林齢に沿った林分構造と冠雪害の関係

誌名	日本林學會誌 = Journal of the Japanese Forestry Society
ISSN	0021485X
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巻/号	69巻3号
掲載ページ	p. 94-104
発行年月	1987年3月

論　文

Stand Structure and Snow Damage in Relation to Stand Age ——Sugi Plantations in Fukui Prefecture in the 1981 Heavy-Snowfall——

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FUJIMORI, Takao, MATSUDA, Masahiro, and KIYONO, Yoshiyuki: **Stand structure and snow damage in relation to stand age—Sugi plantations in Fukui Prefecture in the 1981 heavy-snowfall J. Jpn. For. Soc. 69:94〜104, 1987** The snow damage of sugi plantations which suffered from an unusual heavy wet snowfall in Fukui Prefecture at the end of December, 1980 was analyzed focussing on the relationship between damage and stand structure in relation to stand age. The diameters at broken points of stems (D_{BP}) were almost all in the range of 7〜20 cm in all stands. Therefore, there was a tendency for the heights at broken points (H_{BP}) to increase proportionally as tree height (H) increased, but the heights at crown bottoms (H_{CB}) did not vary much with the variation of H. Thus, as H increased, H_{BP} was placed at a greater distance upward from H_{CB}, and as H decreased, H_{BP} was placed at a greater distance downward from H_{CB}. This implies that a long lotation is desirable to reduce such damage from the viewpoint of forest management. The proportion of bending was small even in small-sized trees, and the proportion of breakage was extremely large. The proportion of damage in dominants was small, but that in suppressed trees was large as it was in intermediates. Extraordinary large D_{BP}s were found. These characteristics can be said as an index of snow damage of sugi under the severest of meteorological conditions.

藤森隆郎・松田正宏・清野嘉之: **林齢に沿った林分構造と冠雪害の関係—56豪雪福井スギ人工林 日林誌 69: 94〜104, 1987** 1980年12月末に北陸地方を襲った豪雪によるスギ人工林の冠雪被害地で林齢に沿った林分構造の違いと被害形態との関係を調べた。すべての林齢を通して幹の折損部直径はほぼ7〜20 cmの範囲内にあった。したがって折損高は樹高に比例して高くなる傾向を示した。それに対して枝下高は樹高に対応した変化が少なく，折損高は枝下高に対して樹高が大きいほど高い位置に，樹高が小さいほど低い位置にみられた。これによって折損位置の基本的決定要因は幹の太さであり，枝下高との位置関係でないことが明らかになった。径級の小さな個体でも曲がりの被害率は小さく，折損の被害率が圧倒的に高かった。上層木の被害率は小さく，中，下層木の被害率が高かった。小径木の折損被害率の高いこと，下層木の被害率の高いことは気象条件の厳しさを示す尺度といえそうである。折損部位から被害木の回復や利用歩留りを判断すれば長伐期が有利といえる。また豪雪の降りやすい所での間伐は下層間伐が望ましい。

I. Introduction

Snow damage generally is classified into two types. One is the damage of seedlings and saplings by deeply piled snow. The other is the damage of more mature trees by the snow loads on the crowns. The snow damage analyzed in this study is of the latter type.

Snow damage of coniferous plantations has been increasing in Japan, especially in the last decade. One of the causes seems to be that the meteorological conditions conducive to snow damage often occurred accidentally, and another seems to be the increase of young coniferous plantations susceptible

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to snow damage. To decrease snow damage in coniferous plantations, it is important to analyze the actual conditions of the damaged forests and to clarify the mechanisms of damage.

The type and severity of snow damage are dominated by the severity of meteorological conditions, site conditions, and stand structure, and as site conditions have close relationships both to meteorological conditions and to stand structures, analyzing all of the causative factors of damage at a same time is not easy. In this study, the analysis was focussed on the relationship between the difference of stand structure in relation to stand age and the characteristics of damage under the severest meteorological conditions conducive to snow damage.

Under the severest of meteorological conditions, snow damage extends to various types of forests from young to old. Analyzing the characteristics of snow damage through various stand structures in relation to stand age, we consider as an effective approach to clarifying the mechanisms of snow damage. However, studies which analyze the mechanisms of damage by means of this method have not been made to date. Therefore, we analyzed the sugi (*Cryptomeria japonica*, (LINN. FIL.), D. DON.) plantations of various ages in Fukui Prefecture which suffered damage from the extraordinary heavy wet snowfall with comparatively strong winds at the end of December, 1980.

In this study, the diameters and heights at broken points on the stems mainly were analyzed, and we obtained the data necessary to clarify the mechanisms of damage and to discuss silvicultural treatments. Thus, we will point out the characteristics of snow damage suffered under severe meteorological conditions and will discuss an index of the severity of meteorological conditions in relation to snow damage. Also, we will discuss some methodologies in the measurement of snow damage in connection with the topics stated above.

II. Damaged Area and Meteorological Conditions

The area damaged by the heavy snowfall under a winter-type distribution of atmospheric pressures at the end of December, 1980 extended from the Japan Sea side of the Tohoku Region to the Sanin Region, and the most severely damaged area was in Fukui, Ishikawa, and Gifu Prefectures. The area we studied was the low-lying land (below 300 m above sea level) of the Echizen Mountain area, the most severely damaged area near Fukui City. The mean deepest snow in Fukui City from 1887 to 1970 was 72 cm with a maximum of 213 cm and a minimum of 14 cm (Fukui Meteorological Observatory, 1976).

After a low pressure system passed on December 26, the winter-type atmospheric pressure became strong and heavy snow fell from 27 to 29 December. Especially on the 28 th and 29 th, the meteorological conditions produced the so-called low-land heavy-snow type, and a heavy, wet, and sticky snowfall resulted. At most times air temperatures were close to freezing. The amount of snowfall at Miyama-Cho near Fukui City was 54, 80, and 65 cm on the 27 th, 28 th, and 29 th, respectively, a total of 199 cm in the three days. Mean wind-speed per the day at Fukui City on the 27 th was 4.8m/sec and the greatest wind speed per minutes was 18.0 m/sec, and on the following day both were almost the same. Mean-wind speed per day and the greatest wind speed per minutes on the 29 th were two-thirds of those on the previous two days (Fukui Prefecture, 1982). According to witnesses, the damage increased from the 27 th and became serious on the 28 th and 29 th. It has been acknowledged that winds prevent snow from sticking to crowns when snow is dry, but when snow is wet, the winds increase snow damage (NITTA, 1983). The damage at this time seems to have been promoted by the winds.

Because this heavy snowfall continued from the end of December, 1980 to the end of January, 1981, it has been called the 1981 heavy-snowfall. Most of the heavy snow damage occurred at the end of December, 1980 in Fukui area, but in this paper we still refer to it as the 1981 heavy-snowfall, as it usually is called, and its associated severe snow-damage.

III. Methods

Six sample stands were chosen from damaged sugi plantations in the area to represent various stand ages. The stands ranged in altitude from 50 to 180 m in the Echizen Mountain area of Fukui Prefecture (Table 1). Hereafter, the studied area is called the Fukui area in this paper. Young fallen stands which were expected to recover by themselves or with artificial supplements were excluded from the sample stands. The proportion of damaged trees of all trees in each sample stand was in the range of 50-84 percent.

In the Fukui area several local cultivars of sugi exist, and the stands composed of the most popular local cultivar, Ajimano, were chosen as the sample stands (the local cultivar of one stand was uncertain although it was possibly Ajimano). The yield indexes which imply the relative stand densities (ANDO, 1968) of sample stands were from 0.62

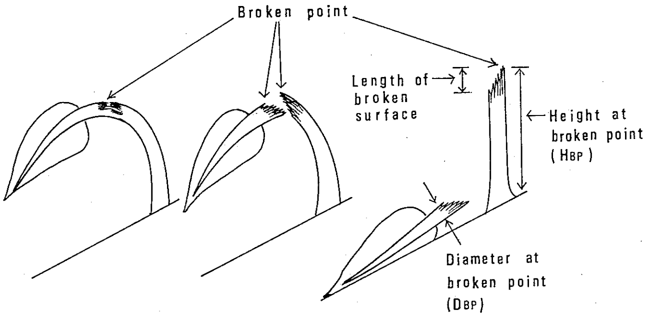

Fig. 1. Points of measurement of broken points of stems

Table 1. General features of the studied stands

Plot number	Plot area (m²)	Stand age	Local cultivars	Stand density (No. /ha)	Ry	Mean DBH (cm)	Mean H (m)	Mean H_{CB} (m)	Proportion of damaged trees (%)
1	126	13	Ajimano	2, 381	0. 75	11. 6	11. 3	5. 0	50
2	225 (900)	19	Unkown	1, 689	0. 80	18. 1	16. 0	8. 5	84
3	225	25	Ajimano	1, 333	0. 66	15. 3	13. 4	3. 5	53
4	225	28	Ajimano	977	0. 67	21. 9	17. 0	9. 7	82
5	400	45	Ajimano	625	0. 66	29. 3	20. 4	9. 9	64
6	900 (2, 500)	80	Ajimano	433	0. 62	37. 6	25. 6	13. 3	79

Ry stands for the yield index which means the ratio of stem volume of a stand to that of a stand of full density for each mean tree height of stands (ANDO, 1968).
H_{CB} stands for the height at the crown bottom. The figure in the parentheses indicates the area of the survey for the damage type.

Table 2. Symbols of the terms used in this paper

Diameter at breast height	DBH
Diameter at broken height	D_{BP}
Tree height	H
Height at broken point	H_{BP}
Height at crown bottom	H_{CB}
Height at definite diameter	$H_D(x)$

to 0. 80. Although the yield indexes of the sample stands were not uniform, neither extremely dense stands nor sparse ones were involved. The silvicultural systems for these stands seemed to be similar. Namely, the number of planted trees per ha is 2, 000~3, 000, light but relatively frequent thinnings are made, and light prunings are practiced two or three times. There were no distinctive relationships between slightly different silvicultural treatments and snow damage in the Fukui area (Fukui Prefecture, 1982). Therefore, this study was made on the assumption that any differences of silvicultural systems of the sample stands were negligible in relation to snow damage.

In our observations, the relationship between differences of slope and exposure of the stands in the area and the severity of damage was not clear, and the same was reported earlier (Fukui Prefecture, 1982). Therefore, the uniformity of the slopes and exposures of the stands was not considered when the sample stands were chosen.

On that part of each stand where the damage was considered as the standard for that stand, square sample plot was marked with the length of each side taken to be nearly equal to the average tree height of dominant trees in the stand. Diameter at breast height (DBH), tree height (H), and the height at the crown bottom (H_{CB}) of all trees were measured on each sample plot. Damage was classified into three types, that is, bending, breakage including top breakage, and uprooting. Bending of a stem is defined as that occurring from the lower half of H, upward. If splitting occurred in addition to bending, it was regarded as breakage. For broken trees, the diameter (D_{BP}) and the height (H_{BP}) at the broken point were measured. The symbols designating the terms used in this paper are shown in Table 2.

The measuring point of D_{BP} and H_{BP} is defined as being just above the top point of the broken surface because the top point of the broken surface of a stem is considered to be the original point of the breakage of the stem as shown in Figure 1. With the snow load on the crown, the stem bends toward the downhill side, and the original point of the breaking of the stem is found on the upper side of the bent stem. Then splitting occurs from

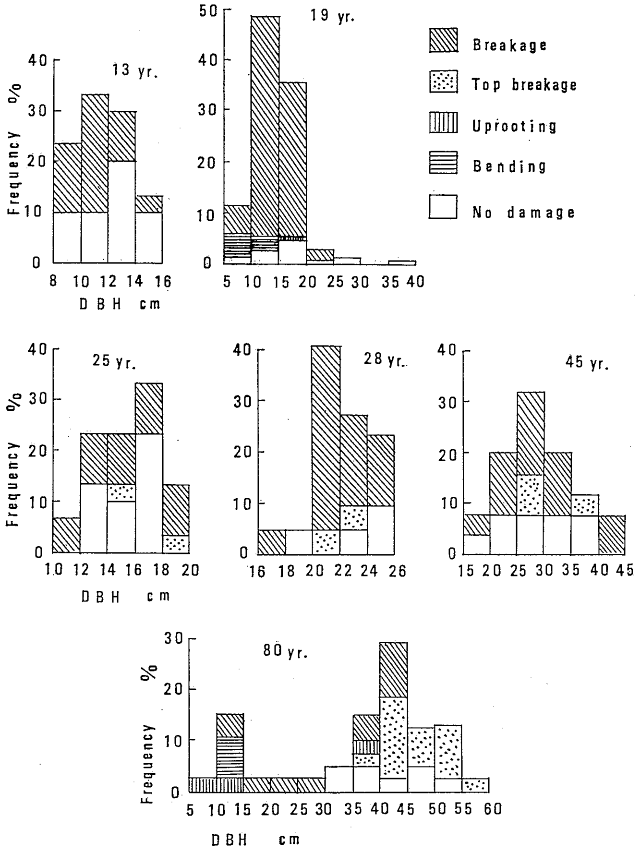

Fig. 2. Frequency distribution of the types of damage of trees in each stand

the original point toward both the top and bottom of the stem. Finally, the stem is severed from the original point downward (Fig. 1). This was proved when a small sugi (5 cm *DBH*) was bent by hand toward the downhill side, and the stem broke in the manner shown in Figure 1. The occurrence shown in Figure 1 also can be explained by the fact that the direction of bending of most bent trees is downhill and the fact that most of the broken surfaces of the stems face downhill.

IV. Results

1. *Damage type*

The relationship between *DBH* and damage type is shown in Figure 2. Bending and uprooting were found only in 19- and 80-year-old stands, but the damage type in all other stands was only breakage. According to the reports on sugi stands, bending is found mainly in trees whose *DBH*s are less than 15 cm, and the proportion of bending becomes greater than that of breakage in trees whose *DBH* are less than ten centimeters (ISHII *et al.*, 1980, 1981; Silviculture Division, Hiroshima Prefectural Forest Experiment Station, 1979; SUGIYAMA and SAEKI, 1963). YAMAYA (1972) reported that bending was common in the stands whose *DBH*s were small. However, in this study, although 13- and 25-year-old stands had many trees whose *DBH*s were less than 15 cm, the damage type of these stands was only breakage.

Bending was found in the trees whose *DBH*s were less than 15 cm in 19- and 80-year-old stands. These stands had relatively large ranges of *DBH*s and the stratification of crowns was relatively advanced. SUGIYAMA and SAEKI (1963) and ISHIKAWA and KATAOKA (1968) pointed out that bending was found in the suppressed trees of sugi stands where stratification was advanced. Judging from these reports, suppressed trees in stratified stands seem to be susceptible to bending.

Uprooting was found in the intermediate class of the 19-year-old stand and in the suppressed and intermediate classes of the 80-year-old stand. However the proportion of total damage charged to uprooting in each stand was very small.

Trees whose broken points were in the upper

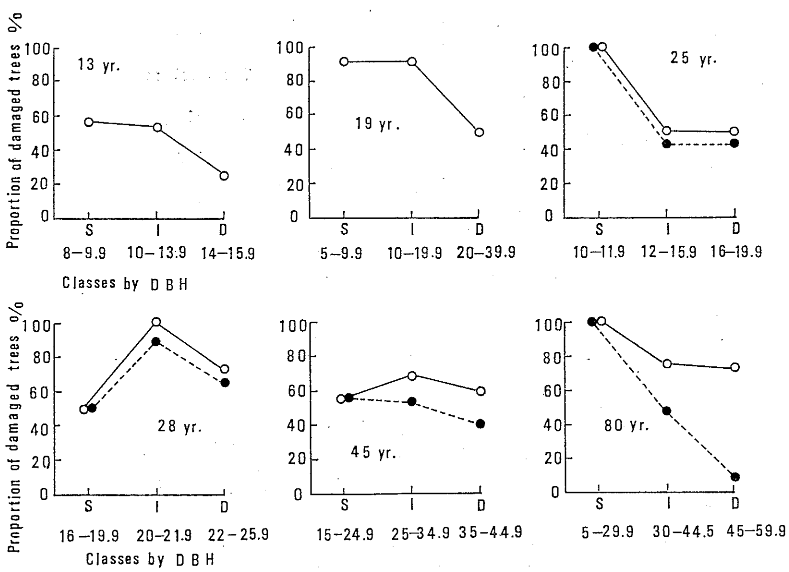

Fig. 3. Relationship between the proportion of damaged trees and the classes by *DBH* in each stand

S, I, and D denote suppressed, intermediate, and dominant, respectively. Values on x co-ordinate denote the ranges of *DBH*s. White dots denote all damaged trees and black dots denote damaged trees excluding those with top breakage.

part of crowns were found often. In sugi if 50 percent of the length of the crown is removed, it is not fatal for the growth of the tree (FUTAMI and KAJITANI, 1981; OOHARA *et al.*, 1983) and even if the damaged tree is felled, the loss to forest management is relatively small, because the yield ratio is relatively large. In this sense, the breakage in the upper 50 percent of the crown is distinguished from the breakage of the lower part and this type of breakage is called top breakage in this paper. There are several reports in which top breakage in the upper crown is discussed, but no reports have indicated a basis of distinction between top breakage in the upper crown and breakage in the lower part of it.

ISHII and others (1980) pointed out that the breakage in the upper crown seemed to be different from the breakage in the lower part of it from the viewpoint of the mechanisms of the outbreak of damage. It would be a future subject to clarify the mechanisms of the outbreak of the breakage in the upper crown.

As shown in Figure 2, top breakage was found in stands whose age was at least 25 years, and the proportion of it was especially large in the 80-year-old stand. There was a tendency that as stand age increased top breakage increased. Also there was a tendency for top breakage to be found mainly in the larger trees of each stand. ISHII and others (1980) and INOUE and KAKIHARA (1958) reported that top breakage was found mostly in dominant trees. One of the causes of these tendencies is discussed later in association with Figures 7 and 8.

The relationship between the proportion of damaged trees and the tree size-classes in each stand was analyzed. As the classes of *DBH* in Figure 2 were too finely designated to see this relationship, the classes were rearranged into three, judging from the shape of the frequency distributions in Figure 2. The relationship between the classes thus formed and the proportions of damaged trees is shown in Figure 3. Although all of the patterns were not the same, there was a tendency for the proportion of damaged trees to be small in the dominants and large in the intermediates and the suppressed.

According to data reported to date, in even-aged sugi stands, the proportion of damaged tree is small in the dominant and suppressed classes, and it is large in the intermediates (ISHII *et al.*, 1980; SUGIYAMA and SAEKI, 1963). The reason for the proportion of damaged trees being small in the suppressed class seems to be because of the shelter of the dominants and the intermediates (CREMER *et al.*, 1983). On the other hand, in the 1981 severe snow-damage of sugi plantations in Toyama Prefecture, the proportion of damaged tree apparently was small in the dominants but large in the suppressed as well as in the intermediates

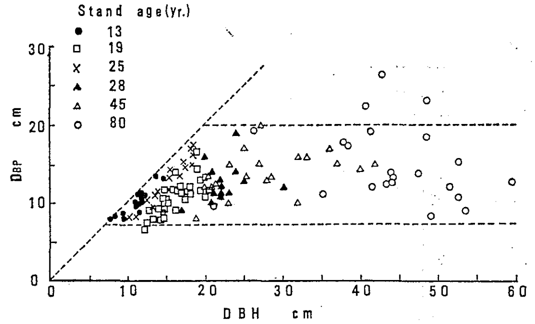

Fig. 4. Relationship between the diameter at the broken point (D_{BP}) and DBH

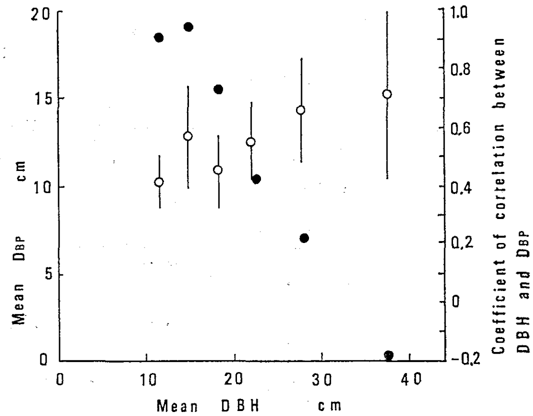

Fig. 5. Relationships between mean diameter at the broken point (D_{BP}) and mean DBH and between the coefficient of correlation between D_{BP} and DBH and the mean DBH in each stand

White dots, black dots, and vertical lines denote mean D_{BP}, coefficient of correlation, and standard deviation, respectively.

(KATO and TAIRA, 1982). As the meteorological conditions of 1981 heavy-snowfall seemed to have been especially severe, it is assumed that the suppressed trees could not be protected by the shelter of the dominants and intermediates.

2. *Diameters and heights at broken points*

Figure 4 shows that the relationship between the diameter at the broken point (D_{BP}) and DBH in each tree of the six sample stands. The dashed line whose angle to the x co-ordinate is 45° indicates the D_{BP} which is equal to the DBH. A D_{BP} larger than DBH is not found in Figure 4. This phenomenon is attributed to the fact that the trunk just below the DBH forms the butt. The upper limit values of DBP are close to the angled dashed line in the range where DBH is less than 20 cm, but in the range larger than 20 cm, they do not increase even if the DBH increased, and a D_{BP} which surpassed 20 cm rarely were found. In the 80-year-old stand, several D_{BP} were larger than 20 cm, and the upper limit was not obvious. MATSUDA (1982) calculated the upper limit value of D_{BP} by the reciprocal regression between DBH^2H and $D_{BP}{}^2$ in the 1981 severe snow-damage, and it was 24 cm. But when the relationship between D_{BP} and DBH in Figure 4 is observed, the upper limit of D_{BP} is about 20 cm, and the D_{BP}s range from about 7 to 20 cm as shown by the horizontal dashed lines.

For each stand in Figure 4, the coefficient of correlation between D_{BP} and DBH is greater as the mean DBH becomes smaller. This is shown clearly in Figure 5. In Figure 5, as the mean DBH increases the mean D_{BP} increases gradually approaching to saturation. The mean D_{BP}s were in the range of 10 to 15 cm.

Figure 6 shows the relationship between the height at the broken point (H_{BP}) and tree height (H). In each stand, a plus correlation between H_{BP} and H (most of the coefficients of correlation

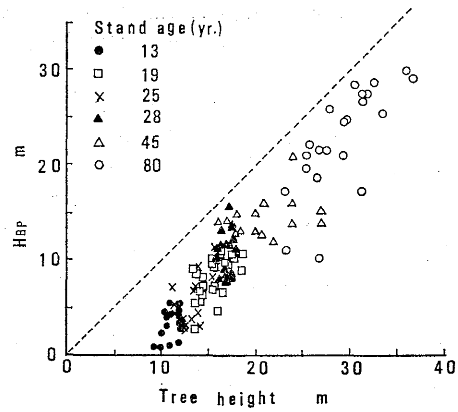

Fig. 6. Relationship between the height at the broken point (H_{BP}) and tree height (H)

Dashed line stands for tree height.

were about 0.5) is found. The correlation between them through individuals of all stands was fairly high ($r=0.93$), and a linear regression equation by the method of least equations was $H_{BP}=1.03H-7.54$. The fact that the coefficient of regression is 1 means that the length from the top of a tree to the broken point is not so different irrespective of the difference in H.

The relationships between H, H_{BP}, and the height at the crown bottom (H_{CB}) of the sample stands are shown in Figure 7. The coefficient

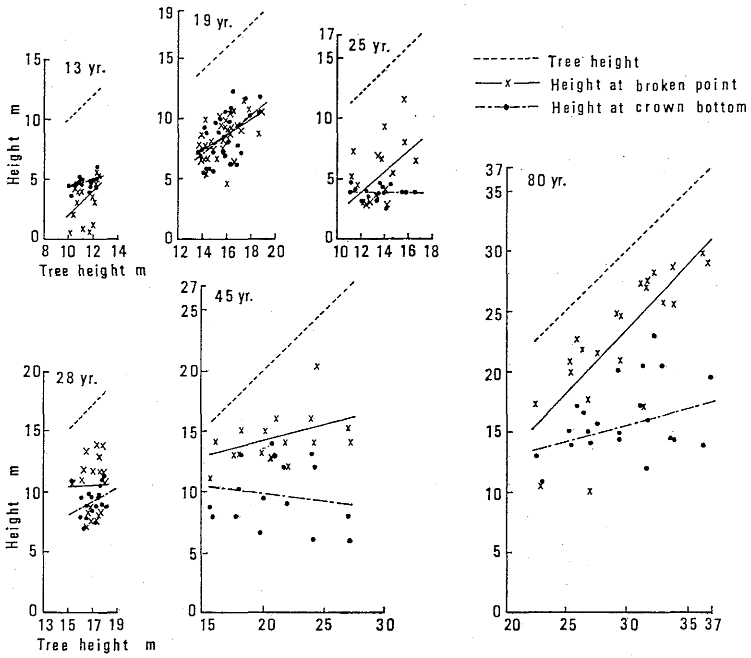

Fig. 7. Relationships between the height at the broken point (H_{BP}), height at crown bottom (H_{CB}), and tree height (H) in each stand

of regression for the relationship between H_{BP} and H was larger than that for H_{CB} and H in four stands (13, 25, 45, 80 yrs.). The coefficients of both relationships were similar in the 19-year-old stand. In the 28-year-old stand, the coefficient for H_{BP} was smaller than that for H_{CB}. However, as the range of Hs in this stand was quite small for the value of the average H, it is difficult to obtain the tendencies of the coefficients of both regressions in this stand. Therefore, the coefficient for H_{BP} and H was larger than that for H_{CB} and H in most of the stands in this study. In these stands, there was a tendency that as H decreased the H_{BP} was farther down from H_{CB} when the H_{BP} was below the H_{CB}, and as H increased, the H_{BP} was farther up from the H_{CB} when the H_{BP} was above the H_{CB}.

FUJIMORI and others (1984) analyzed the relationship between H, the height at a definite diameter of the stem ($H_D(x)$), and H_{CB} in a sugi plantation and pointed out that as H increased, $H_D(x)$ increased, although H_{CB} increased little. From this information and that obtained in this study which showed that D_{BP}s were in a definite range (Fig. 4), the phenomenon which showed that the H_{BP} increased proportionally as H increased could be explained fundamentally, and the relationship between H_{BP} and H_{CB} also could be explained.

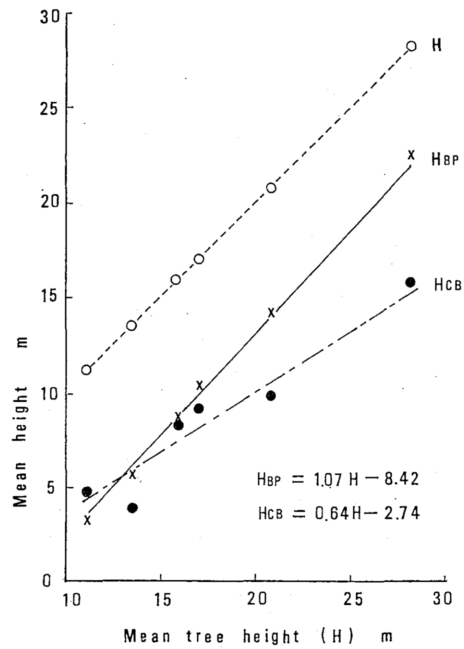

Fig. 8. Relationship between mean tree height (H), mean height at the broken point (H_{BP}), and mean height at the crown bottom (H_{CB}) of broken trees

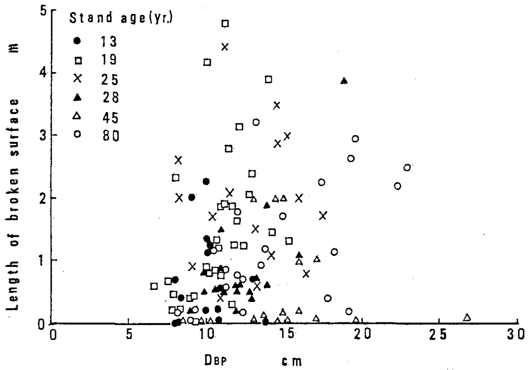

Fig. 9. Relationship between the length of the broken surface and the diameter at the broken point (D_{BP})

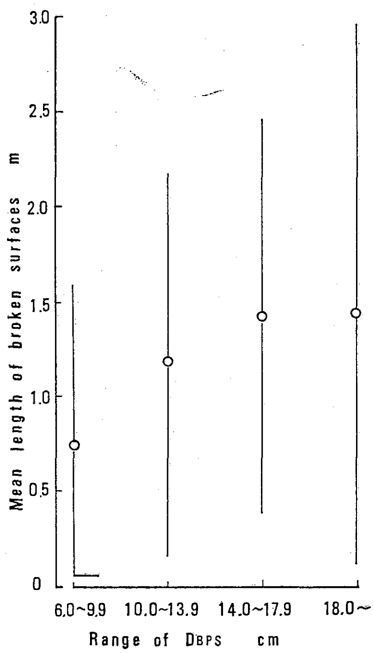

Fig. 10. Relationship between mean lengths of broken surfaces and the range of diameters at the broken points (D_{BP})

Figure 8 shows the relationship between mean H, mean H_{BP}, and mean H_{CB}. The coefficient of the regression for the relationship between mean H_{BP} and mean H was 1, and that between mean H_{CB} and mean H was much smaller than 1. Therefore, as the mean H increased the mean crown length increased, and the mean H_{BP} became relatively higher in the crown. On the other hand, as the mean H decreased the mean H_{BP} became relatively lower in the crown and moved to a position below the crown bottom.

SHIDEI (1954) reported that the positions of broken points of stems were found mainly in the middle of the crown, just below the crown, and in the butt. He assumed that the variation of it was attributable to the boundary points of different tissues and mechanically weak points. Opposing it, ISHII and others (1982 a) assumed that the position of the broken point in relation to the position of the crown bottom was explained by the phenomenon which shows that the D_{BP} would be destined to a certain range by meteorological conditions, and in a tree whose crown length was large the D_{BP} (H_{BP}) would appear in the crown and if that crown length was small it would be positioned below the H_{CB}. The results of this study proved the assumption of ISHII and others. However, this would not deny SHIDEI's insistence wholly. There is a possibility that the factors which SHIDEI assumed partially work in addition to the factors we present.

3. Lengths of broken surfaces

As shown in Figure 1, the breakage of stems usually takes place with a split from the original broken point, and the broken surface is comparatively long vertically. The difference between the highest point and the lowest point of the broken surface is reffered to as the length of the broken surface in this paper (Fig. 1). Figure 9 shows the relationship between the diameter at the broken point (D_{BP}) and the length of the broken surface. No tendency was found, and the dispersion of individuals was great, both in each stand and throughout all stands. However, a relationship was found between each range of D_{BP}s and the mean lengths of the broken surfaces, in each range of D_{BP}s (Fig. 10): namely, as D_{BP} increased the mean length of broken surfaces increased gradually approaching saturation.

V. Discussion

1. Meteorological conditions and types of damage

One of the characteristic points of the damage type of sugi forests caused by the 1981 heavy-snowfall in the Fukui area was that the proportion of bending, even in trees whose *DBH* is taken to be susceptible to bending, is small, and the proportion of breakage is tremendously great (Fig. 2). In the snow damage of sugi forests in Shimane Prefecture, in 1978, which took place under weaker meteorological conditions than those of Fukui in 1981, the proportions of bending in sugi plantations whose ages were from 14 to 25 were from about 10 percent to about 60 percent with an average of 20~30 percent (ISHII *et al.*, 1981). INOUE and KAKIHARA (1958) pointed out that in young stands the proportion of bending was comparatively high, but in our study, bending was found only in one stand out of three young stands, and the proportion of bending in that stand was only ten percent.

Around the study area where meteorological conditions conducive to snow damage often occur, stand density generally is maintained relatively low, and the yield index (Table 1) was little smaller than that of the damaged stands in Shimane Prefecture. However, the mean height : diameter (H/D) ratios of 13- and 25-year-old stands of our study were 97 and 88, respectively; these ratios are quite larger than those of the damaged stands in Shimane Prefecture (ISHII *et al.*, 1981). (This phenomenon can be attributed to site conditions of the stands in Fukui being better than those in Shimane.) Even so, in these stands of our study, bending was not found and the type of damage was only breakage. It can be said that this is attributable to the severity of the meteorological conditions.

ISHII and others (1980) assumed that the diameters at broken points (D_{BP}) were an index of the amount of snow load on the crowns, and they proposed to call this the severity of snow loads. ISHII (1982 b) estimated the values of D_{BP}s in several instances in sugi from the data of relevant reports and compared the severity of snow loads with each other. He called the D_{BP} the severity of the snow load, but we want to call it the severity of meteorological conditions because snow damage often is affected by winds too (NITTA, 1983). According to ISHII (1982 b), the mean D_{BP} of the damaged trees in various areas were from 7.2 to 18.1 cm, and the largest, 18.1 cm, was the mean value of four damaged stands (the range was 13.0~20.3 cm) measured by ISHII in the Fukui area which suffered the 1981 heavy-snowfall. The mean D_{BP} of the stands in our study was 12.6 cm (10.1~15.0 cm), much smaller than the mean value of the stands measured by ISHII. (However, 12.6 cm is larger than any other values except for those by ISHII in Fukui Prefecture.) The pattern of such difference in the Fukui area is attributed to the difference in sampling the stands in accordance with the purposes of the research.

Even for the purpose of obtaining the severity of meteorological conditions, it would be necessary to use same method as far as possible to be able to compare each data. ISHII (1982 b) also proposed that the expression of the largest D_{BP} would be more suitable as an index of the severity of meteorological conditions than would the mean values of stands. This idea seems clear, and it would be supported fundamentally. But if the value of only one tree is used, there is the possibility that it is an abnormal tree which has hidden weak points. Thus we propose that as the index of the severity of meteorological conditions, the mean value of several trees with the largest values growing throughout the stands in the area be used. Although there is no solid basis to decide on the number of trees to be chosen, the five or ten largest values would be suitable for choosing from the viewpoint of decreasing the influence of abnormal trees and of the convenience of the work.

In addition to the methodology discussed above, it is necessary to standardize on the place of measurement of D_{BP}s. In this study, we measured D_{BP} at the position closest to the highest point of the broken surface which is regarded as the original point of breakage as shown in Figure 1. ISHII and others (1982 a) mentioned that they measured D_{BP} at the position which was considered the original point of breakage. But the original point was not clearly designated by them although it would coincide with the position which we decided. The point of measurement has not been shown in any of the other reports in which the D_{BP} was measured.

2. *Silvicultural implications*

As the larger classes of trees were resistant to severe meteorological conditions (Fig. 3), thinning from below seems the desirable thinning method in areas where severe meteorological conditions conducive to snow damage often occur.

On the basis of the facts that the height at the broken point (H_{BP}) increased proportionally with increased tree height (H) (Fig. 6) and the H_{BP} occurred relatively higher in the crown as H increased (Figs. 7 and 8), it can be said that as trees become taller the damage becomes smaller. In the case of breakage in the upper part of the crown, recovery in the growth of the tree can be expected (FUTAMI and KAJITANI, 1981; OOHARA *et al.*, 1983) and when the tree is cut it will produce a high yield. On the other hand, when trees which are small suffer damage, the breakage occurs in the lower part of the crown or below the crown bottom; consequently, full recovery cannot be expected, and the utilization of the stem is difficult. Therefore, it is not desirable to use short rotations in areas where meteorological conditions conducive to snow damage often occur.

VI. Conclusions

1) Throughout all stands, from young to old, the proportion of breakage in the total damage was overwhelmingly large, and that of bending was very small. This is considered one of the characteristics of damage under the severest meteorological conditions conducive to snow damage.

2) The proportion of snow damage was small in large diameter class of trees as has been pointed out in many reports. However, the result in this study showed that the proportion of damage was larger in small diameter class as well as in the intermediate class. This also is one of the characteristics of damage under the severest meteorological conditions.

3) The diameters at broken points (D_{BP}) were in a certain range (7-20 cm), irrespective of DBH and tree height (H), throughout all stands.

4) The height at broken points (H_{BP}) was proportional to H both in each stand and throughout the stands.

5) H_{BP} had a proportional relationship to H in each stand, but the height at crown bottom (H_{CB}) had little correlation with H. Thus, there was a tendency that as trees were taller, the broken point was located farther upward from the crown bottom; as trees were shorter, the broken point was located farther downward from the crown bottom.

6) A plus correlation was found between mean H_{BP} and mean H, and it also was found between mean H_{CB} and mean H. As the coefficient of regression of the former was larger than that of the latter, the larger the mean H was, the farther upward from the mean H_{CB} was the mean H_{BP}; the smaller the mean H was, the farther downward from the mean H_{CB} was the mean H_{BP}.

7) Judging from the relationships between H, H_{BP}, and H_{CB}, the damage to forest management is smaller in taller stands or in larger trees in a stand. And in stands, there was a tendency for the proportion of damage to be small in dominant trees. On the basis of these facts, adopting long rotations and thinning from below are recommended in areas where meteorological conditions conducive to snow damage often occur.

Acknowledgement

We thank the staff of the Forestry Division of Fukui Prefecture for its help with the field work, Dr. Masaki KATSUTA, Dr. Ryuzo NITTA, and the late Mr. Masao SAEKI of the Forestry and Forest Products Research Institute, and Mr. Masaaki KUWABARA of the Forest Agency, Ministry of Agriculture, Forestry, and Fisheries, for their cooperation in starting this work.

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* In Japanese with English summary
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The titles in parentheses are tentative translations from the original Japanese titles by the authors of this paper.

(Received September 10, 1986)

学会記事

「継続研究（シリーズもの）の投稿」のしかたについて

編集理事

報文の表題は報文の顔ともいえる重要なもので，報文の内容を的確に表現していなければならないことは言うまでもありません。日本林学会誌としては基本的に著者が付した表題を尊重していますが，表題が極めて不適当な場合には審査者からその旨，意見を申し上げています。

報文表題に一連の番号を付した，いわゆるシリーズものと呼ばれる報文の形が最近，安易に用いられている傾向がありますが，それらのなかに，表題の付け方，および投稿の仕方に対して問題があるものが見受けられます。

日本林学会編集委員会では，このような投稿の可否，および表題に関する基本的事項について検討しましたので，その内容をここに紹介します。

1. 継続研究報文の表題の付け方 俗にシリーズものと呼ばれる，継続研究報文の表題は，現行執筆要領によると，主題に（Ⅰ），（Ⅱ），… を付し，副題をつけることになっています。過去に掲載されたシリーズものを見ると，①長期間にわたる継続研究，②グループで一つのテーマを多方面から追及した研究，③内容が膨大な量になる研究，の場合に用いられています。

しかし日本林学会誌では，シリーズものといえども各報文ごとに独立性を有し，内容が完結していることを建前としています。したがって報文はできるだけシリーズものとせず，それぞれ独立した表題を付すことが望まれます。

2. 継続研究報文の投稿 シリーズものでさらに問題となるのは，一連の報文が複数の学会誌にまたがって投稿される場合です。たとえば第１報はＡ誌に，第２報はＢ誌に，というように，いろいろの学会誌に掲載される場合です。このようなケースが最近非常に目立つようになりました。この場合，次のような問題点が生じます。

1) 各学会誌によって，審査基準が必ずしも同一の水準ではありません。したがって審査にあたってシリーズものの報文の価値あるいは各報文の関連性を著しく損ない，場合によって審査が不可能となることもあります。

2) 審査者は他誌に掲載された論文をも評価しなければならない場合が生じます。

以上の理由により編集委員会としては，シリーズものの報文の投稿に際して，「シリーズものとする必然性があるか否か」を今一度ご検討していただき，やむをえない場合も，必ず同一学会誌に投稿されるようお願いいたします。