CHAPTER VII

CONCLUSIONS

In this thesis, the structural properties of partially oriented flakeboard mats were mathematically investigated according to the random field theory and probability distribution. Computer simulations, robot mat formation, and X-ray scanning techniques were also used to verify the model. Through extensive review of the past research, the author believes that the contribution of this thesis to the field of wood science could be concluded as follows:

1. A mathematical model based on random field theory was developed to characterize the horizontal density distribution in partially oriented flakeboard mats. In this model, the flake position was considered to be random because there is no intention to control it in commercial products. The orientation angle of the flakes was assumed to follow either the Von Mises distribution function characterized by concentration factor k or the uniform distribution function within a range of angle $\pm q$ ($0 \leq q \leq 90$). Under this assumption, the autocorrelation function and variance function of the horizontal density distribution were investigated at different values of k and q. Results indicate that when the concentration parameter k is greater than 700 in the Von Mises distribution, the orientation of all flakes can be regarded as parallel to each other, which is equivalent to the case when all the flakes have the same orientation angles in the uniform distribution. The upper and lower limits of the autocorrelation functions and variance functions for any given value of k and range of angle q can be identified as the perfectly oriented and

completely randomized cases, respectively.

2. The characteristic area concept from random field theory was first introduced to evaluate the degree of orientation of the flakes in a mat according to its autocorrelation function. For known flake geometry, the maximum characteristic area is roughly equal to the flake length squared and the minimum characteristic area to be equal to the area of the flake, which also correspond to the perfectly oriented and completely randomized flake orientations, respectively. The predicted and simulated degree of orientation agrees well based on the characteristic area concept, but differ slightly from the degree of alignment as defined by Geimer (1976).

3. The estimation of the degree of orientation for commercial panels could be a tedious task if the orientation of each flake needs to be measured. The model developed here allows estimating the degree of orientation non-destructively if the autocorrelation function and its characteristic area could be evaluated from the horizontal density distribution. For this reason, a non-destructive method, X-ray scanning technique, was used to extract the density profiles from flakeboard mats. A model that calibrates and maps X-ray voltage levels to overlaps and/or density was presented and discussed. The density and/or overlap were found to be a logarithm function of the X-ray intensity ratio (I_0/I: the intensity of the incident radiation to the intensity of radiation at location (x, y) in a mat).

4. Wood composites may suffer from two kinds of swellings in two different application stages: the swelling due to absorbing moisture in normal application conditions, and the swelling due to absorbing water during exposure to severe climate (e.g., direct exposure to rain water during construction). A study on the relationships between thickness

swelling and mat structures in robot-formed flakeboard mats was conducted under 95% and 90% relative humidity conditions and 24-hour water soaking tests. A model was established such that the thickness swelling of a flakeboard mat can be predicted, provided that the amount of moisture absorbed and the density distribution of the mat are known. The thickness swelling is also horizontally distributed due to the horizontal distribution of density and the amount of moisture absorbed in a particular location. Further studies are needed to determine the relationship between the thickness swelling and the amount of water absorbed in soaking tests because the water absorption is less predictable than the moisture absorption due to the sample becoming saturated in a relatively short period of time.

5. A simulation program ***Winmat***©, based on the Monte Carlo technique, was written to compute all the statistics discussed in the thesis. The inputs to the program are: the simulated mat geometry, target mat density, the distribution of flake geometry, flake density and the distribution of the flake orientation angles. The output from the program includes: the horizontal distribution of overlap and density, free flake length and its distribution, number of flake crossings, the location and distribution of void sizes, the autocorrelation function, variance function and the degree of orientation of flakes in a mat. The simulation program can also determine the effect of sampling zone size on the density/overlap distribution. Similar analysis could also be performed on experimentally designed and robot-formed mats.