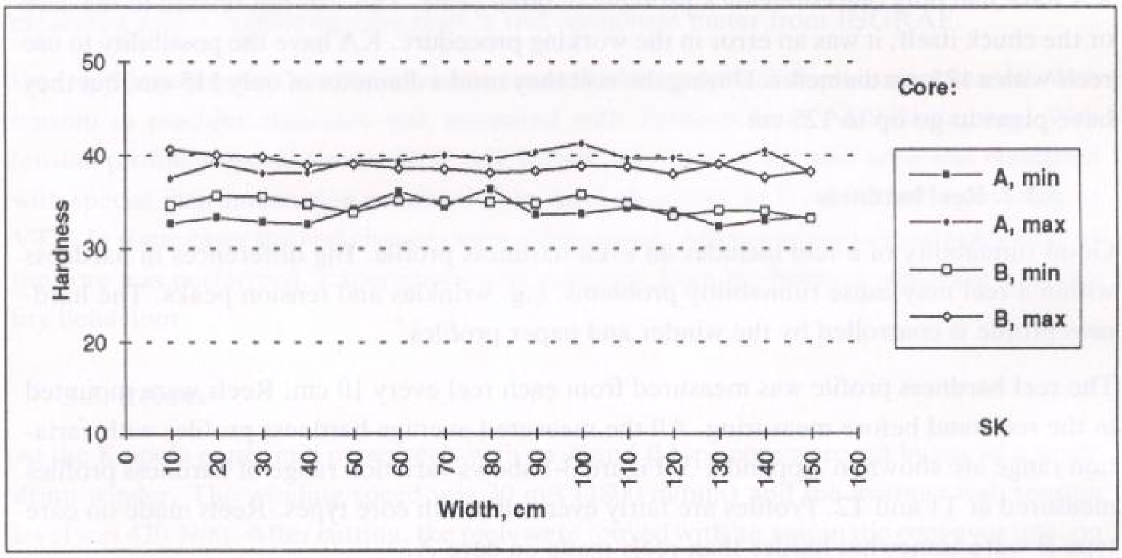


Figure 3-2. Variation range of hardness profiles of reels made with A- and B-type cores at SK.

higher than with other reels. Variation range of hardness of core type C can be seen in Figure 3-3. The reason for this difference can be found in the difference between cores or in a difference in the winding procedure. Reels with C-type cores were made in different paper machines and they were cut with a different type of a winder than A- or B-type reels. Also the diameter of C-type reels (125 cm) differ from the reels made on A- and B-type cores (115 cm).

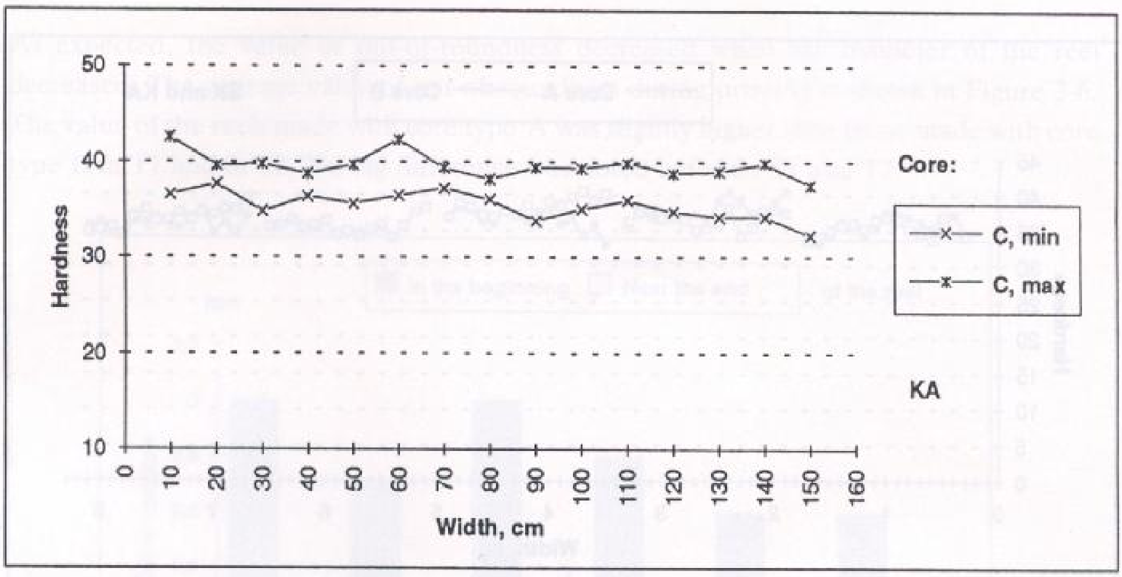


Figure 3-3. Variation range of hardness profiles of reels made with C-type cores at KA.

Figures 3-4 and 3-5 show hardness profiles in paper machine scale. Reels for T1 and T2 were cut from a different paper machine roll than reels for SK and KA.

From the figures we can see that the shape of the hardness curve depends somewhat on the position from which the reel is cut. We can also note, again, that in the case of T1 and T2 core B gave harder reels than core A, but in the case of SK and KA no remarkable differences were found.

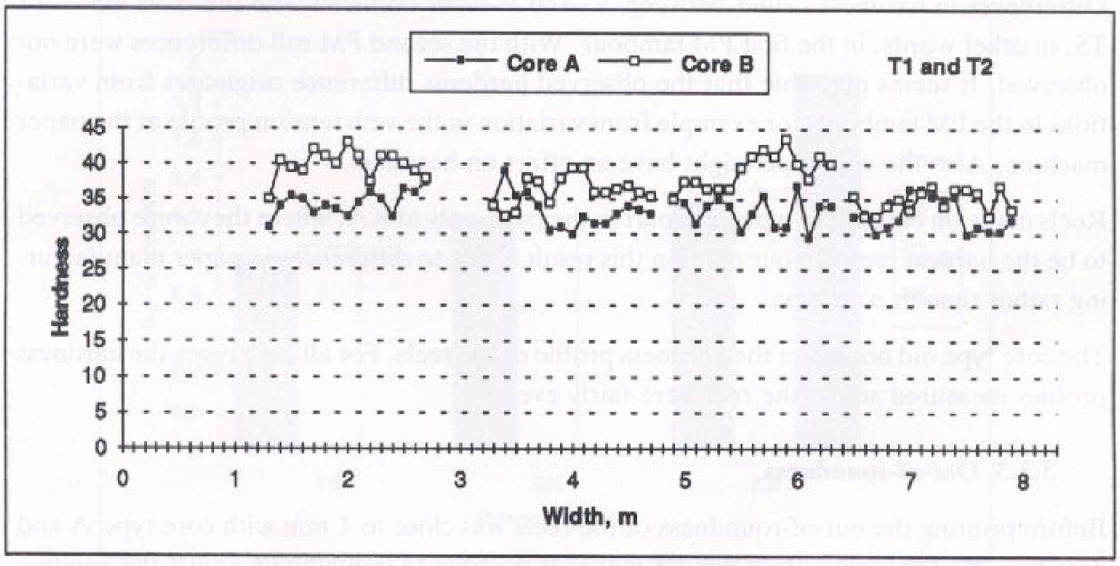


Figure 3-4. Hardness profiles of reels cut from different positions of the paper machine roll. Reels made on A- and B-type cores for T1 and T2.

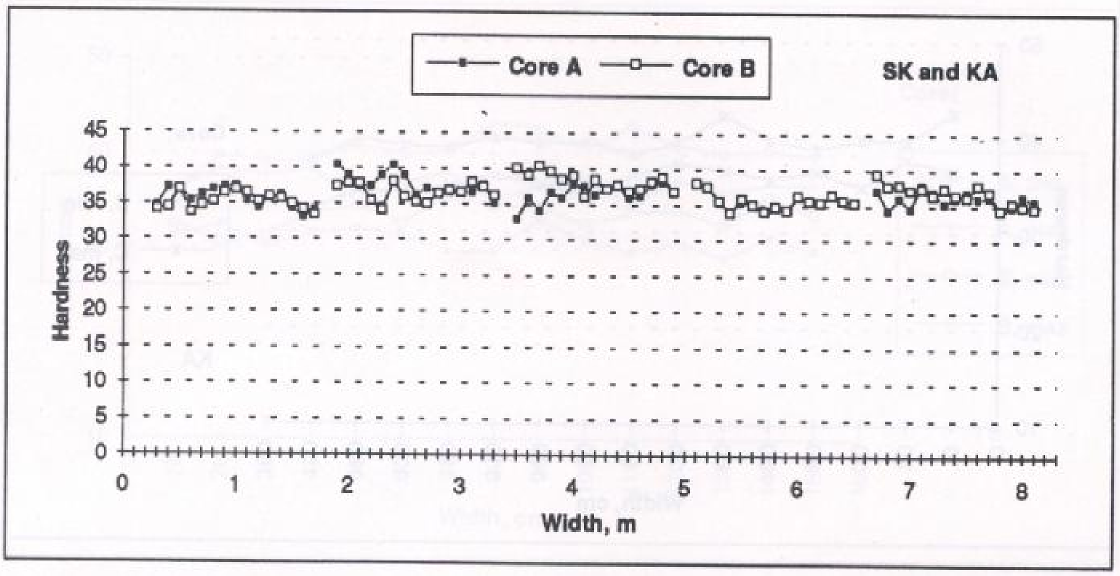


Figure 3-5. Hardness profiles of reels cut from different positions of the paper machine roll. Reels made with A- and B-type cores for SK and KA.

Reels made on core types A and B were produced at the same paper mill and winder. The wound in tension at the winder was constant (420 N/m). Reels were made from two paper machine (PM) tambours, which were wound consecutive to each other. At the winder the reels were made so, that only one type of core was used on one set. Reels for TS were made from the first PM tambour and reels for SK and KA from the second PM tambour.

Differences in hardness values between A- and B-cores occurred with the reels made for TS, in other words, in the first PM tambour. With the second PM roll differences were not observed. It seems probable that the observed hardness difference originates from variations in the PM tambour, for example from variation in the web tension profile at the paper machine. Also the core type might have an effect on hardness.

Reels made on cores of C-type took part in the trials only at KA, where they were observed to be the hardest reels. In our opinion this result is due to differences in paper manufacturing rather than in core type.

The core type did not affect the hardness profile of the reels. For all core types the hardness profiles measured across the reel were fairly even.

3.3.3. Out-of-roundness

Before printing the out-of-roundness of the reels was close to 1 mm with core type A and core type B. The single drum winder makes it possible to individually adjust the winding parameter of each reel. During printing out-of-roundness was measured both in the beginning and near the end of the reel.

As expected, the value of out-of-roundness decreased when the diameter of the reel decreased. The average value of out-of-roundness during printing is shown in Figure 3-6. The value of the reels made with core type A was slightly higher than those made with core type B in T1 and in T2. No big difference was noted between T1 and T2.

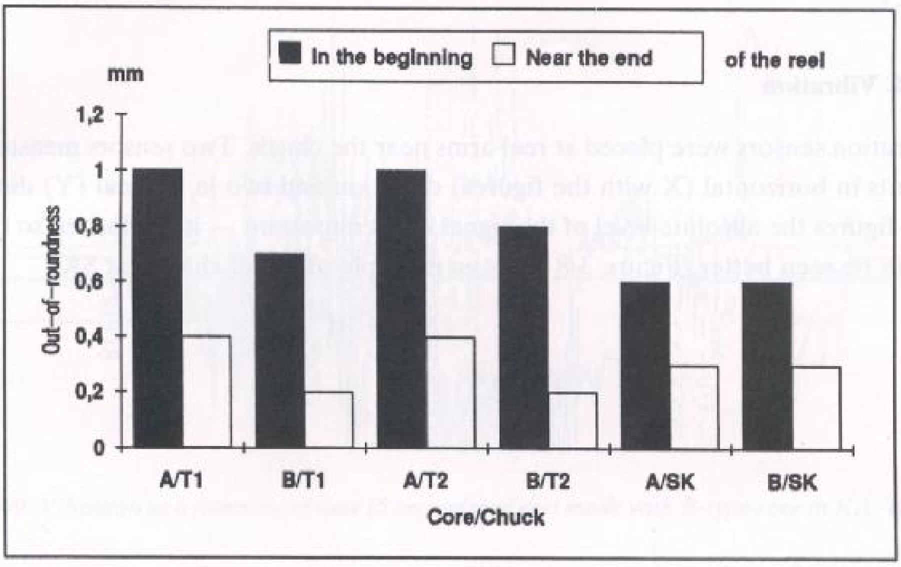


Figure 3-6. Average out-of-roundness of reels made with A- and B-type cores in T1, in T2 and in SK during printing.

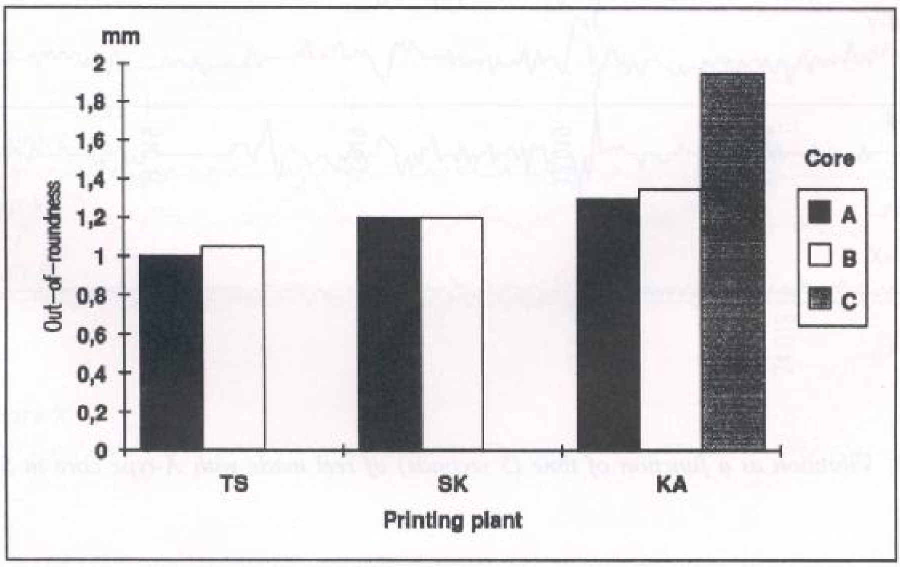


Figure 3-7. Average out-of-roundness of reels made with A-, B- and C-type cores before printing. Diameter of the reel: A/B 110 cm in TS, otherwise A/B 115 cm, C 125 cm.

At SK the out-of-roundness was smaller at the beginning of the reel (0.6 mm) than in Turku. No clear difference could be seen between the core types A and B in SK. In KA the reels made with the third core type C had the biggest out-of-roundness before printing but this is obviously because the diameter was 125 cm and the reels were cut with a two-drum winder. The average value of out-of-roundness before printing is shown in Figure 3-7.

3.3.4. Vibration

Four vibration sensors were placed at reel arms near the chuck. Two sensors measured the movements in horizontal (X with the figures) direction and two in vertical (Y) direction. With the figures the absolute level of the signal is not important — it is adjusted so that the curves can be seen better. Figure 3-8 gives an example of a reel change at SK.

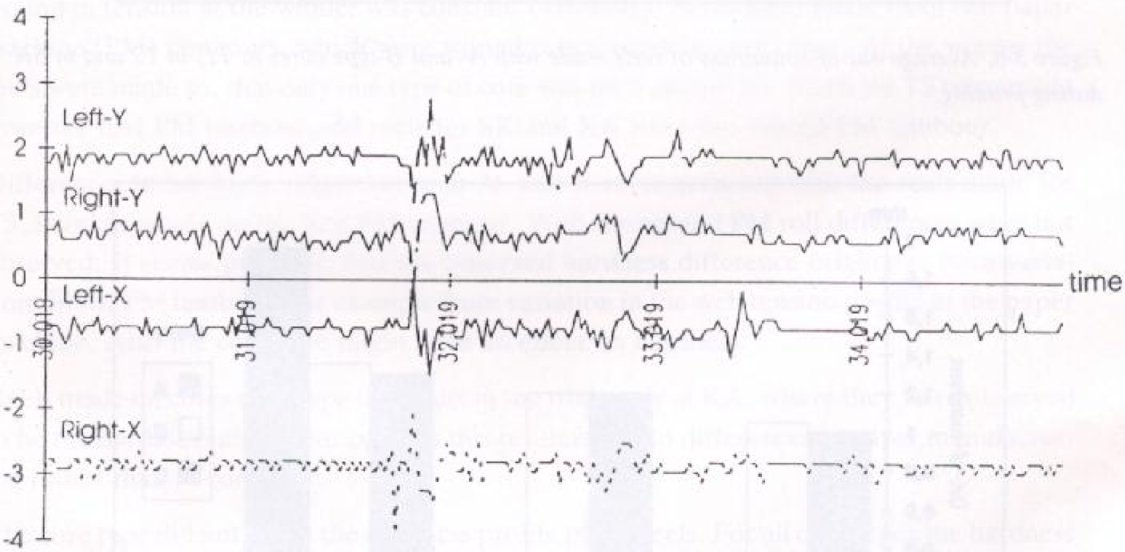


Figure 3-8. Vibration as a function of time (5 seconds) of reel made with A-type core in SK. Reel change.

An example of the emergency stop procedure is shown in Figure 3-9. An example of vibration caused by out-of-roundness in one reel arm is shown in Figure 3-10.

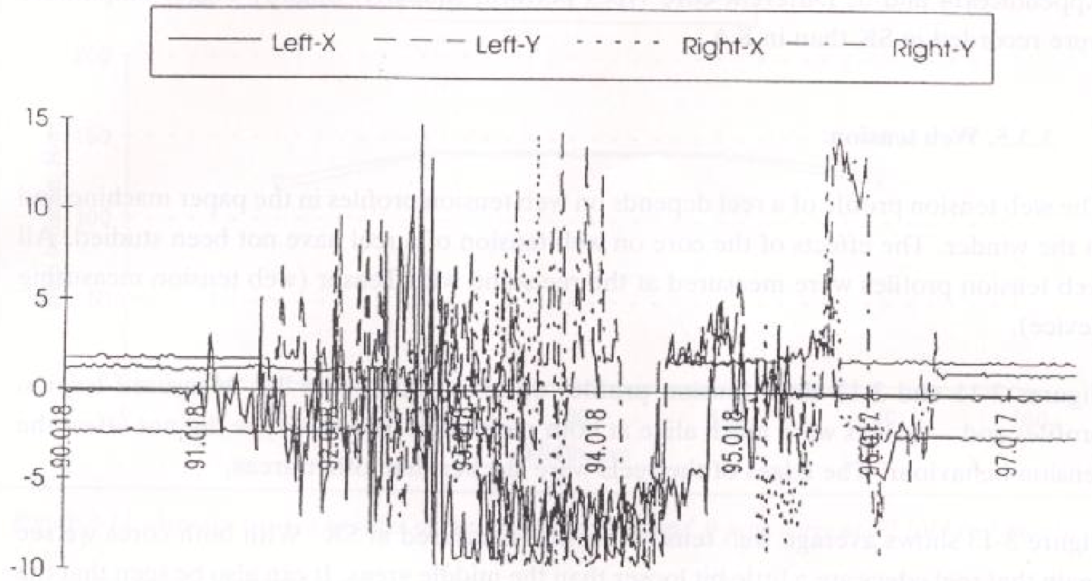


Figure 3-9. Vibration as a function of time (5 seconds) of reel made with B-type core in KA. Emergency stop.

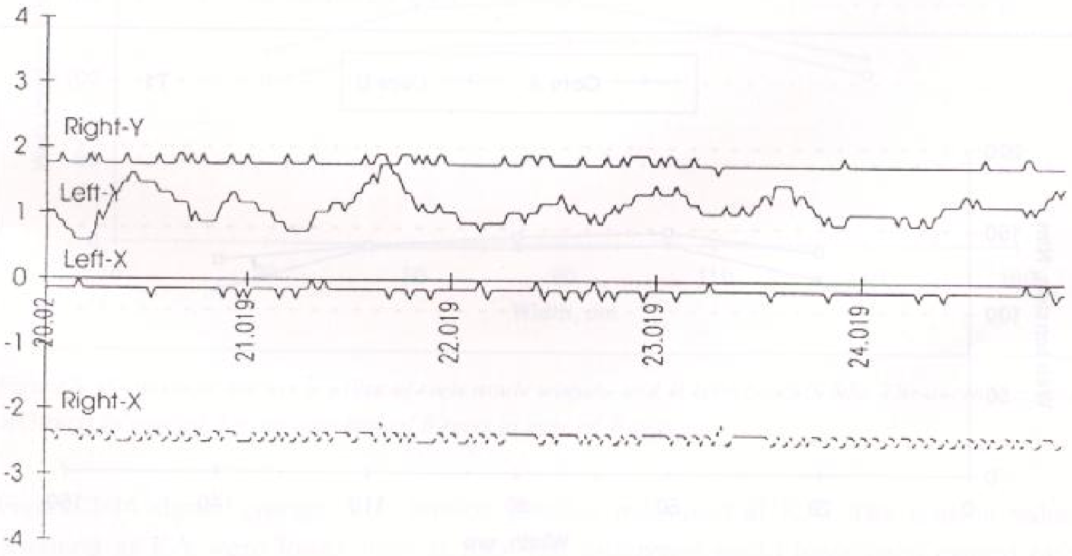


Figure 3-10. Vibration as a function of time (5 seconds) of reel made with C-type core in KA. Middle of the reel.

An emergency stop always leads to a vibration so big that differences could not be recorded with the instrumentation used. More results of the vibration measurements can be seen in Appendices 4 and 5. Different core types perform similarly. Slightly bigger amplitudes were recorded in SK than in KA.

3.3.5. Web tension

The web tension profile of a reel depends on web tension profiles in the paper machine and in the winder. The effects of the core on web tension of a reel have not been studied. All web tension profiles were measured at the reelstand with Tensor (web tension measuring device).

Figures 3-11 and 3-12 show tension profiles observed at T1 and T2. Measured tension profiles and — values were much alike at both reelstands. The core type did not affect the tension behaviour. The edges of the reels were slacker than other areas.

Figure 3-13 shows average web tension profiles measured at SK. With both cores we see again that reel edges are a little bit looser than the middle areas. It can also be seen that the tension level measured from reels on A-type cores is higher than in the case of B-type cores. Since the tension profile was not measured at the winder it is not clear whether the variation is caused by the core type. It must also be borne in mind that we had three measurements with A-type reels against 6 measurements with B-type reels.

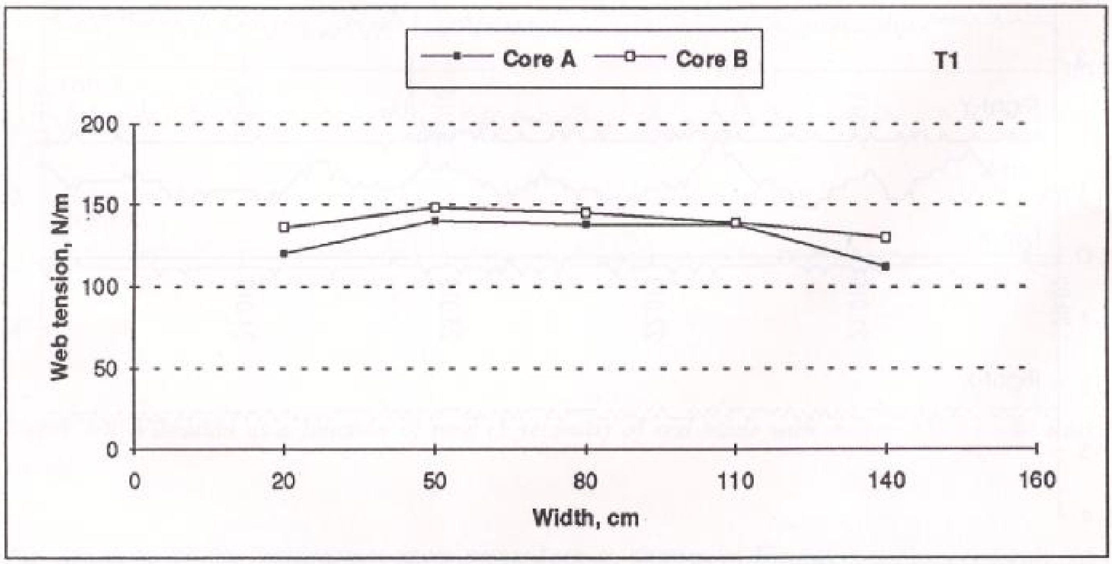


Figure 3-11. Average tension profiles of reels made with A- and B-type cores at T1 (new reel stand).

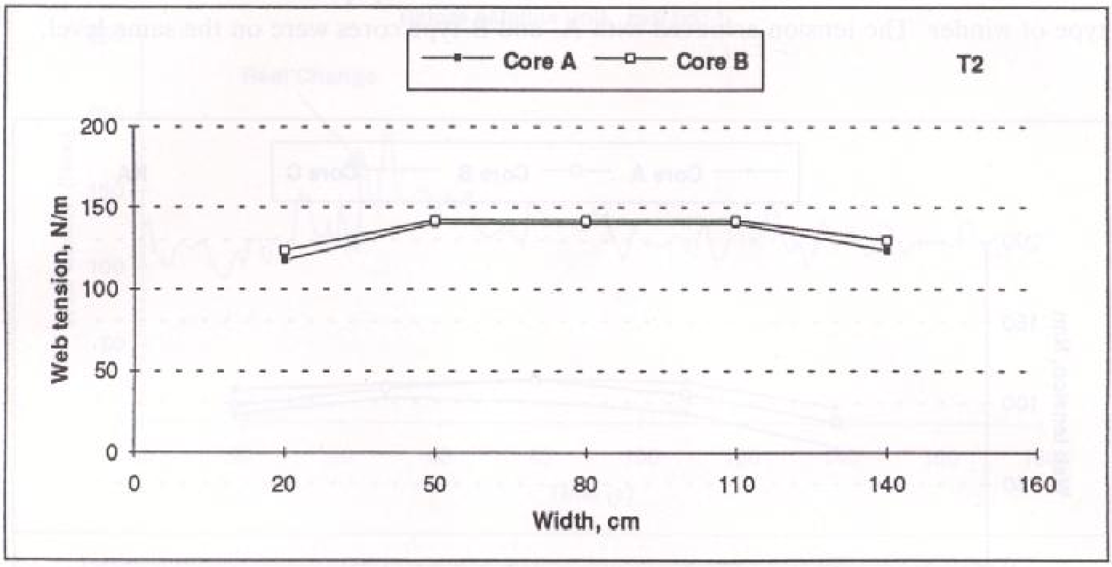


Figure 3-12. Average tension profiles of reels made with A- and B-type cores at T2 (old reel stand).

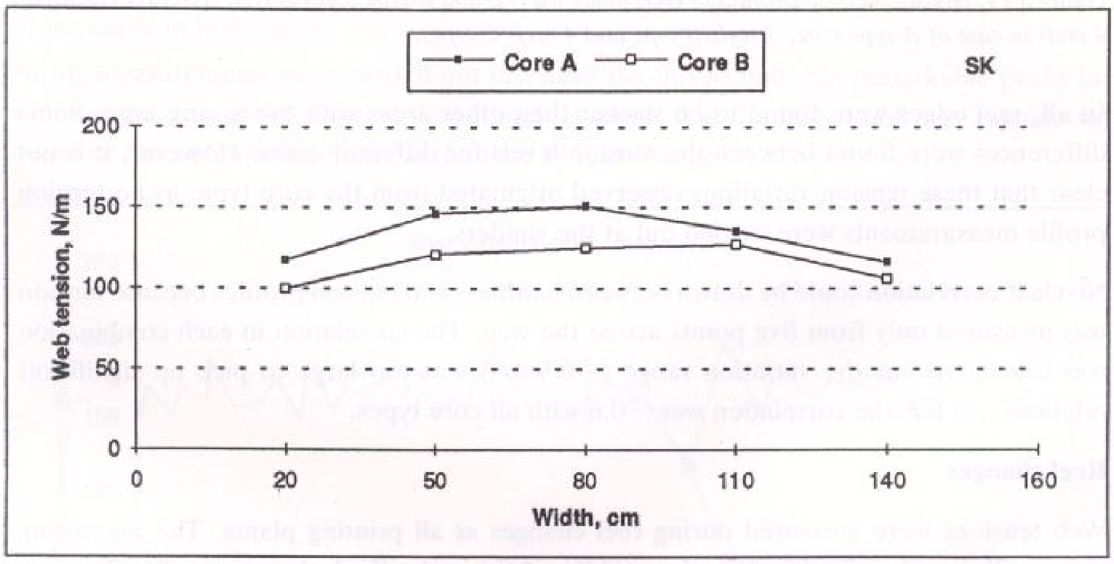


Figure 3-13. Average tension profiles of reels made with A- and B-type cores in SK. The average consist of 3 reels in case of A-type core and of 6 reels in case of B-type core.

Figure 3-14 shows average web tension profiles measured at KA. The tension values obtained at KA were lower than at SK. The difference could have been caused by a different infeed adjustment. It can be seen that mainly the left edge of the reel is slacker than other areas of the reel in all cases. C-type cores gave the lowest tension level. We must bear in mind that reels with C-core were made in a different paper mill and with a different type of winder. The tension achieved with A- and B-type cores were on the same level.

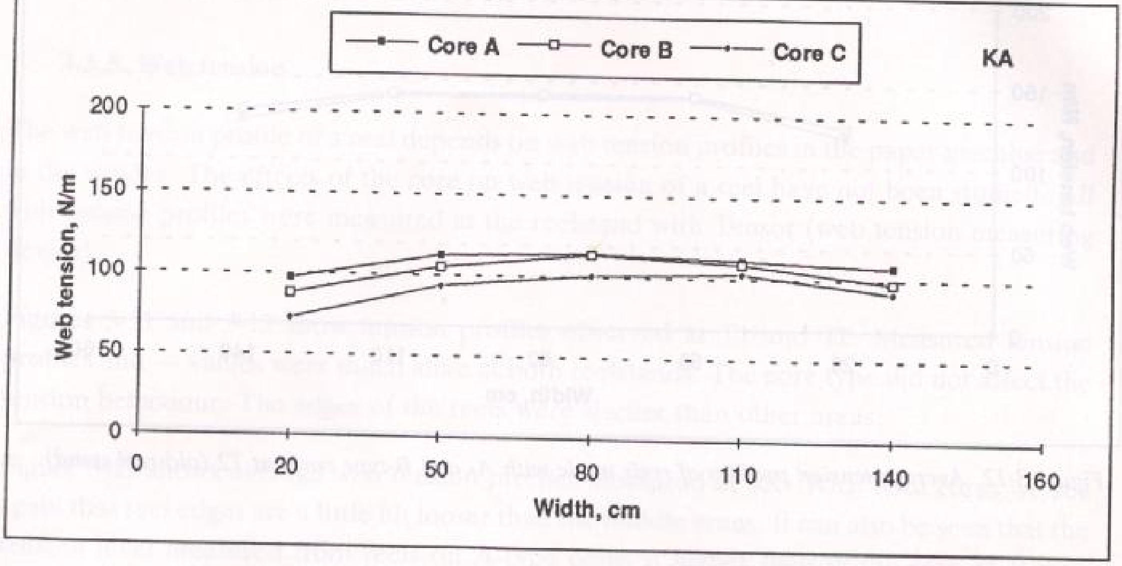


Figure 3-14. Average tension profiles of reels made with A- and B-type cores at KA. (Average consist of 4 reels in case of A-type core, 3 reels/B-type and 4 reels/C-type).

In all, reel edges were found to be slacker than other areas with every core type. Some differences were found between the tension levels for different cores. However, it is not clear that these tension variations observed originated from the core type, as no tension profile measurements were carried out at the winders.

No clear correlation could be drawn between hardness and tension profiles because tension was measured only from five points across the web. The correlation in each combination was calculated but the variation range (−0.9-0.8) was too large to pick up significant relations. At KA the correlation was −0.6 with all core types.

Reel changes

Web tensions were measured during reel changes at all printing plants. The measuring sensor (Tenscan) was placed in the middle of the web. Reel changes at T1 were not measured as there was no free space for the sensor.

Reel changes at T2 were measured before and after the first printing unit. This old reel stand had no infeed unit. Figure 3-15 shows web tension as a function of time during a reel change. The web tension strongly rises just after the reel change. Later the fluctuation of web tension clearly relaxes. This kind of variation in web tension has been reported also in other studies.

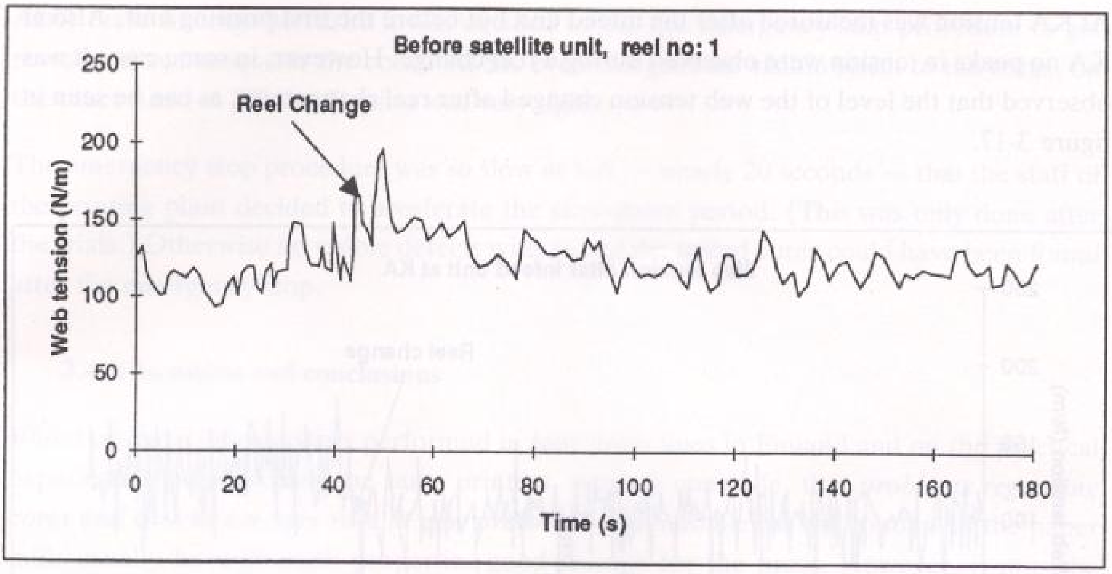


Figure 3-15. An example of web tension as a function of time during reel change at T2. Measurement after reel stand before the first printing unit.

The same kind of disturbances in web tension were also observed after the first printing unit, as can be seen in figure 3-16. The different core types had no clear effect on the shape of the curve in both cases.

At SK measurements were carried out just after the infeed unit. No remarkable peaks in web tension during reel change were found. It seems that the infeed unit was capable to even out the web tension peaks at the time of reel change.

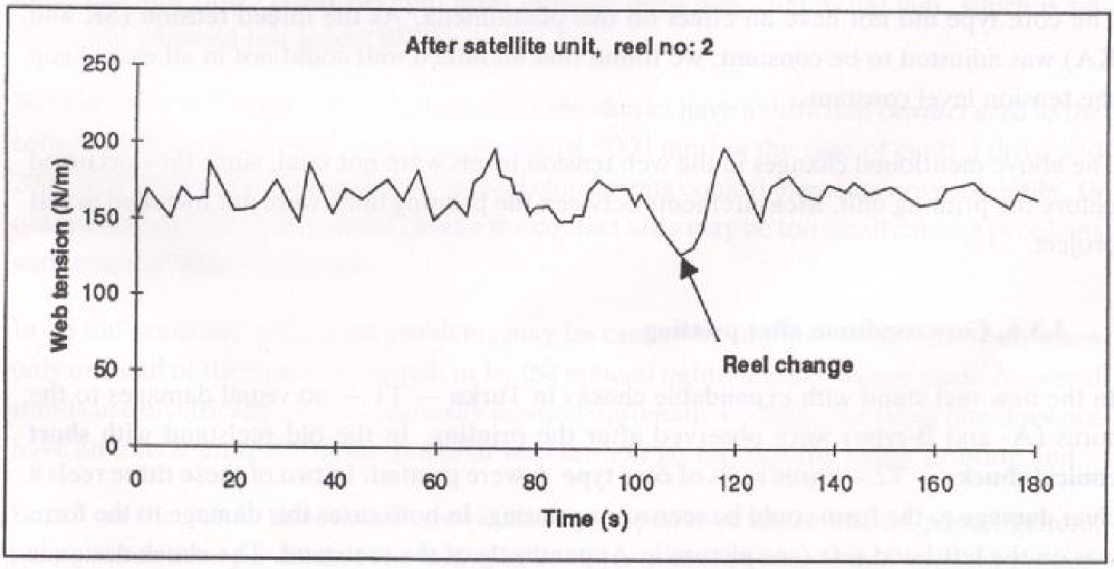


Figure 3-16. An example of web tension as a function of time during reel change at T2. Measurement performed after the first printing unit.

At KA tension was measured after the infeed unit but before the first printing unit. Also at KA no peaks in tension were observed during a reel change. However, in some cases it was observed that the level of the web tension changed after reel changeover, as can be seen in figure 3-17.

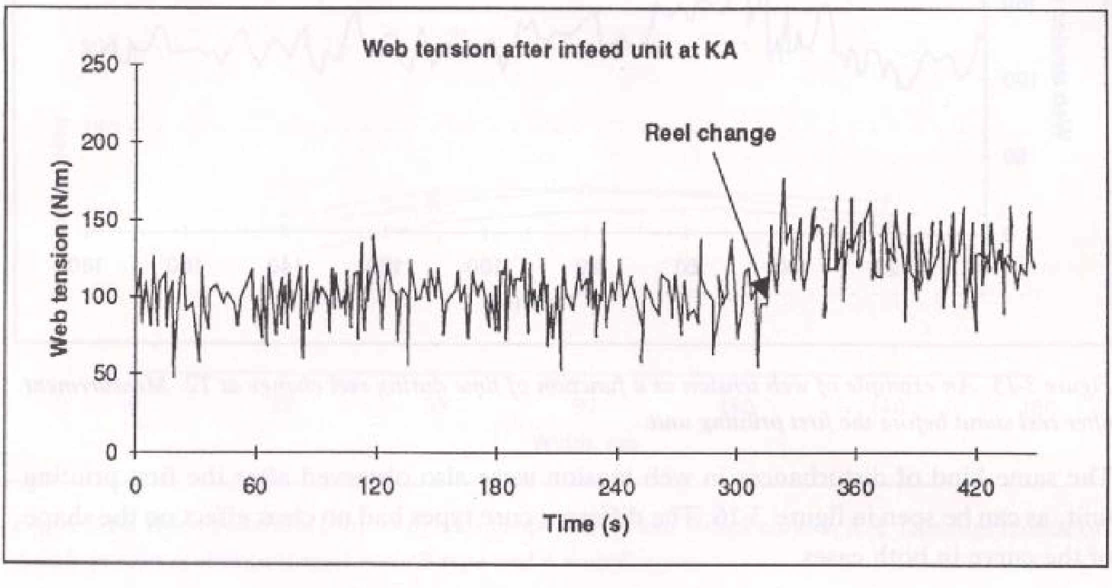


Figure 3-17. An example of a change in web tension level after reel changeover. (Measured at KA, after the infeed unit).

The core type did not have an effect on this phenomena. As the infeed tension (SK and KA) was adjusted to be constant, we found that an infeed unit could not in all cases keep the tension level constant.

The above mentioned changes in the web tension levels were not fatal, since they occurred before the printing unit. Measurements between the printing units were not included in this project.

3.3.6. Core condition after printing

In the new reel stand with expandable chucks in Turku — T1 — no visual damages to the cores (A- and B-type) were observed after the printing. In the old reelstand with **short conical chucks** — T2 — three reels of **core type A** were printed. In two of these three reels a clear **damage** to the form could be seen after printing. In both cases this damage to the form was on the left-hand side (see picture in Appendix 1) of the reelstand. The chuck design is different on both sides of the reelstand since only the left side is tightened to the gear to brake the residual reel during the changeover procedure.

After these findings in Turku it was decided to use the emergency stop procedure to get more load and torque to the cores. At SK even this gave no visible effect to the cores, on the other hand at SK the fixation was very tight.

The emergency stop procedure was so slow at KA — nearly 20 seconds — that the staff of the printing plant decided to accelerate the slow-down period. (This was only done after the trials.) Otherwise no visible defects with any of the tested cores could have been found after the emergency stop.

3.4. Discussion and conclusions

Based on the full scale trials performed in four press lines in Finland and on the practical experience collected from the same printers, we may conclude, that ***problems regarding cores and chucks are very rare in new presses***. Cores suitable for the winders in the paper mills usually have strength properties good enough for the press. However, it must be stated that the members of the working group had experienced problems also recently related to non satisfactory chuck designs. If the chuck is of no good design — no core can be manufactured to fulfill its requirements.

In these full scale trials cores and chucks did not cause any web breaks or other disturbances in the press lines. Only in one newspaper plant web breaks occurred and were then due to malfunction in the automatic system of the reel stand. The only visible damages were found in a core with low crush strength after use in a reelstand with a short conical chuck. Even these damages were not fatal for normal production. However, it should be borne in mind that the "low" crush strength level in these trials was 2700 N/100 mm, which is far above the planned test level (2000).

Nevertheless, it is of utmost importance that the chucks have a sufficient ***contact area*** to the core. For *expanding chucks* this area should be 5000 mm^2 in the case of central drive and 2000 mm^2 otherwise. In the case of conical chucks long conical elements are preferable. In old reelstands with short conical chucks the contact area may be too small causing problems with cores of limited strength.

In an old reelstand additional problems may be caused by uneven tension profiles, when only one end of the reel is tightened, or by the manual tightening procedure itself. New reel stands use electrically or pneumatically assisted automatic loading. If a press line does not have an infeed-unit, the disturbances in web tension go through the entire printing unit.

Based on the results mentioned above and the experience of the expert panel, general ***recommendations for cores*** — including both dimensional, structural and strength properties — have been developed and the figures are presented in Chapter 4.1. These recommendations could easily be reached by at least the participating core manufacturers, and in most cases they will be enough to warrantee a complete marriage between the core and the chuck. They may, therefore, earn as an economic platform for specification.

However, in some cases problems in the core/chuck marriage may occur — e.g. with extremely short conical chucks. For these cases the core manufacturers may offer a wide range of ***special cores*** with properties exceeding the proposed specifications. But a core with better strength properties is usually more expensive. In order to enable the core manufacturer to select the most suitable (and economic) solution for a problematic reel stand, he should have the essential data about the reel stand in question. The data needed is listed in Chapter 4.3.

According to the collected experience of the press manufacturers, there is a ***trend towards expanding chucks and longer conical chucks***. Big geographical differences exist in this respect — e.g. between Europe and U.S.A. Nevertheless, both types of chucks will be used in parallel also in the future.

An additional problem area — not included in this study — is the marriage between the paper and the core and the specification of the reel itself. It is well known that a hard reel can be built up on a hard core. Individual winding of the reels can today be reached with single drum winders and such equipment are used mainly for high quality papers. Newsprint reels are in many mills cut by using a two-drum winder. It is then very important to have stable paper profiles from the paper machine -especially caliper — and no out-of-roundness of the core because with this winder type the winding parameters of a single reel cannot be adjusted.

4. Recommendations for reel core and chuck specifications

Based on the collected information and experience as well as on the results obtained in the full scale trials described above, the Working Group has agreed upon the following practical recommendations, which should serve as a platform for further specifications for reel cores and chucks. More important than any of these recommendations is, anyhow, a good cooperation between the press manufacturer, the paper maker, the core manufacturer and the printer.

4.1. Core properties for a reel up to 1.7 m in width

1. Inner diameter: 76.2 + 0.4 mm; − 0.0 mm.
2. Outer diameter: maximum 107 mm (to enable fixed splicing).
3. Weight: ≤4 kg/m (to avoid heavy waste).
4. Moisture content: 6 … 9 percent.

5. Crush strength (compression strength): >2000 N/100 mm (other strength properties also important, though less common in practice due to lack of standard measuring methods).
6. Elasticity modulus: >2700 N/mm². Not critical at normal web widths (1.6 m), but becomes critical at web widths of 2.5 m.
7. Linearity (warpage): ≤2 mm/m.
8. Out-of-roundness: maximum 0.5 mm.
9. Deformation on core: Acceptable on inner diameter to a certain extent without mayor fibre damage, not on outer diameter. The reel must be demountable and replaceable.
10. Before the reuse of a reel, core damage must be evaluated.
11. Information to be listed inside core: manufacturer, type of core, identification code.

4.2. Chuck properties

Expanding chucks

1. Nominal diameter: preferable 75 mm.
2. Expansion movement: high, preferably 82 … 85 mm in diameter.
3. Contact surface: 5000 mm², central drive; 2000 mm², belt drive.

Conical chucks

1. Contact surface: Long type of chucks recommended.

4.3. Information needed for core selection

In order to enable an optimum choice of core the following data concerning the reel and the reelstand should be given to the core manufacturer. This is of utmost importance in more problematic cases, such as extremely short conical chucks, big reel diameters or widths.

1. Maximum web width (cm)
2. Maximum reel diameter (cm)
3. Maximum reel weight (kg)
4. Paper caliper (μm)
5. Chucking thrust force (kp/cm² or kPa)
6. Maximum press speed (m/s)
7. Maximum deceleration rate (m/s²)

5. References

1. IFRA Newsprint and Newsink Guide. Newsprint Reel Cores. IFRA Darmstadt 1982.
2. IFRA Questionnaire Report. Newsprint Reel Characteristics. IFRA Darmstadt 1991. 14 p.

3. Juhola, H., Komppa, A., Koskinen, T., Lindqvist, U. and Linna, H., Newsprint and Newspaper Printing. A Handbook for Branch People. Finnish Newspaper Association, Uusimaa, Porvoo, 1991 136 p. (in Finnish).

4. König, M. & Müller, D., Hartpapierhülsen in Papierrollen im Tiefdruck. Bundesverband Druck E.V., Abt. Technik + Forschung. Wiesbaden 1988. 8 p.

5. ISO/CD 11 093-1 … 093-9: Testing of paper and board cores. Draft.

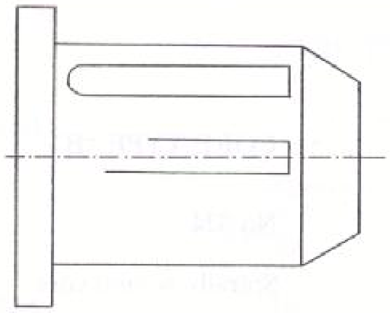
6. Lindquist, Å., Core chucks — an always topical theme. SCA Ortviken. 7 p.

7. IFRA Rotary Press Guide. Choosing the Correct Reel Chucks. IFRA Darmstadt.

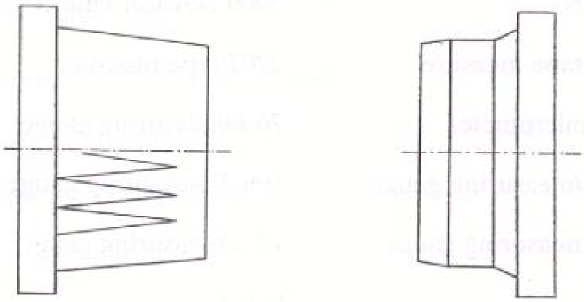
6. Appendices

1. Chucks in the tested presses.
2. Technical specifications of the tested cores.
3. Average hardness profiles with variation range.
4. The effect of reel diameter on vibrations.
5. The effect of core type on vibrations.

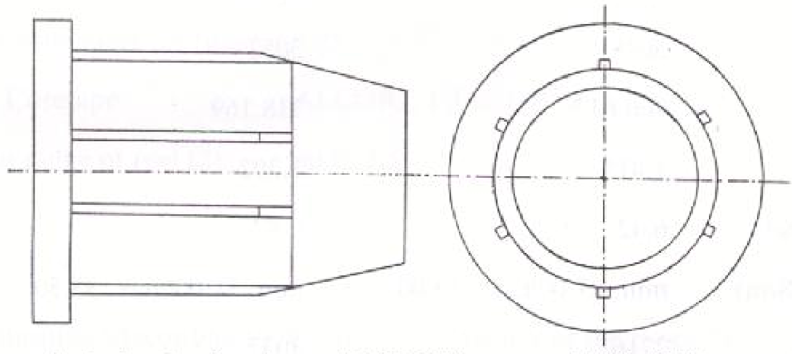
Appendix 1. Chucks in the tested presses



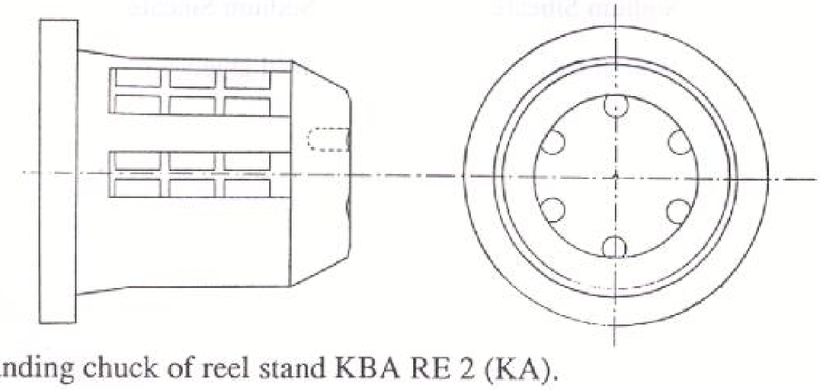
Expanding chuck of reel stand Goss CT-45 (T1).



Short conical chuck of Goss old type reel stand (T2).



Long conical chuck of reel stand MAN Flypaster 1150 (SK).



Expanding chuck of reel stand KBA RE 2 (KA).

Appendix 2. Technical specifications of the tested cores

Test reports from Paul & Co.

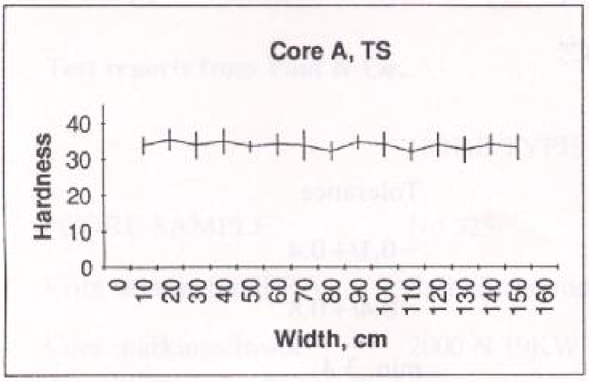
	CORE TYPE "A"	CORE TYPE "B"
"CORE SAMPLE"	No 325	No 324
Core sample for IFRA	Spirally wound core	Spirally wound core
Core markings/Inside	2000 N 19KW P	3000 Newton
Core markings/Outside	2000 N	3000 Newton Paul & Co.
Length of the sample (mm)	2005/tape measure	2207/tape measure
Inner diameter (mm)	76.7 micrometer	76.6/measuring gauge
Outer diameter (mm)	106.4/measuring gauge	106.2/measuring gauge
Wall thickness (mm)	15.1/measuring gauge	14.9/measuring gauge
Torus (dm^3)	0.427	0.424
Volume (dm^3/m)	4.271	4.249
Weight (g/m)	3018	3052
Density (g/m^3)	706.617	718.169
Bulk factor (cm^3/g)	1.415	1.392
Moisture content (%)	6.42	6.87
Crush resistance (kN/m)	min. 27.00/max. 30.00	min. 31.00/max. 33.50
E-Module (N/mm^2)	2716	3037
Pasting agent	Sodium Silicate	Sodium Silicate
Glueing	Well glued	Well glued

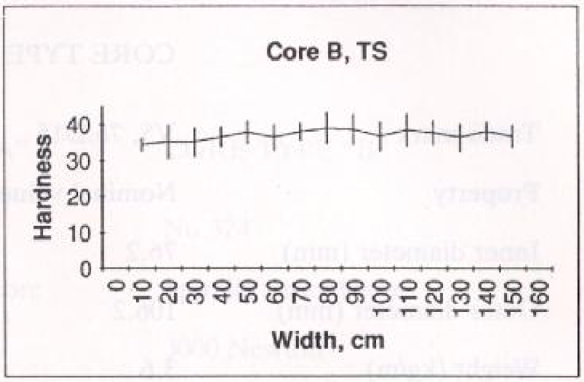
Technical specification of ALCORE V5

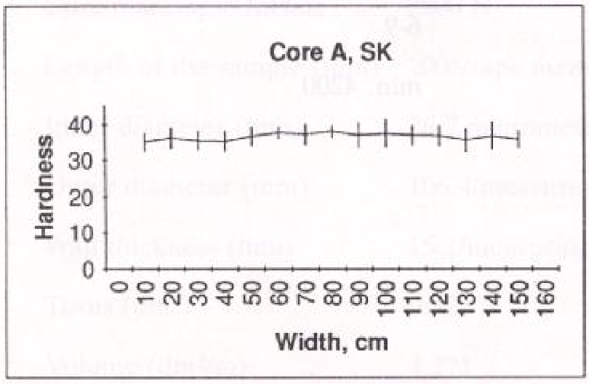
	CORE TYPE "C"	
Trade mark	V5, 76.2/15	
Property	Nominal value	Tolerance
Inner diameter (mm)	76.2	−0.1/+0.4
Outer diameter (mm)	106.2	−0.4/+0.8
Weight (kg/m)	3.6	min. 3.4
Moisture content (%)	6-9	6-9
Crush strength (N/100 mm)	5000	min. 4200
Other strength definition		
Chuck test (2) (N/100 mm)	10,000	
Elasticity modulus (1) (N/mm^2)	3100	
Bending (2) (mm/m)	2.0	
Out of roundness (2) (mm)	0.25	
Print, Coretape	ALCORE *V5* 170991 SF	
Weight range of reel (2) 1000 kg	up to 2.5	
Width of reel (2) (m)	up to 2.45	

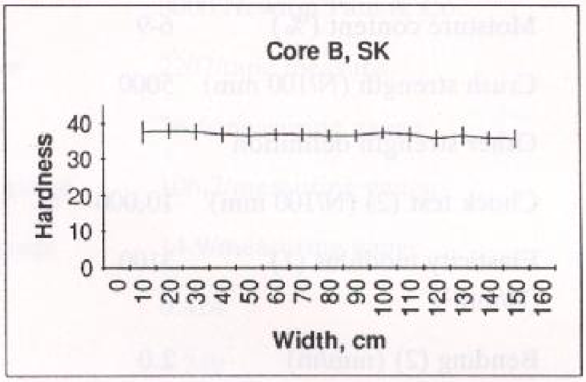
(1) Indicative./According to the specific frequency of the property.
(2) Indicative./Not calibrated./Not in the test of each make.

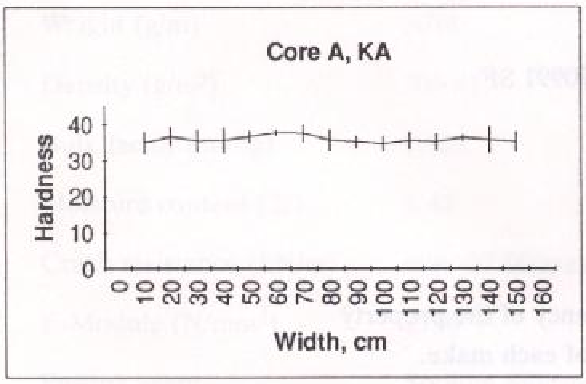
Appendix 3. Average hardness profiles with variation range

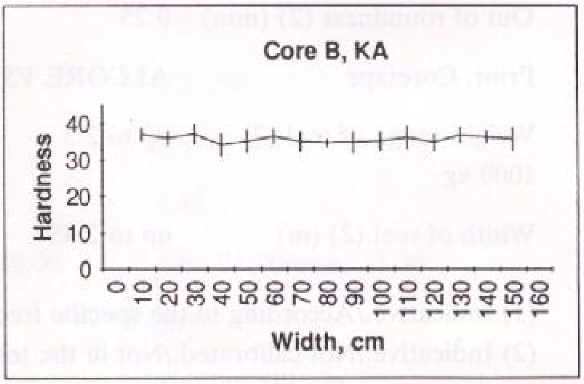


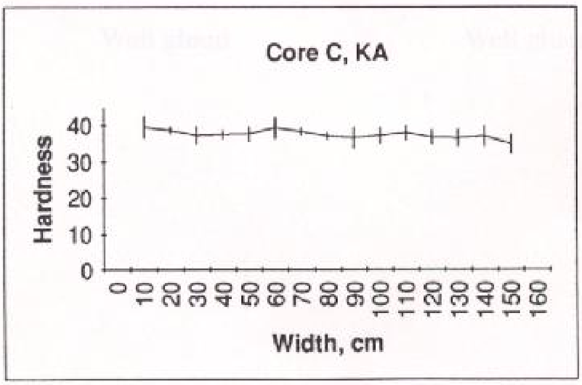




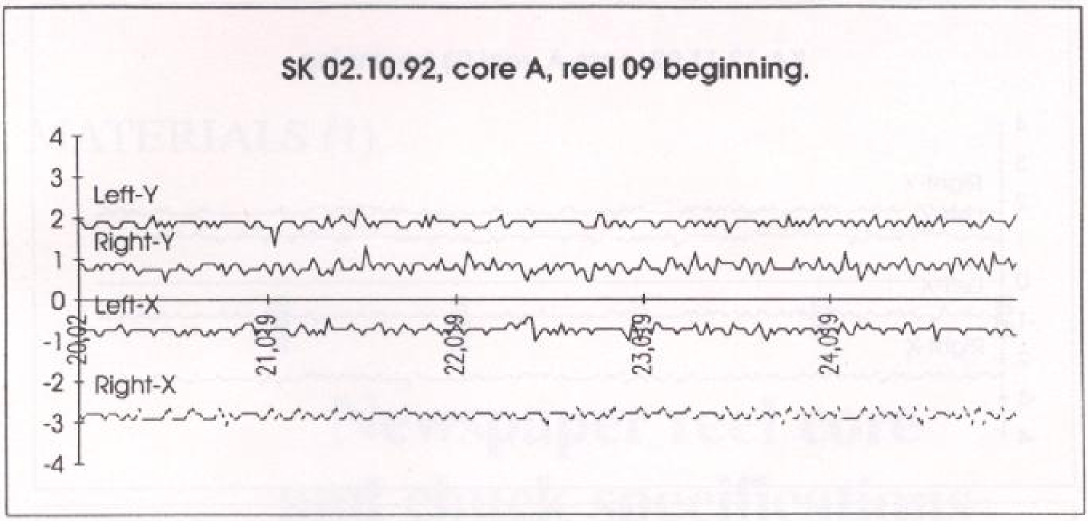


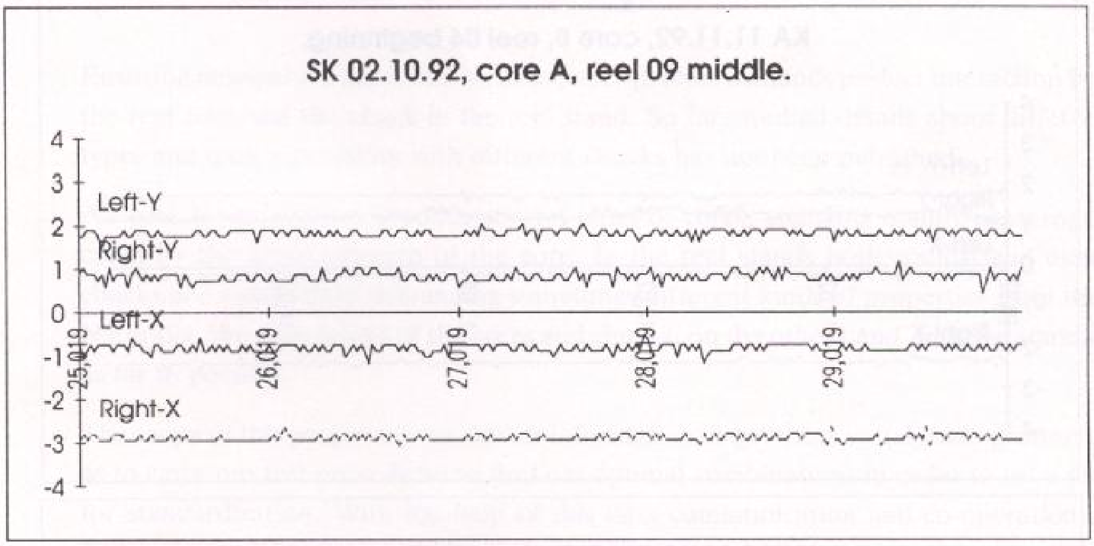


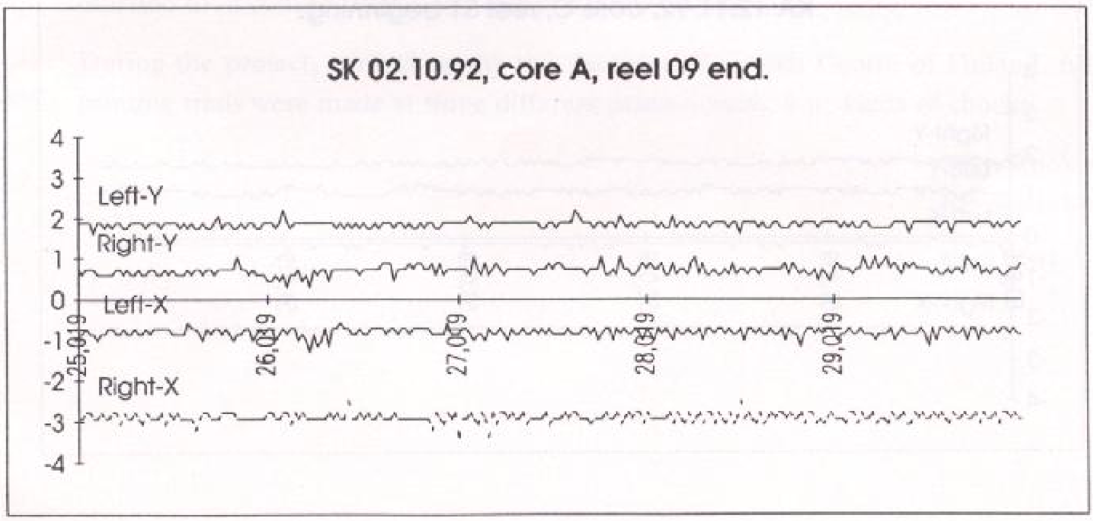




Appendix 4. The effect of reel diameter on vibrations

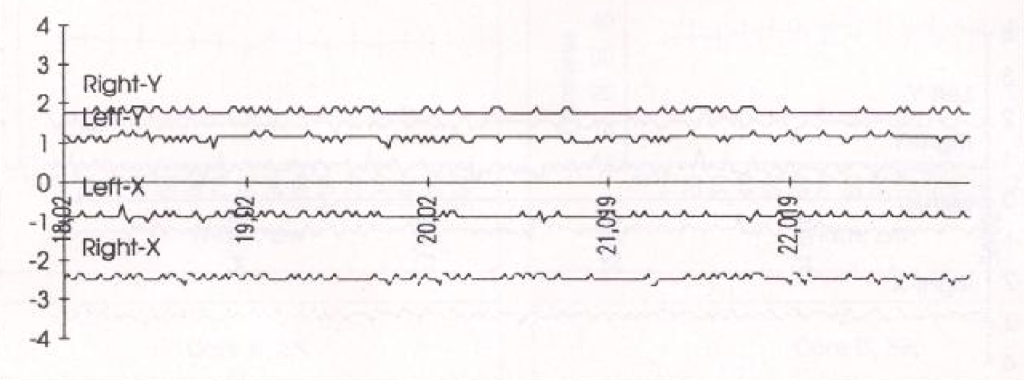




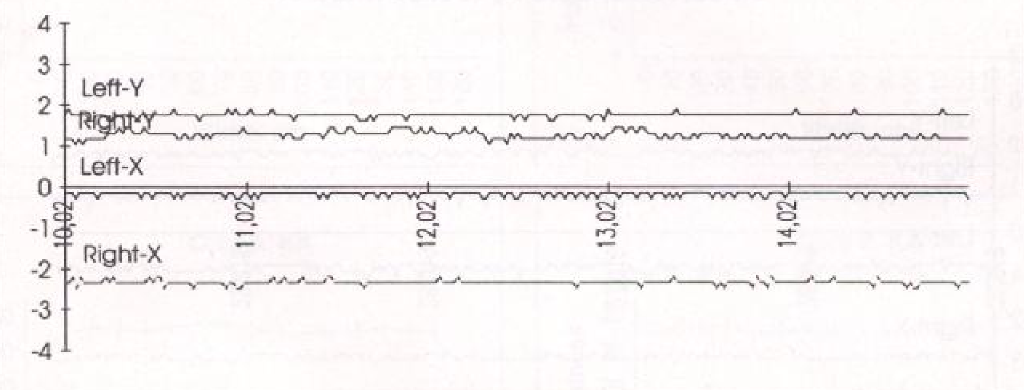


Appendix 5. The effect of core type on vibrations

KA 12.11.92, core A, reel 08 beginning.



KA 11.11.92, core B, reel 04 beginning.



KA 12.11.92, core C, reel 51 beginning.